UNIVERSITY OF
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Exploring the impact and effectiveness of prescribing error feedback in an acute hospital setting

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy

By

Michael Lloyd
June 2017

I declare that this thesis is the result of my own work and the material contained in it has not been presented, wholly or in part, for any other degree or qualification.

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Michael Lloyd

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List of abbreviations used in this thesis

φ	Phi (effect size of chi-squared test)
χ2	Chi-squared test
95%CI	95% Confidence Interval
A&E	Accident and Emergency Department
ACE	Angiotensin Converting Enzyme
ADE's	Adverse Drug Events
ADR	Adverse Drug Reaction
AfC	Agenda for Change
Bd	Twice daily
BNF	British National Formulary
CDSS	Clinical Decision Support Software
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CIT	Critical Incident Theory
CPOE	Computerised Physician Order Entry
CQC	Care Quality Commission
CMT	Core Medical Trainee doctor
CT	Core Training doctor
d	Cohens D (effect size of t-test)
df	Degrees of freedom
DOH	Department of Health
eGFR	estimated Glomerular Filtration Rate
EP	Electronic Prescribing
FY1	Foundation Year 1 trainee doctor
FY2	Foundation Year 2 trainee doctor
EPMA	Electronic Prescribing and Medicines Administration
GFR	Glomerular Filtration Rate
GMC	General Medical Council
GP	General Practitioner
GPhC	General Pharmaceutical Council
GPST	Specialist GP training doctor
H_A	Alternate hypothesis
H_0	Null hypothesis

H_1	Hypotheses 1-4
HO	House Officer
IOM	Institute of Medicine
IQR	Interquartile Range
KBE	Knowledge Based Error
KBM	Knowledge Based Mistake
MA	Master of Arts degree
ME	Medication Error
MPharm	Master of Pharmacy degree
NHS	National Health Service
NMP	Non-Medical Prescriber
NSAID	Non-Steroidal Anti-Inflammatory
NPSA	National Patient Safety Agency
NICE	National Institute for Health and Care Excellence
Od	Once daily
p	P-value
PE	Prescribing Error
PEs	Prescribing Errors
r	Pearson correlation coefficient
RBE	Rule Based Error
Reg	Specialist registrar grade doctor
RPSGB	Royal Pharmaceutical Society of Great Britain
SAS	Specialty and Associate Specialist grade doctor
SD	Standard Deviation
SEM	Standard Error of the Mean
SHO	Senior House Officer
SpR	Specialist Registrar
SPSS	Statistical Package for the Social Sciences
ST	Specialty Training doctor
STHKH	St Helens and Knowsley Hospitals NHS Trust
t	t value in a t-test
TTA	To Take Away (discharge prescription)
TTO	To Take Out (discharge prescription)
UK	United Kingdom

US   United States

Publications and conference abstracts

Publications

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Submitted manuscripts

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Manuscripts in preparation

Lloyd M, Watmough SD, O'Brien SV, Furlong N, Hardy K. Exploring the impact of constructive feedback on prescribing errors in an acute hospital setting

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Awards

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Finalist Patient Safety Awards 2017: Lloyd M, Watmough SD, O'Brien SV, Hardy K, Furlong N. Attitudes to and effectiveness of prescribing error feedback in an acute hospital setting. Winner to be announced 4th July, Manchester.

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Abstract

Exploring the impact and effectiveness of prescribing error feedback in an acute hospital setting

Michael Lloyd

Background

Prescribing errors (PEs) are prevalent and a prominent cause of patient safety incidents. Feedback has the potential to improve prescribing with pharmacists potential facilitators of PE feedback. However, evidence supporting PE feedback in a hospital setting is limited.

Aims

The aims of this thesis were to explore the effectiveness and impact of feedback on prescribing, prescribing behaviour, and the feedback participants: prescribers and pharmacists.

Methods

A mixed methodology was adopted. Focus groups were used to explore pharmacist experiences of delivering PE feedback prior to the intervention. A pilot study was then undertaken with prescribers on two wards receiving constructive PE feedback, and two wards continuing with existing practice. Prescribing was audited over a five-day period before delivery of PE feedback verbally, and in writing. Prescribing was re-audited after 3-months. A larger controlled study across 16 wards was then repeated. Change in PE rates were compared between groups.

Semi-structured interviews were used to explore prescriber's and pharmacist's experiences of receiving and delivering feedback and the impact on prescribing behaviour. All interviews and focus groups were analysed thematically using a framework approach.

Results

Twenty-four pharmacists were recruited to one of four focus groups. Prior to the intervention, PE feedback was delivered inconsistently. Ward-based pharmacists were considered suitable facilitators of PE feedback, but expressed concern that the process may adversely affect prescriber-pharmacist relationships.

Ten and eleven prescribers were included in the pilot intervention and control groups. There was a mean reduction in overall PE rates of 11.5% in the intervention group and an increase of 5.9% in the control group, a significant change in PE rates of 17.4% ($p < 0.05$) between groups.

Thirty-six and forty-one prescribers were included in the intervention, and control groups for the larger cohort study. PE rates reduced by 18.3% in the intervention group and increased by 5.4% in the control group, a significant change in PE rates of 23.7% ($p<0.05$) between groups.

Eighteen pharmacists and ten prescribers were interviewed to explore their experiences of the intervention. Feedback was valued, considered sustainable, and pharmacist's credible facilitators. Increased information and feedback-seeking behaviours were noted from prescribers with raised discretionary efforts and prioritisation of prescribing tasks. Feedback is an educational process benefiting both facilitator and recipient. Enhanced rapport was noted with pharmacists also reporting improved self-worth and self-efficacy.

Thirty-eight interviews were conducted with twenty-three prescribers to explore the impact of feedback on prescribing behaviour. Feedback is an educational process but benefits extend beyond knowledge-based improvements, with a range of adaptive prescribing behaviours reported. These included more mindful prescribing and engagement with prescribing tasks. Feedback facilitates reflection, increases self-awareness and informs self-regulation of prescribing behaviour. Prescribers reported greater situational and error awareness and improvements in their prescribing.

Conclusions

PE feedback is valued, considered sustainable and positively influences prescribing. However, it is a complex intervention with potential benefits extending beyond PE reduction with pharmacists working less in parallel, and more integrated within clinical teams. Feedback supports prescribing practice with changes in prescriber behaviour resonating with non-technical prescribing skills. Feedback can develop the situational-awareness for prescribers to reflect-in-action and adapt their behaviour to the clinical environment. Contextualised inter-professional and non-technical skills training could enhance prescribing education further.

Chapter 1. Introduction and Background

1.1. Chapter Introduction

This thesis explores the impact and effectiveness of feedback on prescribing. Prescribing and feedback both involve people and the impact of feedback on prescribers and the facilitators of feedback, pharmacists, will also be explored. In this chapter, the background and motivation for this research will be described before exploring key terms and concepts used throughout this thesis. The chapter will then progress to provide an overview of prescribing error (PE) causation and outlining the scale of prescribing errors (PEs) in hospital settings.

1.2. Overview and context of this research

PEs are a prevalent and prominent cause of medication safety incidents in the United Kingdom (UK) (Ross *et al.* 2009) with reductions in these incidents a national priority (Vincent *et al.* 2009). This research takes place in St. Helens and Knowsley Hospitals (STHKH) which is an 800 bed, acute hospital in the North West of England. Patient safety is a key priority of the organisation who are fully committed to reducing avoidable harm in line with national recommendations (Vincent *et al.* 2009, Department of Health (DOH 2000)). At commencement of this research, the organisation employed 33 pharmacists, and several hundred prescribers of various grades.

The author has an interest and investment in prescribing and PEs as a clinical pharmacist with twelve years' experience, following involvement in large PE studies (Dornan *et. al* 2009, Seden *et al.* 2013), and facilitation of local PE audits. An interest in prescribing pedagogy kindled this interest further and was supported by a formative role as a specialist medical education pharmacist for seven years. This role informed what PE reduction strategies were in place, and that further interventions were necessary to improve prescribing.

This catalysed the inception of a qualitative study that was undertaken as part of a Master of Arts (MA) in clinical education. The research explored the attitudes and opinions of junior doctors to receiving prescribing feedback (Lloyd 2014). Despite local audits suggesting PE rates of 20-42% (Lloyd 2013), prescribers struggled to recall a PE they had made but acknowledged that pharmacists frequently asked them to amend prescriptions. Prescribers reported that they did not receive feedback on their prescribing, but that it would be welcomed to support their professional development, and improve patient safety.

This preliminary research was followed by a proposal to pursue this line of enquiry further with formalized pharmacist-led PE feedback delivered to prescribers. The project received executive level support and funding that has allowed the author to undertake the research reported in this thesis.

1.2.1. Aims and Objectives

The overall aim of the research in this thesis is to explore the effectiveness and impact of PE feedback.

Specific research objectives include to explore and investigate:

1. The impact of pharmacist-led feedback on prescribing error rates.

2. The views, attitudes and impact on prescribers of receiving prescribing error feedback.

3. The views, attitudes and impact on pharmacists of delivering prescribing error feedback.

4. The impact of feedback on prescriber behaviour.

The overall research hypothesis is that a programme of pharmacist-led PE feedback will improve prescribing. Research questions and hypotheses will be revisited in chapter 3 and relevant results chapters.

Some of the key definitions and terms used throughout this thesis will now be explored.

1.3. Medication errors and prescribing errors

There is a heterogeneity in PE definitions within the literature (Franklin 2005, Tully 2012) and so it important that these terms are considered and defined from the outset.

1.3.1. Error

Generically, an error can be defined as a 'mistake' or 'the state of being wrong in conduct or judgement', or at the technical level; 'the degree of inaccuracy in calculation' (Oxford Dictionary 2016). Other definitions are used such as "a failure to complete a planned action as intended, or the use of an incorrect plan of action to achieve a given aim" (Kohn *et al.* 1999). Reason (1990) in his seminal work on error causation, described an error as 'the failure of a planned sequence of mental or physical activities to achieve its intended outcome when failures cannot be attributed to chance.' Reason's definition excludes chance as a causative factor, that is, errors are preventable events, an important consideration when discussing errors and patient safety.

1.3.2. Medication

There are a multitude of medications used for the prevention and treatment of disease. Healthcare is increasingly complex with patients prescribed larger numbers of medications. A recent Scottish study suggested 22% of the population are taking five or more medications, and 5.8% are taking ten or more medications (Guthrie and Makubate 2012). A medication has been described as 'a product that contains a compound with proven biological effects, plus excipients, or excipients only; it may also contain contaminants; the active compound is usually a drug or prodrug, but may be a cellular element' (Aronson and Ferner 2005). For the purpose of this research, a

medication is any prescribed medication in the hospital setting. Considering these two terms now allows us to consider what a medication error (ME) is.

1.3.3. Medication error

The DOH (2001) define a ME as;

 "…any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of a health professional, patient or consumer."

A more recent and simple definition is provided by Aronson (2009a) who defines a ME as;

"a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient".

Here, the use of the term 'failure' clearly focuses on harm and signifies that the process has fallen below some attainable standard (Aronson 2009a), the standard being governed by local medicines policies (STHKH 2014) and national prescribing guidance stipulated by the General Medical Council (GMC) who are the regulatory body for UK doctors. The 'treatment process' includes treatment for symptoms, their causes, investigation, prevention of disease or physiological changes.   The definition does not specify who makes the error – it could be a doctor, a nurse, a pharmacist, a carer or another individual involved in the medication use cycle (figure 1). It should also be noted that this definition is more reflective of MEs in general:- not all errors reach or indeed harm the patient as they are intercepted before they reach the patient with Leape *et al.* (1995) reporting that pharmacists and nurses intercept 70% of all medication errors whilst elsewhere, others report that around 10% of errors result in patient harm (Moyen *et al.* 2008) in one setting. Considering this, 'near miss' errors (An error that does not cause harm but has the potential to do so) (NPSA 2007) are an important consideration and component of PEs through their 'potential' to cause harm.

Figure 1: The medication use cycle (National Patient Safety Agency (NPSA) 2007)

Prescribing

Monitoring

Dispensing/
preparation

Administration

1.3.4. Prescription

A prescription is defined as "a written order, which includes detailed instructions of what medicine should be given to whom, in what formulation, and dose, by what route, when, how frequently and for how long" (Aronson 2006). Prescriptions are written by prescribers who are typically doctors but can also be non-medical prescribers.

1.3.5. Prescribing

The prescription is the final product of the prescribing process. Prescribing is the first stage of the medication use cycle (figure 1) and is a process whereby a doctor or other registered prescriber authorises the use of medications for a patient, instructing how and when those medications should be used to help optimise their care. This process consists of two distinct phases; an initial decision making process to decide what drug, dose and route to prescribe, followed by the technical process of completing the prescription with clear and complete instructions (Lesar *et al.* 1997a). Technical errors are easier to identify in practice with some authors (Calligaris *et al.* 2009) focusing on this definition although these studies may

under report PEs as a result. Hence, both stages are capable of introducing PEs and should be considered in any PE definition.

1.3.6. Prescribing error

A general definition of a PE has been proposed (Dean *et al.* 2000) as:

"A clinically meaningful prescribing error occurs when, as a result of a prescribing decision or prescription writing process, there is an unintentional significant (1) reduction in the probability of treatment being timely and effective or (2) increase in the risk of harm when compared with generally accepted practice"

This definition covers both the decision making process and technical aspects of prescribing and has been widely used in PE studies in the UK (Dean and Schater *et al.* 2002, Tully and Buchan 2009, Franklin and Birch *et al.* 2009, Caruba *et al.* 2010, Franklin *et al.* 2011, Ryan *et al.* 2014). The definition was developed by the Delphi process (Jones and Hunter 1995), a consensus process that elicits views of experts that consisted of nurses, pharmacists and prescribers. The expert panel individually agreed or disagreed with a series of questionnaire statements that were then summarised before repeating the questionnaire following review of the group's responses.

As the process involved prescribers, the authors suggested this makes the definition valid and acceptable to prescribers (Dornan *et al.* 2009). However, this definition focuses on the clinical impact of the PE, ruling out PEs that do not result in harm (Aronson 2009a) such as failure to comply with national guidelines, trust formularies and product licenses for example (Dean *et al.* 2000). Equally, and perhaps more importantly, it ignores the fact that PEs that are not clinically meaningful, can still have considerable impacts on those involved with the medication use cycle. For example, incorrect completion of a controlled drug prescription at discharge is unlikely to cause harm or delay treatment, but it can delay processing of the prescription.

Indirectly, the need to correct and amend the PEs can have cost implications, create inefficiencies in the system and distractions that could become error inducing conditions themselves. Equally, non-compliance to guidelines could create rule-based errors whilst non-adherence to trust formularies could increase the risk of memory failures; all latent error inducing conditions that could result in patient harm. Finally, "generally accepted practice" is too vague and prescribing should be compared to local and national standards including medicines policies, national guidelines and formularies. Perhaps these confounding issues influence the choice of researchers to develop their own definitions, with one systematic review (Lewis *et al.* 2009) reporting 42% of researchers modifying existing, or creating their own, definitions of a PE.

As Aronson (2009a) argues, an error "indicates a weakness in the system, which might on a future occasion lead to an error of clinical relevance". Put more simply, a clinically non-meaningful error may become meaningful in a different context with a different medication at a different time. Aronson (2009a) attempts to simplify the PE definition by proposing that a PE is;

"a failure in the prescription writing process that results in a wrong instruction about one or more of the normal features of a prescription'.

This definition allows scope for pharmacists to record all prescriptions that require intervention, irrespective of clinical significance at the decision making or technical stage.

In this study, any prescription that does not comply with the standards outlined in the hospital medicines policy will be classed as a prescribing error. That is, any prescription that requires a pharmacist intervention to make it complete or safe, including both technical and clinically relevant interventions, will be included.

1.3.7. Prescribers

A prescriber is an appropriately qualified healthcare professional who prescribes a medication for a patient. These are typically doctors although non-medical prescribers (NMPs) undertake some prescribing duties. In the hospital setting, independent NMPs could include nurses or pharmacists who would prescribe medications for medical conditions that they are familiar with.

Doctors in the UK typically study undergraduate medicine for five years although there is a shorter four-year degree available to postgraduate trainees. Following completion of their degree, doctors undertake 12 months of training as a foundation year one doctor (FY1) after which they can register with the General Medical Council (GMC) before completing the second year of their foundation training as a foundation year two (FY2) trainee. For those doctors pursuing a career in hospital they can follow a Core Training (CT) or specialist training (ST) programme in medicine or surgery. This training involves completion of further assessments and typically last for 8-10 years before they qualify as a consultant physician. Experience or stage of their training is denoted by a numerical suffix i.e. CT1 / ST1 is a first year core or specialist training doctor. Specialist registrars (SpRs) are senior specialist training grade doctors although this term is being phased out. Staff grade doctors or Specialty and Associate Specialist (SAS) doctors are typically non-training roles with at least four years of postgraduate training, including two years of specialist or core training.

Doctors pursuing a career in general practice (GP) follow a similar pathway as a specialist GP (GPST) trainee over a typical 3 year period (GPST1-3) before qualifying as a General Practitioner.

Although the literature reports that foundation trainees undertake the majority of prescribing (Dornan *et al.* 2009, Ryan *et al.* 2013, Ross *et al.* 2013a), audit work by the author suggests that junior CT (CT1-2) grade doctors are equally prolific with their prescribing (Lloyd 2013).

Table 1: Overview of doctor grades in a hospital setting

Grade	Description
FY1	1st year foundation trainee. Not yet registered with the GMC.
FY2	2nd year foundation trainee registered with the GMC.
CT1-2	Core medical training doctor
ST1-7	Specialty training trainee
SpR	Specialist registrar
Staff Grade / SAS grade	Non-training / Specialty and Associate Specialist grade doctor
Consultant	Completed postgraduate training in hospital
GPST1-3	Specialist GP trainee undertaking clinical placements in hospital practice

1.3.8. Pharmacists

Pharmacists in the UK typically study pharmacy for four years to gain an MPharm degree in a UK University accredited by the General Pharmaceutical Council (GPhC). This is proceeded by a 12-month pre-registration period that is typically completed in either community pharmacy or hospital pharmacy. A small number of trainees undertake 6 months in the industrial or community sector and 6 months in hospital. Following this training period, eligible trainees have to pass a registration entrance examination to register with the GPhC, the independent regulator of pharmacists in the UK. The majority of the workforce typically work in community pharmacy with increasing numbers of pharmacists working within Clinical Commissioning Groups (CCGs) in the primary care sector. Within hospital, pharmacists are graded (See table 2) according to the agenda for change (AfC) system. A junior or rotational grade pharmacist commences as

a band 6 before undertaking a further 2-years of postgraduate training in clinical pharmacy. Band 7 pharmacists have usually completed their postgraduate training and are typically specialist pharmacists or have extended work-based rotations for further experience. Band 8a pharmacists are advanced pharmacists working within a given specialty, usually with at least five years postgraduate experience. Band 8b-c are highly specialist pharmacists with significant managerial responsibilities and usually at least ten years of experience. The head of a hospital pharmacy is typically a band 8d or 9 with at least ten years' experience in hospital pharmacy.

Table 2: Overview of Pharmacist grades in a hospital setting

Grade	Description
Band 6	Newly qualified or junior pharmacist typically undertaking postgraduate clinical training. Registered with the GPhC.
Band 7	Typically completed or about to complete postgraduate clinical training.
Band 8a	Specialist pharmacist employed to focus on a specific area of interest.
Band 8b	Advanced specialist pharmacist with managerial commitments
Band 8c	Typically deputy heads of department with significant managerial commitments
Band 8d	Typically a chief pharmacist post
Band 9	Chief pharmacist / Director of pharmacy

In this research, all pharmacists are hospital based. Ward-based pharmacists perform medicines reconciliation and supply non-stock items as part of their routine responsibilities. They will also review medication charts for clarity, completeness and appropriateness and, where discrepancies or errors are identified, resolve them with a prescriber although this may not be the original prescriber. Pharmacists can also participate in ward rounds, educational sessions and team meetings with doctors although this is not routine practice. Discharge prescriptions are also checked and authorized by pharmacists although this may be completed remotely in dispensary for example.

1.4. Error causation

Errors occur at any stage of the medication use cycle from prescription initiation through to transcription, ordering, dispensing, administering and monitoring processes (Aronson 2009b). However, prescribing errors (PEs) are a substantial problem (Barber *et al.* 2003) and predominate (70% of all ME's) (Velo *et al.* 2009). Equally, PEs are more likely to cause harm (Bates 1995, Leape *et al.* 1995) or at the least, create inefficiencies in the care system through the need to contact prescribers to clarify or amend prescriptions, resulting in unnecessary delays to, or omissions of, treatment.

The healthcare system is a complex working environment and humans are prone to making errors, nobody is infallible (Ferner 2012, Leape 1997, Reason 1990) with the inevitability of human error argued by psychologists (McDowell *et al.* 2009, Reason 1990). PE causation is complex and varied with multiple points of error possible throughout the prescribing journey. Recognition of human error in healthcare industries is well documented. In the seminal institute of medicines (IOM 1999) report "To err is human", complexity of healthcare and use of technologies were highlighted as contributing factors to human error.

One of the most widely used taxonomies in the literature for defining error causation, including PEs, is James Reason's "Swiss Cheese" model

(Reason 1990). Within this model (see figure 2), an error is considered to be 'a failure to achieve the intended outcome of a planned series of actions, when the failure is not due to chance'.   Reason (1990), a British Psychologist, devised a now well recognized and established taxonomy of human error from observation of other high risk industries such as aviation, nuclear power, petro-chemical and military sectors (Flin *et al.* 2008). Analyses of accidents in these sectors revealed that 80% of errors were attributable to human factors (Reason 1990). Reason proposed a "Swiss Cheese" model of error causation in complex systems (figure 2) with available defensive mechanisms represented by the layers of cheese and error causation by the holes.

Figure 2: James Reason's Swiss Cheese Model of error causation (Reason 2000)
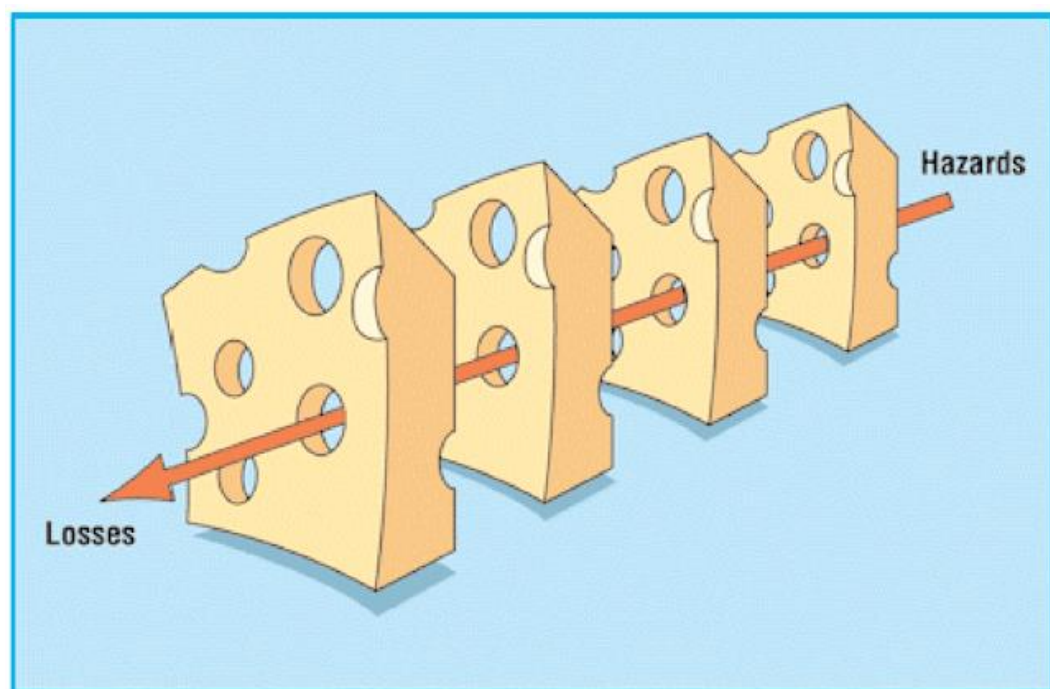
With enough layers, or without superfluous holes in the cheese, the risk of an error reaching the patient should be negligible. However, humans are not infallible and the real world is more dynamic than a stationary piece of cheese; the size, shape, location and distribution of the holes (or gaps in the

defensive process) will be changing fluidly with the working environment and the individuals involved in the process. Where these holes, or errors align, an error can occur and patient care compromised. The risk of PE propagation is thus part of a chain of events (See figure 3) of latent conditions, error provoking conditions, active failures and inadequate defenses where knowledge and understanding of the risks is paramount to implementing effective barriers to harm.

Figure 3: Incident analysis framework (from Dornan *et al.* 2009, Coombes *et al.* 2008 based on Reason 1995)

Latent conditions
Organisational processes- workload, handwritten prescriptions
Management decisions- staffing levels, culture of lack of support for junior staff

Error-producing conditions
Environmental – busy ward
Team- lack of supervision
Task- poor medication chart design
Patient- complex, communication difficulties

Active failures
Slip, lapse, rule-based mistake, knowledge-based mistake

Defences
Inadequate, unavailable, missing

In order to correct and prevent errors, it is important to understand where and why errors are occurring in the prescribing process. Is it the decision making or technical aspects or both? Fundamentally, psychologists (Reason 1995) differentiate errors according to broad groups, execution and planning failures (see figure 4).

With execution failures, the intentions and plan are correct but are not

executed correctly, deviating from prescriber intentions for example. These are commonly referred to as 'slips' or 'lapses' and occur during automatic or routine tasks such as prescribing a common medication that the prescriber clearly knows and understands. Given time to review their prescribing, prescribers would typically identify such errors (Lewis *et al.* 2014). Conversely, planning failures are considered 'mistakes' and may be executed correctly but the plan is inadequate with the failure originating from a higher process of planning, judging, formulating and solving (Reason 1995). Hence, such mistakes are less likely to be recognized by prescribers and pose greater risks to patient safety (Lewis *et al.* 2014) where an external source is required to highlight the mistake.

Figure 4: Execution and planning failures (from Reason 1995)
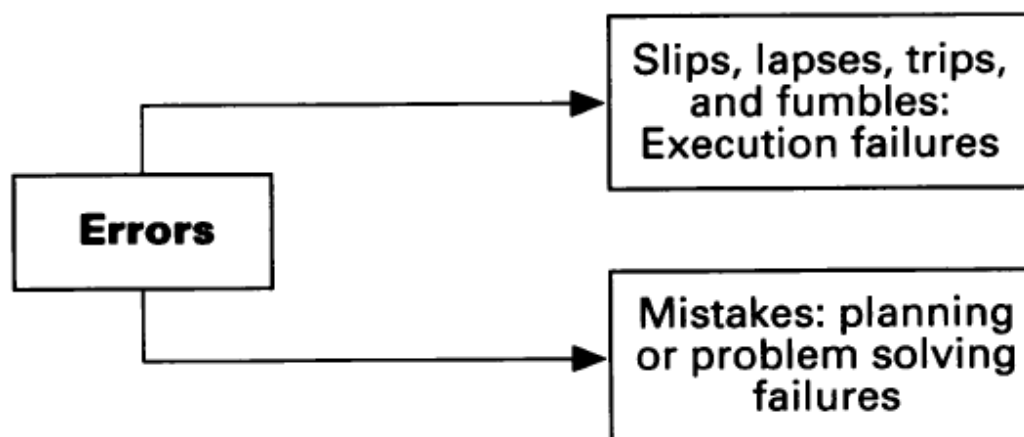
Reason (1995) advocates a systems approach to error, considering both active failures and latent conditions. This approach avoids individual blame and weakness but rather focuses on the environment and conditions that the individual works within to improve system wide defenses (Reason 2000).

1.4.1. Active failures

As discussed, this psychological approach to error causation proposes two main types of error, mistakes and failures of skills. These are further divided into four distinct classifications; knowledge and rule based errors (planning

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mistakes), and action and memory based errors (Execution failures) respectively (figure 5).

Figure 5: Error classification system based on a psychological approach (Aronson 2009b)
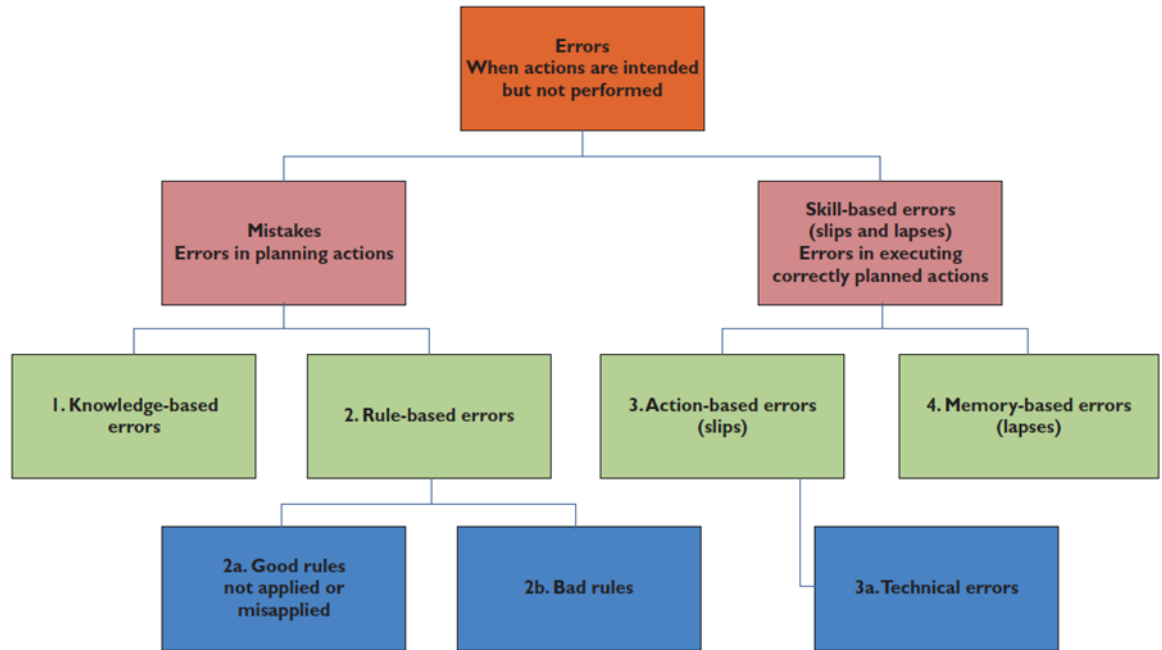
Active failures are unsafe acts (Moyen *et al.* 2008, Reason 1990) that can present as slips, lapses or mistakes. Examples of such PEs can be seen in table 3 below. Human performance has been described (Rasmussen and Jensen 1974, Carayon 2012) according to skill-based, rule-based or knowledge-based behaviours and can be considered under two main types of error; mistakes and skill-based errors (Figure 5). This systems approach has been widely adopted in the literature to describe, classify and understand both PEs and MEs in general (Keers *et al.* 2015, Lewis *et al.* 2014, Ross *et al.* 2013a, Ajemigbitse *et al.* 2013, Ferner 2012, Dornan *et al.* 2009, Velo and Muniz 2009, Aronson 2009b, Williams 2007). Slips and lapses are considered unintended actions whilst mistakes and violations (see later) are considered intentional actions (Reason 1995).

Table 3: Example prescribing errors and their error causation using the systems approach (Reason 1990)

Error Causation	Example of PE
Knowledge based mistake	1. Prescribing tramadol without controlled drug requirements because you are unaware it is a controlled drug
	2. Starting a patient on 100mcg/hour fentanyl patch because of lack of knowledge of potency of fentanyl
Rule based mistake	1. Prescribing an adult dose to a paediatric patient
	2. Prescribing full dose acyclovir to a patient with reduced renal function
Slip	1. 50mg of morphine prescribed IV instead of 5mg
	2. Selecting three times a day instead of twice a day from a drop down menu on electronic prescribing systems
Lapse	1. Renal function improves but dose reduced medications are not increased
	2. Forgetting a patient is penicillin allergic and prescribing them a penicillin
Violation	1. Abbreviating isosorbide mononitrate as ISMN to save time
	2. Not checking all prescription charts leading to duplication of a medication or drug interaction
Latent Error	1. e-prescribing system allows selection of drug based on no minimum letter combinations resulting in LANsoprazole 15mg od prescribed instead of oLANzapine 15mg od or AZathioprine 250mg od instead of AZithromycin 250mg od
	2. Lack of feedback on prescribing so doctors are unaware of their PEs

Reason (1990) defines a 'slip' as a failure to execute an action correctly due to a routine behaviour being misdirected. For example, prescribing the incorrect units of a medication, miscalculating a dosage or prescribing a medication for the wrong patient.

A lapse is defined as a failure to execute an action due to memory failure and a routine behaviour being omitted. For example, forgetting to restart a patient's withheld medication when their renal function improves, or failing to put a review date on a course of antibiotics leading to inappropriately long treatment. Slips and lapses are unintended skill-based errors (see figure 5) where routine behaviours are either omitted or performed inappropriately (Reason 1990).

A mistake is an intended action or error in the planning process and can be either a knowledge based error (KBE) or rule-based error (RBE). For example, an angiotensin converting enzyme (ACE) inhibitor is prescribed to a patient with known renal artery stenosis because they either do not know the patient has renal artery stenosis or they are unaware of the contraindication. A RBE could be the misapplication that all penicillins end in "illin", for example Dornan *et al.* (2009) report an example where timentin [brand name for ticarcillin] is prescribed to a patient who is penicillin allergic. Lewis *et al.* (2014) differentiated the causation between KBEs and RBEs in the doctors interviewed in their study, was one of 'consciously incompetent' and 'unconsciously incompetent'.

Where prescribers intentionally deviate from best practice, this type of error is called a violation and can be a routine violation to save time, a situational violation where rules are difficult to follow or an optimizing violation to demonstrate skill (Dornan *et al.* 2009, Parker and Lawton 2006:31-40). Such violations have been reported in the literature (Ajemigbtse *et al.* 2013, Tully *et al.* 2009, Dornan *et al.* 2009, Dean *et al.* 2002) although less frequently than slips and lapses for example and include abbreviated drug names, not checking a medical student's transcription or omitting information that they

knew should be included.

1.4.2. Latent Conditions

In other industries, 80% of errors have been attributable to human factors and active failures (Reason 1990). However, error causation is not entirely due to active failures. The impact of the system, organization, policies and procedures can all create 'holes' in the system or layer of cheese and influence active failures. Moyen *et al* (2008) describe this quite adroitly by referring to these latent conditions as 'pathogens'.

For example, a consultant may prescribe 50mg of morphine intravenously instead of 5mg, a clear slip. They know the standard dose of morphine and have prescribed it routinely for a long time, but distractions, and absence of a junior doctor on the ward round meant they had to prescribe themselves in addition to all of their other responsibilities leading to the PE. Ross *et al.* (2013a) have recently reported on the causes of PEs in junior doctors with time pressures and workload a recurrent work environment theme.

Characteristics of the clinical environment, prescribing culture, workload, time, staffing levels and skills mix, available support, hierarchical influences and technologies all have an important impact on active failures. These conditions influence prescribing outcomes and equally need to be addressed to improve patient safety (Dornan *et al.* 2009, Tully *et al.* 2009).

In their systematic review, Tully *et al.* (2009) reported latent conditions influencing PEs including, and most pertinent to this thesis, low self-awareness of PEs (Dean *et al.* 2002) and lack of feedback on PEs (Lesar *et al.* 1997a).

Latent failures also include error-provoking conditions (Reason 2000) relating to the task and environment. These have been categorized as the individual (prescriber), the work environment, the healthcare team, prescribing task and patient factors (Tully *et al.* 2009). These factors may not directly cause error

but they can strongly influence situations, leading to stress, fatigue and confusion that in turn diverts prescriber attention, lowering the threshold for active failures. As the term 'latent' suggests, these conditions can lie dormant for a long period (Reason 2000) until they combine with active failures and local factors to create a PE.   Examples of error-provoking conditions are provided in table 4 below.

Table 4: Example error provoking conditions

Condition	Example
Individual prescriber	1. Limited training in prescribing / lack of knowledge
	2. Lack of experience (i.e. a junior doctor or new rotation)
Work environment	1. Lack of access to relevant resources
	2. Workload and time pressures (i.e. to process prescriptions but also less time to check your prescription also)
Healthcare team	1. Poor communication from senior team members on prescribing decisions
	2. Prescribing for an unfamiliar patient increasing the risk of knowledge based errors
Prescribing task	1. Polypharmacy (Multiple medications to prescribe) increases the risk of an error
	2. Unfamiliar prescription chart resulting in mistakes, omissions or discrepancies
Patient factors	1. Complex patient with multiple morbidities so increased chance of a contraindication or inappropriate dose for example
	2. Ward areas for example paediatrics or intensive care settings

1.5. Prescribing error causation

PE causation is complex and multi-factorial with no single error invoking condition. An Australian study (Coombes *et al.* 2008) reported a median of four different error influencing factors per incident. A 2009 systematic review (Tully *et al.* 2009) reported that knowledge based mistakes (especially lack of drug or patient knowledge), slips, and lapses in memory were all common causes of PEs and reported on the error provoking conditions and latent errors that influenced error causation.

Recently, Ross *et al.* (2013a) interviewed 40 junior doctors and reported that the most common PEs were slips (30%) or mistakes (18%) with multiple error provoking conditions reported. Doctors interviewed also reported expecting pharmacists to intercept their PEs and suggested a lower task priority was afforded to prescribing, key latent conditions that can influence active failures.

More recently, a qualitative study (Lewis *et al.* 2014) reported that over half of errors reported in 30 junior doctor interviews were mistakes. These were compounded by a multitude of error-producing latent conditions including time and workload pressures, poor communication and hierarchical barriers.

These studies highlight that whilst slips, lapses and mistakes are common, they are influenced by a multitude of conditions that make the error more likely to occur. Reason (2000) analogized this with controlling mosquitoes; "active failures are like mosquitoes. They can be swatted one by one, but they still keep coming. The best remedies are to create more effective defences and to drain the swamps in which they breed. The swamps, in this case, are the ever present latent conditions."

Understanding error causation is important to identify and implement effective interventions to reduce PEs. Increasing awareness of factors and conditions that can cause error may increase the threshold of PEs and is a theme that will be explored further in this thesis.

1.6. Prescribing error prevalence

Precise PE rates are unknown but it is clear from the literature and personal experience of the author, that they are common events in the hospital setting. Annual audits in STHKH suggest typical PE rates of 20% (Lloyd 2013).   Single hospital studies in the UK (Fowlie *et al.* 2000, Gethins 1996) have reported PEs in 7.4–18.7% of prescriptions.   Most published reports have involved data collection from healthcare professionals, with pharmacists the usual medium for collecting data alongside their routine daily duties (Lewis *et al.* 2009).

A systematic review (Lewis *et al.* 2009) of handwritten prescriptions in 65 studies, reported that a median 7% (2-14%) of medication orders, 2% of patient days and 50% of hospital admissions were affected by a prescription error.   Most studies were undertaken in the US or UK as a single site study, although 16% of published studies were performed across multiple sites. PEs were mostly intercepted before they caused harm.   Wide variations in PE rates were reported, an outcome possibly explained by heterogeneity in PE definitions and data collection methods (Franklin and Birch *et al.* 2009). For example, using incident reports (Sangtawesin *et al.* 2003) to collect PE information provided lower error rates (0.4 errors per 100 admission) compared to triangulated data (Dale *et al.* 2003) collection methods (323 errors per 100 admissions).

Considering voluntary incident reporting is acknowledged as underestimating the true scale of medication or PEs, (Williams *et al.* 2013, Franklin and Birch 2009, Meyer-Massetti *et al.* 2011, DOH 2004) it is of no surprise that such data collection methods have different outcomes and lower PE rates. Equally where PE definitions exclude certain types of error or pertain to likelihood of harm of delay in treatment, then variations are to be expected. These differences and variations also make it difficult to draw valid conclusions on the effect of ward areas, environments and specialties for example, on PE rates (Lewis *et al.* 2009, Franklin *et al.* 2011).

Another systematic review (Ross *et al.* 2009) of 24 studies, predominantly in the UK and USA, reported an error rate of 2–514 per 1000 items prescribed and 4–82% of prescription charts reviewed although this review was concerned with junior doctors only.

In recent multi-site studies, PEs were estimated to affect between 2% and 15% of prescriptions (Dornan *et al.* 2009, Franklin et al 2011, Seden *et al.* 2013) in the hospital setting. The large and pivotal EQUIP trial (Dornan *et al.* 2009) audited prescribing in 19 hospitals across North West England and reported a mean error rate of 8.9 errors per 100 medication orders for foundation trainees; rates far greater than consultants (5.9% PE rate) or non-medical prescribers. Considering the larger volume of prescribing undertaken by junior doctors, newly qualified doctors were considered twice as likely to make a PE compared to senior doctors.

A three-centre study in London (Franklin *et al.* 2011) reported a median error rate of 14.7%, (95% CI 13.8%-15.6%) and demonstrated variations between error rates (13.6%-18.4%) across hospital sites.

In a cross-sectional study of hospitals on Merseyside, Seden *et al.* (2013) reported an observed error rate of 10.9% with only 56.2% of overall prescriptions error free.

More recently in Scotland (Ryan *et al.* 2014) a mean PE rate of 7.5% was reported across eight hospitals. These findings are consistent with earlier studies (Bates 1995, Dean *et al.* 1995, Dean 2002, Glavin 2010, Neale *et al.* 2001, Vincent 2009, Lewis *et al.* 2009) and iterate the ongoing prevalence of PEs and need for further interventions to tackle the problem.

PEs can include incorrect dosing, frequency, quantity, indication, drug-interactions and contraindications. Other confounding factors may include illegible prescriptions, inaccurate drug histories, drug name confusion, abbreviations and drug calculation errors. Other errors that may not directly affect patient safety at the point of prescribing are use of trade names,

forgetting to date or sign the prescription and failure to document course durations for example.

It could be argued therefore that PE studies, overestimate PE rates: omission and comission errors at point of admission are difficult to categorise as 'errors' as prescribers may not have all available information for example. An omission error is a failure to perform an appropriate action (Pronovost *et al.* 2005), whilst a comission error can be defined as performing an inappropriate action (Pronovost *et al.* 2005).

1.7. Impact of medication errors

Where PEs occur, patients can be harmed, confidence in the medical profession undermined, staff time wasted in correcting errors and the associated costs a massive burden to the NHS (NPSA 2007).

Reports estimate MEs kill 7000 patients yearly in the United States (US) (Phillips 1998) and cause 1 in 20 hospital admissions; figures considered commensurate in the UK (Williams 2007). In the UK, it was reported that 1100 patients were killed each year because of ME's or adverse drug events (ADE's) (Audit commission 2001). More recently, the NPSA (2007) reported 92 cases of serious harm or death from MEs. Considering under reporting is a concern (Williams *et al.* 2013), it is likely that this figure is even higher. These figures may appear abstract but comparing to other industries can contextualize the issue, with Ferner (2012) illustrating that healthcare is one of the most dangerous encounters a human can face, akin to bungee jumping and mountain climbing; an eerie thought given the *raison d'etre* of healthcare.

Where patients are harmed, their hospital stay can be prolonged and in some cases their health permanently affected. The impact of these errors can carry huge financial burdens. MEs can prolong hospital stay by three days at a cost of £265 per day (National Institute for Health and Care Excellence (NICE) 2015) whilst 25% of litigation claims in general practice

result from MEs (Aronson 2009b). The NPSA estimated that preventable MEs cost the NHS a staggering £750million per year (NPSA 2007): a huge financial burden.

It is recognized that the risk of harm from PEs needs to be addressed (Velo and Minuz 2009, Dean 2002). The DOH outlined the need for a 40% reduction in serious medication errors (DOH 2000) with good practice recommendations published (DOH 2001). Similar recommendations have been endorsed elsewhere (DOH 2004) although it should be noted that baseline error rates appear irrelevant and error severity is not quantified. More recently (DOH 2014), the health secretary has urged NHS institutions to reduce serious errors by half with financial incentives for those trusts who demonstrate this affect. However, this is a curious recommendation: Considering PEs are largely preventable and avoidable incidents, this figure should be non-negotiable at 100% and a target that every organisation strives towards.

Recently, the care quality commission (CQC) (CQC 2014) have questioned the legibility of prescriptions and signatures at one hospital with implications for accountability and risking repeat of the same errors. It is conceivable that prescribing will come under increased scrutiny as part of the wider mandate to improve patient safety; to some extent this project could be getting ahead of the curve.

The research in this thesis is concerned with exploring the impact and effectiveness of pharmacist-led prescribing error feedback. The intervention is described in more detail in chapter 3 but is designed to reflect principles of effective feedback, encouraging reflection on prescribing performance and negotiating actions to improve practice further. This process is distinct from practice prior to this research where pharmacists would typically inform a prescriber of an error and ask them to amend the prescription.

1.8. Organization of this thesis

Chapter 2 presents a literature review of the research subject. Strategies that have been employed to reduce PEs are discussed and the need for further interventions outlined. The potential for PE feedback is described considering available evidence for impact on prescribing performance, and principles of effective feedback to inform intervention design.

Chapter 3 describes the research methodologies and methods that underpin this research. Research questions and hypotheses are reviewed and the choice of both qualitative and quantitative methods to address research aims discussed. The chapter concludes with consideration of the data collection and analysis techniques.

In chapter 4, the attitudes and experiences of pharmacists towards delivering PE feedback prior to the intervention are reported using focus groups.

Chapter 5 presents results of a controlled pilot-study exploring the effectiveness of PE feedback on PE rates.

In chapter 6, the attitudes and experiences of prescribers towards receiving formalized PE feedback are described. Specifically, their views on the process, impact on their prescribing and working relationships, and use of pharmacists as facilitators of feedback are explored.

Chapter 7 presents the results of the larger cohort study to determine the reproducibility of pilot results. Quantitative results are presented descriptively before the research hypotheses are tested using relevant inferential statistics to measure the impact on prescribing, and different error types and severities.

In chapter 8, the experiences of pharmacists of delivering the intervention are described. There is particular reference to the value and sustainability of

the project as well as an exploration of the perceived impact on prescribing, prescribers, pharmacists and pharmacist-prescriber relationships.

Chapter 9 describes the impact of feedback on prescribing behaviour. Individual PEs are classified according to James Reasons' psychological approach before exploring the impact of the intervention on prescribing behaviour following feedback on these different error types.

Chapter 10 concludes the thesis with a summary of key findings. Implications for practice are considered and recommendations for further research outlined.

1.9. Chapter Summary

This introductory chapter has described key terms and concepts that will be discussed throughout this thesis. The context and background for the intervention has been described and overall aims and objectives presented. The prevalence and impact of PEs has been defined and an overview of error causation and typology presented to inform further reading in chapters 3 and 9. Chapter 2 will now review what interventions have been implemented to address PEs and why PE feedback and the research proposed in this thesis is needed.

Chapter 2. Literature review

2.1. Chapter Introduction

This chapter will explore the literature reporting PE reduction initiatives. Firstly, the literature reporting strategies to reduce PEs will be reviewed and the need for additional interventions outlined. The chapter will then progress to describe and outline what feedback is, and the principles and processes underpinning effective feedback. This will be followed by a review of the empirical literature reporting the impact of feedback on skill-based performances. The literature regarding feedback and PEs and how it informs the research in this thesis will then be described.

2.2. Prescribing error reduction initiatives

It is prudent to consider what interventions have been researched previously. This will inform the need for the research in this thesis and the contribution the author is making to this field of study.

Suggestions to improve prescribing have been proposed previously (Dornan *et al.* 2009) and include changes to the working environment, medical education at undergraduate and postgraduate level, and inter-professional education. This focus on education resonates with many of the interventions reported in the literature to reduce PEs. Other interventions include equipment or resource redesign such as electronic prescribing or standardized medication charts, and greater use of clinical pharmacists. These interventions will now be reviewed.

2.2.1 Educational interventions

A variety of educational interventions have been assessed to improve prescribing competency and performance. A systematic review (Ross *et al.* 2009) of educational interventions to improve prescribing in medical students and junior doctors concluded that the WHO (World Health Organisation) good prescribing guide increased prescribing competency in a variety of

international settings. The guide includes a six-step prescribing model to choose, prescribe and monitor a medication with a core list of personal drugs that prescribers are tacitly familiar with. Educational interventions based on this guide have the greatest body of evidence (Kamarudin *et al.* 2013) with retention of knowledge (Akici *et al.* 2003, Gordon *et al.* 2011) and transfer of effect to other situations also reported (Akici *et al.* 2003, Richir *et al.* 2008). However, whilst the studies reported significant outcomes, they reported prescribing scores using written scenarios with a limited number of diseases, as opposed to practical prescribing stations, limiting conclusions for prescribing in practice. It should also be noted that such interventions demonstrate that an individual 'knows' as opposed to the highest level of competence 'does' that reflects real-world prescribing.

Specific teaching using tutorials and workshops have been shown to be effective in improving prescribing. Coombes *et al.* (2007) reported significant improvements for example in a written paper following problem-based tutorials for medical students. Elsewhere Scobie *et al.* (2003) reported improvements in OSCE station scores following pharmacist-led teaching sessions. One educational programme for final year medical students reported improvements in prescribing and confidence but errors were still present in 30% of prescriptions (Sandilands *et al.* 2011). Ross *et al.* (2009) highlight that the validity and generalizability of these interventions is limited by their diversity, outcome measures, and single site settings.

Another systematic review (Brennan and Mattick 2013) focused on interventions to improve prescribing in junior doctors in the hospital setting only. A wide variety of interventions were reported including use of educational materials such as guidelines, workshops and other training platforms, audit and feedback, educational outreach, alerts and reminders, marketing and patient mediated interventions. All were reported as effective with mixed results for some interventions. The authors concluded that no approach was more effective than others. Equally, it was acknowledged that only 11% of studies investigated single interventions with the majority adopting a triangulated approach. For example, Webbe *et al.* (2007)

reported reductions in PE rates following pharmacist intervention that consisted of attending ward rounds, sharing of errors amongst teams, provision of prescribing tutorials and distribution of prescribing guidelines.

Another review (Ostini *et al.* 2009) concluded that educational outreach, audit, and feedback dominate the research arena into PE reduction and consistently show positive outcomes. They also conclude that little is known as to why certain interventions work whilst others do not. These findings are echoed in a more recent systematic review (Kamarudin *et al.* 2013) exploring interventions to improve patient-focused prescribing competency. The use of the WHO guide to good prescribing was again outlined as improving competency in a variety of settings, whilst other interventions such as academic detailing or personalised feedback also had positive effects.

Prescribing is a recognized role of junior doctors (Ross and Maxwell 2012) although it is a role that all prescriber grades need to be proficient in. *Tomorrow's Doctors* (GMC 2009) outline the standards for undergraduate medical education in the UK and the knowledge and skills expected of medical graduates to "Prescribe drugs safely, effectively and economically." However, undergraduate prescribing education is known to be inconsistent in the UK (O'Shaughnessy *et al.* 2010) with graduates feeling underprepared to prescribe (Heaton *et al.* 2008, Illing *et al.* 2008) and concerns expressed over unsafe prescribing practices (Garbutt *et al.* 2005). For practicing doctors, the GMC have published standards for prescribing (GMC 2013) whilst the foundation programme curriculum (GMC 2012) specifies a list of prescribing competencies to ensure that they are safe and effective prescribers. Specifically, the curriculum states that they should:

"Prescribe drugs and treatments appropriately, clearly and unambiguously in accordance with "Good Practice in prescribing medicines (GMC, 2008)"

Evidence of such should be assessed as part of any trainee's portfolio review by their supervisor. However, each NHS Trust has autonomy in how these

competences are achieved, what evidence is required and what, if any, training is delivered. Equally, variations in foundation doctor training have been reported whilst focusing on knowledge and technical aspects of prescribing (Kirkham *et al.* 2015). Foundation grade doctors have demonstrated inadequate prescribing ability previously (Harding *et al.* 2010), and are reported to have the highest PE rates (Dornan *et al.* 2009), and twice as likely as consultant grade prescribers to prescriber erroneously (Ashcroft *et al.* 2015). At the very least, more could be done to prepare and support newly qualified doctors to reflect the standards outlined in the above documents. Such interventions could support the development of junior doctors in acquiring a complete skill set for safe and appropriate prescribing.

2.2.2. Academic detailing

Educational outreach, or 'academic detailing', describes a visit by a trained person to health professionals (i.e. prescribers) in their place of work (O'Brien *et al.* 2007). It has been identified as "an intervention that has the potential to change health professional practice, particularly prescribing by physicians" (Soumerai 1989; Soumerai 1990). A systematic review (O'Brien *et al.* 2007) of 69 studies involving more than 15,000 health professionals, concluded that educational outreach can be effective in improving practice. The effects on prescribing were small (4.8%) but consistent (O'Brien *et al.* 2007), and potentially important given the likely multi-targeted approach required for improving prescribing practice. Considering the ease of academic detailing as a one-off intervention, it is perhaps no surprise that educational outreach predominates as a PE reduction strategy in one systematic review (Ostini *et al.* 2009). However, educational outreach usually focuses on a particular aspect of prescribing such as antibiotics for example, or adherence to a particular guideline (Ostini *et al.* 2009) and not prescribing as a whole.

2.2.3. Prescribing assessment tools

In the elderly population, assessment tools used in clinical practice to reduce inappropriate prescribing include Beers criteria (American Geriatrics Society 2015) and STOPP/START (Screening Tool of Older People's Prescriptions/Screening Tool to Alert to Right Treatment) (O'Mahony *et al.* 2015). These tools contain criteria that are designed to facilitate review of, or to avoid commencing, inappropriate medication. Application of the STOPP/START criteria also reviews the need to commence other medications that can reduce mortality in the patient population. Use of the STOPP/START criteria has been shown to reduce medication costs, patient falls, number of daily medications and number of potentially inappropriate medications (Lavan *et al.* 2016). However, such tools are not used widely in clinical practice, are often tested in isolated settings and reflect application to only one patient cohort (Lavan *et al.* 2016).

2.2.4. Pharmacists and prescribing errors

Hospital pharmacists perform medicines reconciliation and screen prescriptions as part of their clinical duties, intercepting and resolving PEs where they are identified. In one report, where pharmacists performed the medicines reconciliation before a prescriber in an emergency department, the number of errors reduced from 3.3 per patient to 0.04 per patient (Mills and McGuffie 2010) and is reported to be cost effective elsewhere (Karnon *et al.* 2009).

Where pharmacists intercept and resolve PEs, the risk of harm is reduced with clinical pharmacists reducing PEs in the hospital setting (Tully and Buchannan 2009, Abdel-Qader et al. 2010). The presence of ward-based clinical pharmacists has been shown to reduce PEs whilst also reducing costs from medications and adverse events (Klopotowska *et al.* 2010, Ariano *et al.* 1995). These benefits underscore the recommendation for clinical pharmacists to be involved at all points of the medication process (Agrawal *et al.* 2009) where they are an integral part of the medication safety net.

Contributions of hospital pharmacists are therefore well regarded in reducing error and patient harm (Velo and Minuz 2009) and adverse effects of medications (Leape *et al.* 1999, Holland *et al.* 2008). Considering this role, it is perhaps of no surprise that pharmacists collect the data in many of the PE prevalence studies (Velo and Minuz 2009) and are often involved in the delivery of tutorials or educational outreach materials to prescribers mentioned above. Pharmacists are also involved in undergraduate prescribing education delivering prescribing tutorials for example. Pharmacist involvement in prescribing education has been well received at undergraduate (McGuire *et al.* 2015) and postgraduate level (Kennedy *et al.* 2016) where they were described as "knowledgeable, accessible and important sources of information". This suggests that pharmacists are credible prescribing educators with the working relationship outlined as an important theme (Kennedy *et al.* 2016).

In a primary care setting, use of pharmacists to analyse PEs and agree action plans in General Practitioner (GP) practices, improved primary and secondary composite outcomes and was considered a cost-effective intervention (Avery *et al.* 2012). The intervention in this study consisted of pharmacist-led educational outreach and delivery of feedback on specific prescribing indicators. Qualitative analysis reported the intervention was valued although team integration and credibility of the pharmacist had implications for how the intervention was received. Where GP's were defensive or refused to act on recommendations, pharmacists reported feelings of frustration and isolation.

2.2.5. System redesign

Efforts at the system level to address prescribing standards have focused on electronic prescribing with some arguments also proposed for standardisation of medication charts.

2.2.5.1. Standardised medication charts

The potential for standardised medication charts to reduce PEs is recognised and has been proposed for the UK previously (Barber *et al.* 2003). In Queensland, Australia, a pilot study demonstrated reductions in PE rates from 20% to 16% (Coombes *et al.* 2009). When piloted across Australia (Coombes *et al.* 2011), the standardised chart reduced PEs by almost one third. Where medication charts are standardised, there is clear potential to inform prescribing pedagogy at undergraduate level and for staff moving between hospital sites (Coombes *et al.* 2009).

However, a standardised chart has not been adopted across the UK. There is an all-Wales chart available (Routledge 2012) whilst a standardised chart is also being piloted in Scotland, although results for their effectiveness are currently unavailable.

2.2.5.2. Electronic prescribing

There are various definitions of electronic prescribing but they all typically describe the ordering or prescribing of medication electronically (Ahmed *et al.* 2016). Such systems show considerable promise in reducing PEs and improving patient safety as reported in systematic reviews (Conroy *et al.* 2007, Shamliyan *et al.* 2008, Ahmed *et al.* 2016).

Electronic prescribing is reported to reduce certain error types (Shamliyan *et al.* 2008) including misinterpretation of illegible handwriting, omissions, completeness of prescribed items and patient identification (Ahmed *et al.* 2016). However, these studies were typically in isolated settings, single case studies or heterogeneous in design making comparisons and generalizability difficult. Equally, benefits are not consistent (Shamliyan *et al.* 2008, Ahmed *et al.* 2016) with electronic prescribing introducing new and different PEs compared to paper based systems that can compromise patient safety (Kannry 2011, Esmaeil Zadeh *et al.* 2016). Such errors include incorrect entry of dose, patient information or selection of incorrect drug name and

frequencies from drop down menus. One review (Ranji *et al.* 2014) concluded that such concerns limit any benefits introduced by the technology.

Electronic prescribing systems are not completely adopted in the UK yet with a myriad of platforms used. In some cases, over half of hospitals have been reported to use more than one system and only in limited clinical areas (Ahmed *et al.* 2013). Nonetheless, NHS hospitals in England are expected have paperless prescribing in place by 2020 (National information board 2014) and so the use and potential impact should become clearer in the future with time and motion studies commenced in the UK (Schofield *et al.* 2015). However, given the concerns reported above, it is likely that electronic prescribing, will simply be a partial solution to reducing PEs.

2.2.6. Other interventions needed

STHKH is committed to reducing PEs as part of their pledge to optimising patient safety and reflecting national recommendations (DOH 2000, DOH 2004). An extensive medical education programme is delivered at undergraduate and postgraduate level with considerable pharmacist input. In addition, all medical graduates undertake the national prescribing safety assessment as part of their undergraduate training. Clinical pharmacists are present on most wards and deliver some ward based teaching in the form of academic detailing for example. Whilst full electronic prescribing was not used in the hospital during this research, electronic prescribing was available for discharge prescriptions. Additionally, the inpatient medication chart was designed to comply with national recommendations (Academy of Medical Royal Colleges 2016).

Despite these interventions, there is evidence that PEs are still prevalent (Reynolds *et al.* 2016, Seden *et al.* 2013). Prescribing is a complex skill that requires more than an adequate knowledge base. Practical prescribing training is perceived to be suboptimal by medical students and junior doctors (Heaton *et al.* 2008) with dissatisfied feedback from recent medical

graduates (Nazar *et al.* 2015). Equally, what works in other settings may not necessarily work in all settings where the intervention is dependent on the skill of the facilitator for example. Further interventions are required to align prescribing behaviour with expected competencies and enhance prescribing performance; feedback is one possible intervention that can help to achieve this.

2.3. Feedback

Feedback is considered central to supporting cognitive, technical and professional development of individuals (Archer 2010). This clearly resonates with an educational focus with feedback described as an essential component of the educational process to help trainees reach their maximum potential (Hesketh and Laidlaw 2002). Building on this, feedback has been described as the "cornerstone of effective clinical teaching" (Cantillon and Sargeant 2008, Hesketh and Laidlaw 2002).

2.3.1. What is feedback?

There are various definitions of feedback within the literature. In medical education, feedback has been defined as "information describing students' or house officers' performance in a given activity that is intended to guide their future performance in that same or related activity" (Ende 1983). In the context of this research, the student is the prescriber and the intention is to improve their prescribing performance. However, feedback is not simply a descriptive exercise but a complex interaction between the provider and recipient of feedback, and the type of interaction and elements of effective feedback should be considered when designing any feedback intervention.

2.3.2. Types of feedback

Feedback can be either directive or facilitative (Archer 2010). Directive feedback is simply that, directive. It informs the learner of what requires correction. This model reflects what happened in STHKH prior to this

research with PEs highlighted and amended but rarely discussed, and is clearly not a constructive process. Facilitative feedback uses questions and comments to facilitate the learner in understanding and revising their own practices. This approach is consistent with provision of constructive feedback. One study (Kroll *et al.* 2008) explored doctors' experiences to error, and reported that learning was optimized when error was discussed formally, and constructive feedback provided.

It has been proposed that the purpose of feedback is to encourage learner reflection on performance and how they can improve (Hesketh and Laidlaw 2002). Equally, learners have reported previously that they value and prefer feedback that encourages reflection (Cantillon and Sargeant 2008, Menachery *et al.* 2006, Rees *et al.* 2005), a process that requires facilitative feedback. Sargeant *et al.* (2009) reported that reflection was an important educational focus of feedback to assimilate and accept the feedback. More recently, Archer (2010) concluded that to be truly effective, feedback needs to nurture reflection-in-action so that for example, prescribers are fully engaged with their prescribing and reflect both on and in the prescribing process.

The pedagogical principles of facilitative feedback resonate with the experiential learning cycle (Kolb 1984) (Figure 6). Feedback on prescribing raises awareness of a learner's performance. This is the "concrete experience" yet equally is no more than sensory information. To make sense of that information, reflection is required as is abstraction of ideas to improve practice and finally, the learner then commits to testing the new ideas and agreed ways of working. At a biological level, transformation of information into knowledge and behavioural change requires involvement of the sensory (experience), temporal integrative (reflection), frontal integrative (abstraction) and motor (testing) cortexes (Zull 2002). Therefore, the role of facilitative or constructive feedback in completing the learning cycle can be seen whereas directive feedback may not progress beyond the concrete experience phase. Building on this, facilitative feedback can encourage reflection on the experience, causation and identification of solutions to

complete the learning cycle.

Figure 6: Experiential learning cycle (from Lloyd *et al.* 2016b)
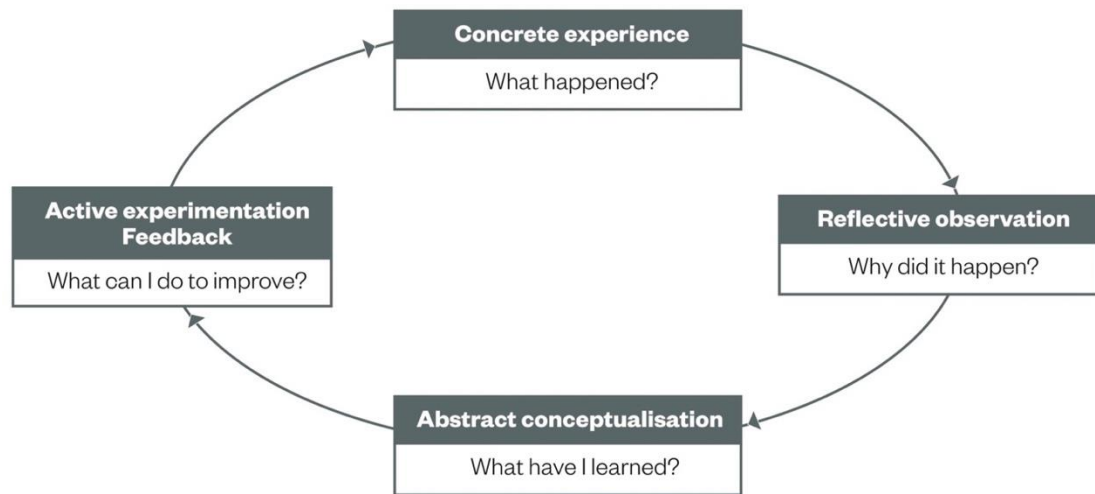
Feedback can be either positive or negative where the aim is to reinforce or correct behaviour. Positive feedback can encourage further exemplary practices and feedback seeking behaviour (Cantillon and Sargeant 2008, Krackov 2009) whilst negative feedback can correct poor performance (Ramani and Krackov 2012) and has been shown to particularly encourage reflection (Sargeant *et al.* 2009). In a systematic review (Ivers *et al.* 2012), feedback designed to reduce certain behaviours was more effective than feedback designed to increase certain behaviours.

Additionally, to be effective, feedback needs to be more than simply praise or criticism, it needs to be constructive following some key principles as described below.

2.3.3. Elements of effective feedback

There are guiding principles that should be considered to enhance the efficacy of feedback. Eight guiding principles are proposed (Cantillon and Sargeant 2008) based on educational theory and research:

1. Feedback should be part of everyday practice
2. Assessment criteria should be clear
3. Feedback should be specific and not vague
4. Feedback should be on observed practice
5. Feedback should be timely
6. Feedback should be limited to one or two items
7. Feedback should seek learner's perceptions
8. Feedback should lead to change in learner thinking, behaviour and performance

A more recent review of the literature (Ramani and Krackov 2012) provided further practical tips for delivery of feedback in clinical practice. These include:

1. Establish a respectful learning environment.
2. Communicate goals and objectives for feedback.
3. Base feedback on direct observation.
4. Make feedback timely and a regular occurrence.
5. Begin the session with the learner's self-assessment.
6. Reinforce and correct observed behaviours.
7. Use specific, neutral language to focus on performance.
8. Confirm the learner's understanding and facilitate acceptance.
9. Conclude with an action plan.
10. Reflect on your feedback skills.
11. Create staff-development opportunities.
12. Make feedback part of institutional culture.

Systematic reviews have reported that feedback is most effective when it is delivered by a supervisor or colleague, presented frequently, features specific goals and action plans, aims to decrease the targeted behaviour and is delivered in both verbal and written formats (Jamtvedt *et al.* 2003, Jamtvedt *et al.* 2006, Ivers *et al.* 2012, Ivers *et al.* 2014).

Considering these recommendations, a ward-based clinical pharmacist should be a respected colleague and suitable facilitator of PE feedback. Feedback should be delivered more than once verbally and supported by written feedback. It should also contain specific actions to be implemented by the prescriber to reduce their PE rates, as opposed to a team or group of prescribers.

The content of the feedback should be clear, understood, specific and relevant. It should also be timely to facilitate memory recall and accompanied by an explanation to raise understanding. Any feedback should recognise the recipient perspectives and allow self-assessment and development of action plans (Boehler *et al.* 2006, Hattie and Timperley 2007, Richardson 2004). Therefore, PE feedback should include an explanation of potential risks, and encourage reflective practice to identify any potential error causation, and strategies to improve practice.

Considering these principles several methods are available to support pharmacists in delivering constructive feedback such as BOOST (Clayton 2012), the sandwich method (Dohrenwend 2002), Pendleton's model (Pendleton *et al.* 1984) and the reflective conversation (Cantillon and Sargeant 2008). BOOST is an acronym for delivery of feedback that is balanced, observed, objective, specific and timely. The sandwich model proposes that any negative feedback is sandwiched between positive feedback. With Pendleton's rules, the facilitator asks what went well, tells the recipient what went well, asks what could be improved and finally tells them what can be improved.

It should be noted that no single approach is most effective (Lefroy *et al.* 2015). The approach, or approaches, that are adopted is likely to be dependent on the facilitator-recipient relationship and the situation, emphasising the need for flexibility and a culture of trust and respect. What is important is that the feedback is not directive or passive (Archer 2010) but rather a dynamic, interactive conversation that facilitates reflection and learning.

A Cochrane review (Ivers *et al.* 2012) of the impact of audit and feedback suggests that the impact of feedback depends on how the intervention is designed and delivered whilst there are reports of interventions developed without consideration of relevant theories (Colquhoun *et al.* 2013). This is reported more recently (Ivers *et al.* 2014) with feedback interventions continuing to be designed and assessed following a single round of feedback. Therefore, the guiding principles and models of delivering feedback described above were used to support design of the written feedback tools (Appendices 1 and 2) and learning materials to train pharmacists as facilitators of feedback.

2.3.4. Empirical evidence for impact of feedback

Effective feedback is considered to direct and motivate behaviour whilst increasing self-awareness, enhancing interpersonal relationships and improving service quality (London 2015:21). It is suggested that when feedback highlights suboptimal performance for important and actionable targets, individuals are more likely to increase their efforts to improve quality of care (Ivers *et al.* 2012).

In educational settings, the power of feedback as an intervention to improve learning outcome and performance has been described (Hattie & Timperley, 2007). In healthcare settings, three Cochrane reviews of audit and feedback (Jamtvedt *et al.* 2003, Jamtvedt *et al.* 2006, Ivers *et al.* 2012) have reached similar conclusions that audit and feedback works with small but potentially important improvements on professional practice.

2.3.5. Need for prescribing error feedback

Despite efforts to improve prescribing, errors persist and further targeted interventions are required to optimise safe and appropriate prescribing. In their review of educational interventions to improve prescribing behaviour, Brennan and Mattick (2013) concluded that there was an urgent need for

educational interventions to support the development of desirable behaviours in doctors. The potential for feedback to improve practice and modify behaviour (Jamtvedt *et al.* 2006, Archer 2010, Ivers *et al.* 2012), including prescribing behaviour (Barber *et al*. 2003, Velo and Minuz 2009), has been described. Doctors have reported valuing and welcoming feedback (Franklin *et al.* 2007, Dornan *et al.* 2009, Bertels *et al.* 2013) yet have reported a lack of awareness of and feedback on their PEs (Lewis *et al.* 2014, Bertels *et al.* 2013, Dornan *et al.* 2009, Franklin *et al.* 2011). One study exploring PEs at discharge reported that 83% of errors were corrected without referral to the prescriber (Abdel-Qader *et al.* 2010). Where errors occur, it is important that the individual (Dean 2002) and the team (Department of health 2000) learn from the error otherwise it is a missed learning opportunity. Feedback has the potential to facilitate this learning and change prescribing behaviour but equally, without it, the status quo may not be challenged and inappropriate prescribing will continue.

One review of prescribing education in the UK suggested that prescribers should have protected time to reflect on prescribing and any feedback, which should be delivered in a blame free environment (Likic and Maxwell 2009). The national prescribing competency framework (RPS 2016) outlines that prescribers should act upon feedback and use tools such as feedback to improve prescribing. Another published framework (Lum *et al.* 2013), based on the WHO safe prescribing model (de Vries *et al.* 1994), highlights that prescribers should have "the ability and willingness to self-reflect on prescribing practice, seeking and acting on constructive feedback". The need for constructive prescribing feedback is therefore clearly recognized yet evidence on its use and application is limited.

2.3.6. Prescribing error feedback evidence

A literature search was undertaken to determine the originality of this thesis and its contribution to the research field.

The initial literature search for the research in this thesis was undertaken in 2014 although it has been updated throughout data collection, analysis and write up of this thesis (2014-2017).

Key search terms included prescribing (OR prescription), error (OR errors), feedback, AND pharmacist (OR pharmacy OR pharmacists). Search terms were combined with and without pharmacist.

The following relevant databases were used to perform the literature search: CINAHL (Cumulative Index to Nursing and Allied Health Literature), Medline, Pubmed and Scopus. In addition, a general search of the internet was also performed. All searches were limited to English language articles.

2.3.7. Systematic reviews of feedback on performance

A systematic review (Jamtvedt *et al.* 2006) reported a median 5% absolute improvement in professional practice following audit and feedback. However, few studies looked specifically at prescribing whilst they were limited to single drug classes (e.g. benzodiazepine prescribing in the elderly) and the effect varied from very large positive effects to negative effects.

A 2012 review of the literature similarly reported small but potentially important effects of feedback on professional practice (Ivers *et al.* 2012). Thirty-nine of the included studies targeted prescribing and the authors commented that feedback was likely to be more effective when it targeted a dichotomous outcome such as prescribing. It was suggested that this may be because prescribing is important but not complex. An exploratory analysis of the prescribing sub-studies reported a median absolute improvement of 13.1% (IQR 3% to 17%) (Ivers *et al.* 2012). Again however, these studies focused on prescribing of specific drugs or for specific medical conditions (e.g. asthma) whilst studies reporting the impact of prescribing feedback in the hospital setting were notably absent.

An updated review (Ivers *et al.* 2014) reported similar findings but was damning in their report that trials were not contributing to existing evidence as the feedback intervention was theoretically flawed. For example, feedback was only delivered once in 47 % of studies, did not include goals or action plans in 61 % of studies, whilst the facilitator was unknown or was the researcher (as opposed to a respected colleague) in 85% of studies.

2.3.8. General perceptions of prescribing feedback

PE feedback at the speciality level has previously been well received by consultants and considered feasible to deliver (Franklin *et al.* 2007). Elsewhere (Bertels *et al.* 2013), FY1 doctors were positive about receiving more individualised feedback and that feedback was likely to improve their prescribing. In a more recent qualitative study (Ferguson *et al.* 2017), feedback was reported to have potential to influence future prescribing behaviour, especially if it was timely and allowed benchmarking to a reference value. These findings echo results of an earlier study (Dornan *et al.* 2009) where FY1 doctors reported welcoming prescribing error feedback as a learning opportunity.

Similarly, pharmacists have reported that they would be willing to provide more formal feedback to junior doctors where time is provided (Bertels *et al.* 2013) although the views of delivering feedback to more senior prescribing grades is unknown.

2.3.9. Prescribing feedback in speciality areas

Various studies have evaluated the impact of feedback in isolated settings. These results may therefore be context specific, reflecting the dynamics of specific areas or indeed the skill of individual facilitators of feedback in those areas.

For example, several studies have reported feedback as a prescribing improvement intervention in the paediatric setting. One study (Eisenhut *et al.*

2011) assessed sixteen prescribers' performance in completing prescribing exercises who then received e-mailed feedback from a pharmacist on their performance. Prescribing was audited prior to and two months following this intervention and the authors reported an improvement in PEs. However, the study was uncontrolled, the assessment and ensuing supervision of prescribers who made errors may have biased results, whilst the feedback process does not resonate with principles of effective feedback.

Another pilot study (Gordon and Bose-Haider 2012) reported reductions in technical PE rates from 8.8% to 1.8% using a departmental poster and e-mailed feedback. Whilst demonstrating clear potential, this study was uncontrolled and did not include verbal feedback that could facilitate further understanding and contextualisation of the feedback. Equally, the feedback focused on the technical aspects of prescribing so inferences for clinical PEs are unknown.

Elsewhere, Booth *et al.* (2012) introduced daily anonymised feedback on previous days' PEs at team hand over and the start of ward rounds. Significant reduction in non-clinical errors was reported with non-significant reduction in clinical errors. Such feedback is clearly timely although lacks individualisation and where error causation is not identified or actions agreed, behaviour is unlikely to change and may reflect the non-significant improvement in clinical errors.

In a neonatal setting (Sullivan *et al.* 2013), one study reported an 83% improvement in days between narcotic PEs although these results did not extend to other prescribed medications (e.g. antibiotics) or overall errors. However, feedback was only delivered via e-mail and at two-weekly intervals and so is likely to be directive in nature and not necessarily timely for any prescribing event.

Recently, (Leach *et al.* 2016) prescribers were taught and assessed on prescribing standards in a paediatric setting. This was followed by feedback at weekly intervals to entire ward areas with charts indicating performance

and star ward of the week. Initial improvements were not sustained although a control group was not used. Whilst such feedback is acceptable (Franklin *et al.* 2007) it lacks the specificity of effective feedback, the directive nature is not constructive and is unlikely to stimulate prescriber reflection.

For adults, one study (Thomas *et al.* 2008) reported improvements in prescription error rates following audit and written feedback at four weekly intervals in an intensive care unit. However, the study design was uncontrolled which limits interpretation. Additionally, the written feedback was provided without discussion and so may not stimulate reflection or facilitate identification of error causation, which would influence any further action or goal setting.

In another study (Chan *et al.* 2010), provision of prescriber education and "real time" feedback demonstrated a reduction in medicines reconciliation discrepancies (mean 2.6 down to 1) in an admissions unit in a New Zealand hospital. However, the study was uncontrolled and so it is unclear what intervention had an effect. More importantly, "real-time" feedback consisted of placing a sticker with a list of potential medication discrepancies in the medical notes for the prescribing team to review. Whilst this can raise awareness of potential errors and improve communication of medication related queries, it lacks specificity, individualisation, targets or actions required for effective feedback.

2.3.10. General prescribing feedback

Franklin *et al.* (2007) reported that feedback delivered at the speciality level was well received by consultants and was feasible although impacts on prescribing were not reported. Their later work built on these findings to design a feedback intervention study (Reynolds *et al.* 2016). In this study, the authors introduced name stamps to facilitate prescriber identification, with provision of feedback on PEs and fortnightly e-mails describing common or serious prescribing errors. A second hospital was used as a control and the authors reported no difference in change in PE rates between

intervention and control sites. It was acknowledged that prescribers were only identifiable in 50% of cases and that this may have limited intervention impact. However, equally, the principles and processes of feedback delivery were not explicitly described. For example, it was unclear if feedback was verbal, written or both, or whether or not the pharmacists delivering the feedback had a working relationship with the prescriber. A description of the process suggested that the feedback may have been directive, for example "This dose is incorrect for this patient: it should be……here's where you find the protocol". Whilst this is feedback, it does not identify the rationale for the error or encourage the recipient to identify solutions themselves. Finally, the intensity of feedback was not reported for each prescriber whilst it was unclear if all prescribers who were involved in the intervention site had received feedback at all. Therefore, the potential effect of feedback may be lost in these design flaws.

In an African study (Ajemigbitse *et al.* 2016), no improvements in overall PE rates were reported following educational outreach and feedback at the departmental level. There were some significant improvements in writing of routes of administration and non-ambiguous orders for example and perhaps echoes the findings of Gordon and Bose-Haider (2012) described earlier. Reported improvements were limited to registrar grade prescribers although the feedback content lacked individualisation and was only delivered once, potentially limiting any effect of feedback.

2.3.11. Prescribing feedback in General Practice

Feedback intervention studies have shown promising results in primary care settings. In one study (Avery *et al.* 2012), pharmacists provided feedback, educational outreach, and dedicated support on a range of prescribing areas. The authors reported significant improvements in unsafe prescribing practices following this intervention. The triangulated approach limits interpretation of the impact of feedback whilst the control arm also consisted of computer-generated feedback and therefore, the effect of the intervention may be underestimated.

More recently, Winder *et al.* (2015) reported 36% reductions in prescription error rates for prescribers following electronic feedback, educational outreach and weekly newsletters. The actual impact of feedback was unclear because of the multiple intervention approach whilst directive, electronic feedback was also used.

2.3.12. Prescribing feedback on specific medication groups

Several studies have explored the impact of feedback on specific medication classes for example antibiotic (McLellan *et al.* 2016) or benzodiazepine prescribing (Ivers *et al.* 2012).

Recently, a controlled mixed-methods UK study (McLellan *et al.* 2016) reported a lower mean suboptimal antibiotic prescribing rate in intervention groups (0.32+0.36) compared to control groups (0.68+0.36). For the intervention group, feedback workshops were provided at two time points with feedback based on theoretical principles. Significant differences between groups were limited to suboptimal prescription writing as opposed to antibiotic choice. However, the nature of the workshops may have meant that feedback was not timely. Additionally, the use of a single facilitator for the workshops (a hospital pharmacist), as opposed to a ward based pharmacist, may have limited any open candour in discussing prescribing. Additionally, provision of feedback at two set time points may not be frequent enough nor part of routine clinical practice. Therefore, despite positive outcomes, the true effect of feedback may be underestimated.

Elsewhere, Hallsworth *et al.* (2016) reported small but significant improvements in antibiotic prescribing following provision of social norm feedback that consisted of written feedback on antibiotic usage. Whilst the effect was small, the low cost and ease of the intervention raises potential to utilize such feedback as part of wider prescribing improvement programmes.

In Norway (Hogli *et al.* 2016), one uncontrolled study combined audit and

feedback with distribution of antibiotic prescribing guidelines. The authors reported significant improvements in overall mean prescribing of appropriate antibiotics from 61.7% to 83.8 %. However, it is unclear what intervention had the impact whilst feedback was only delivered verbally at one time point and was not individualized.

2.4. Chapter discussion

The aim of this chapter was to outline the need for PE feedback as an interventional tool and the theoretical principles underpinning effective feedback. Audit and feedback can improve task performance with evidence supporting its application to improve prescribing. There is a scarcity of literature reporting the impact of feedback on general prescribing or in the hospital setting, supporting pursuance of the research in this thesis.

Feedback is often used in collaboration with other interventions whilst many studies are often uncontrolled making inferences for the effect of feedback difficult. Additionally, theoretical flaws in the design of the feedback intervention echo the sentiments of Ivers *et al.* (2014) that current research efforts are not contributing further to this field of study. Such design limitations could underestimate the impact of feedback where any small or absent effect is less to do with the intervention, and more to do with the design of the intervention. The majority of studies reviewed explored feedback in isolated settings, for specific medications or medical conditions and so feedback may be context specific or reflect the skill of the facilitator. Additionally, the use of hospital pharmacists as credible facilitators of feedback has been overlooked despite being both a colleague and observer of prescribing practice who has potential to deliver timely feedback. Exploring the impact of a feedback intervention that is aligned with the principles of effective feedback has independent research merit.

The research in this thesis builds and innovates on previous research to explore the impact and effectiveness of pharmacist-led PE feedback. These considerations can allow further inferences to be made as to the true effect

of feedback. Additionally, qualitative reports of the impact of PE feedback on key stakeholders (pharmacists and prescribers) are limited. An understanding of pharmacist and prescriber experiences of the process could provide a more detailed understanding of quantitative results. These results could be used to inform why the intervention works, or doesn't work, how to improve or refine the innovation further, and the scope for wider application across the organisation.

2.5. Chapter Summary

This chapter has presented an overview of the literature reporting PE reduction initiatives. The theory and principles of effective feedback have been reviewed and the empirical evidence considering the impact of feedback on task performance considered. The impact of feedback on prescribing has been reviewed to highlight the contribution of this research to existing knowledge and inform research design. The following chapter will now explore the methodologies and methods used throughout this thesis.

Chapter 3. Methodology and Methods

3.1. Introduction

This chapter describes the research methodologies used throughout this thesis. An overview of research methodologies will be presented before discussing their application within this thesis. The choice of research methods and data collection will then be explored, covering use of interviews and focus groups for qualitative methods, and pre / post-test data collection for quantitative methods. The chapter will then describe how both quantitative and qualitative data will be analysed.

3.1.1. Research questions and hypotheses

The main objectives of this research are to explore the effectiveness and impact of pharmacist-led PE feedback as described in chapter 1.

The research questions to be explored include;

1. What is the impact of feedback on prescribing error rates?
2. What are the views, attitudes and experiences of pharmacists to delivering prescribing error feedback?
3. What are the views and attitudes of prescribers to receiving feedback?
4. What is the impact of feedback on prescriber behaviour?

Based on the literature review in chapter 2, the hypotheses are;

H_1: "There is a difference in mean change in prescribing error rate between the intervention and control group"

With two sub hypotheses;

H_2: "There is a difference in the frequency of error severity following the intervention period"

H₃: "There is a difference in the frequency of error type following the intervention period"

And finally;

H₄: "There is an association between number of feedback sessions and change in prescribing error rates"

3.2. Research Methodologies

There are two distinct research paradigms in educational research; positivist and interpretivist. The positivist paradigm is the objective paradigm, often generating large numbers of subjects for statistical analysis and generalisation (Cohen *et al.* 2011). Conversely, the interpretivist, or naturalistic paradigm focuses on in-depth analyses of behaviour allowing interpretation of participant's reality. These conceptual frameworks allow articulation of our world-views, to inform research design (Basit 2010) and actions (Bassey 1999).

These paradigms reflect two distinct research methodologies; quantitative (*positivist*) and qualitative (*interpretivist*). Quantitative methodology is nomothetic and subscribes to the fact that knowledge is generated through testing of hypotheses through collection of data and rigorous statistical analyses (Cohen *et al.* 2011). Conversely, qualitative methodology is idiographic or hermeneutic in nature, with a focus on individual behaviour and reality (Cohen *et al.* 2011).

A third paradigm also exists; mixed methodology or a *pragmatist* approach (Cohen *et al.* 2011), and warrants further consideration for this thesis. It is argued that polarization of research methodology is non-meaningful and unproductive (Ercikan and Roth 2006) with the two approaches compatible. This issue is discussed more vociferously elsewhere with Robinson (1995) arguing that any paradigmatic dichotomous debate should be declared a

draw and all methods of knowledge acquisition equally accepted. Considering this, a combination of quantitative and qualitative methodologies are increasingly favoured within research with Johnson and Onwuegbuzie (2004) proposing that mixed methods research is a 'research paradigm whose time has come'. Mixed methods research can illuminate perspective and corroborate data through triangulation of quantitative data, with qualitative insight. Here, the approach can provide a more complete picture whilst overcoming any weaknesses of individual approaches (Denscombe 2008).

It has also been argued (Onwuegbuzie and Leech 2005) that methodological puritanism should give way to pragmatism in addressing research questions. A quantitative, qualitative or mixed-methods approach may be appropriate (Savanye and Robinson 2004). As Marshall (1996) suggests; methodology "…should be determined by the research question, not by the preference of the researcher".

As outlined above, this thesis is concerned with determining the impact of feedback on PE rates and the recipients (prescribers) and facilitators (pharmacists) of feedback.

The primary research question clearly resonates with quantitative methodology. Quantitative research develops knowledge through cause and effect thinking (Basit 2010). It is an objective approach to quantify reason, with valid inferences derived through rigorous statistical analysis. Epistemiologically, the hard, objective evidence required is consistent with the positivist approach to research as described earlier. The feedback intervention is experimental and the research is concerned with exploring the impact, if any, on PE error rates. Therefore, any paradigmatic view-point is redundant, a numerical method is required to answer this question and hence a quantitative approach is required.

However, where PE rates do change, a quantitative approach will not illuminate why they have changed exactly, what the motivators are, or what

the impact has been on the individuals involved. Arguably, questionnaires could have been designed and distributed to address the latter research questions reporting responses as frequencies and percentages. However, as described in chapter 2, little is known on the subject and considering this, such an atomistic and reductionist approach to research would not provide the depth and richness required to answer research questions 2-4. Equally, the author did not want pre-determined questions to limit findings of the feedback process. The impact of feedback on participants will be subjective and variable, people after all are autonomous beings and create their own reality. By describing events through different lenses, individual perspectives can be illuminated, facilitating comprehension of an authentic world. This resonates with an interpretivist model requiring qualitative methodologies that are more responsive to participants (Basit 2010), who define their own reality (Cohen *et al.* 2011). As suggested elsewhere (Basit 2010:16), the 'devil is in the detail' and a qualitative approach can provide the richness and depth of information to inform the latter research questions.

However, equally, quantitative and qualitative approaches should not be used individually but in combination to support each other. In this thesis, the research questions demand a mixed methods approach to the research and will be "mutually illuminating" (Bryman 2007) to support and corroborate findings.

Therefore, a mixed methods approach is warranted to triangulate both numerical outputs and narrative understanding. A "puritan" quantitative or qualitative approach could not be used, and therefore a mixed methodological approach is needed. Traditionally, mixed methodologies allow triangulation of data, affording greater reliability and inferences for the results (Cohen *et al.* 2011) and are poignantly termed the 'third research paradigm" (Cohen *et al.* 2011:22).

3.3. Research Methods

The ontological view of the author is that personal knowledge and understanding is a subjective acclimation of experience. However, epistemological assumptions depend on the question, i.e. the methods must be fit-for-purpose and the methods used to answer the research questions will be described and justified below.

3.4. Qualitative research methods

Qualitative research allows in-depth review of experiences and attitudes to understand subjective meaningful experiences (Basit 2010) and will be used in this thesis to address the aims and research questions of chapters 4, 6, 8 and 9. A range of methods can be used in qualitative research with interviews and focus groups two of the most common employed.

3.5. Semi-structured interviews

Semi-structured interviews are ubiquitous with qualitative research and case studies, and are most popular in educational research (Basit 2010). They are popular for exploring an individual's opinions and experiences of a particular topic (Roberts and Priest 2010). In this thesis, they have been used to explore experiences, attitudes and opinions of prescribers (chapter 6) and pharmacists (chapter 8) of the feedback process. They are also used again in chapter 9 to explore and understand the impact of feedback on prescriber behaviour following delivery of feedback on different errors. Here, interviews were chosen for as Kvale (2009:xvii) suggests;

"…if you want to know how people understand their world…why not talk to them?"

Interviews allow research and interview-question clarification to minimise any misunderstandings. Pragmatically, it would be easier to negotiate time away from the workplace with individual prescribers compared to a focus group, or

relying on honest and full completion of questionnaires. Equally, prescriber views in chapter 6 may have been limited if they were interviewed as part of a focus group with other grades of prescribers who held different views to them for example. This consideration also informed choice of interviews for exploring pharmacist views post-intervention in chapter 8 as senior pharmacists may have limited or biased the views of more junior pharmacists in a focus group. Interviews were considered more suitable again in chapter 9 as prescribers were discussing personal PEs; information disclosure that may have caused embarrassment if discussed as part of a focus group for example.

A clear advantage of interviews is the depth and richness of data (Basit 2010). Use of open-ended questions can allow the spontaneity for participants to elaborate and articulate views with greater qualitative purpose, than for example with questionnaires (Oppenheim 1992). It is not simply yes / no responses that the researcher is looking to elucidate, but rather the rationale behind their judgements and responses. For example, if the feedback process affects working relationships, interviews allow the opportunity to elucidate this further by asking how, why and by what means. Considering this, interviews, as opposed to questionnaires have a clear advantage.

As the term 'inter-view' suggests, the process is a two-way, interactive conversation between researcher and participant (Cohen *et al.* 2011). Kvale (1996:14) sees an '*inter-view* as an interchange of views between two or more people on a topic of mutual interest'.

To support this 'interchange' of views, topic guides were used (Appendices 3-5) based on pre-determined themes and constructs. These themes and questions were underpinned by the literature review in chapter 2, personal insight of the author and the research questions. Each interviewee was asked core questions for consistency. However, the semi-structured approach allowed a more fluid interview, digressing through relevant topics

and allowing probing and generation of impromptu, spontaneous questions devised during the interview.

These supplementary questions can elaborate responses and ideas to gather richer, in-depth information (Basit 2010:104) that structured interviews may miss. As Walford (2001) suggests, interviews become a co-constructed event, illuminating otherwise hidden information (Basit 2010).   This requires active listening or "listening with the third ear" (Oppenheim 1992:67) for what may be unspoken.   To this end, close observation of body language is necessary to gauge the need for further clarification of interviewee response. Where there is an incongruence between the spoken and unspoken word, follow-up questions were used to clarify the message echoing the view that "…interpersonal skills of a high order…" are essential for successful interviews (Oppenheim 1992:65).   Therefore, face-to-face interviews were used in this thesis as opposed to telephone interviews for example.

3.5.1. Interview study setting

All interviews were conducted in a neutral, private environment away from clinical areas. Pharmacist interviews in chapter 8 were conducted in a private seminar room within the pharmacy department.   Prescriber interviews in chapters 6 and 9, were conducted in a location at their discretion. This was typically in private interview rooms at ward level or in pharmacy, or for more senior prescribers, in their own offices.   For participating pharmacists, protected time off rota was negotiated with the clinical services manager beforehand.   For prescribers, ward staff were informed of their participation and likely duration of the interview in an attempt to limit distractions.

3.5.2. Interview sampling

The research in this thesis is a case study within one NHS organisation. Considering this, participants were recruited from within the organisation only.   Qualitative research often uses non-probability, purposive samples (Cohen *et al.* 2011).   A purposive sample is selected to represent the study

purposes and any participants recruited must have the experience and expertise to answer the research questions (Basit 2010). This informed inclusion and exclusion criteria for participation throughout this thesis. Sampling is therefore selective and results cannot be generalised (Cohen *et al.* 2011, Basit 2010) with any other groups finding applicability in the results a 'fortunate bonus' (Cohen *et al.* 2011:161).

For chapter 6, prescribers were eligible to participate if they had received feedback from a ward based pharmacist. In chapter 8, pharmacists were eligible for participation if they had delivered formalised PE feedback. In chapter 9, prescribers were eligible to participate if they had received feedback on an individual PE.

It is estimated that a 1-hour interview can take up to 6-hours to transcribe (Cohen *et al.* 2011) whilst the coding and data-analysis can be a similarly time-consuming process (Oppenheim 1992). This however, is in countenance of the need to provide rich qualitative data and reach data saturation, that is, no new codes, categories, relationships or themes are emerging from the data (Cohen *et al.* 2011).

3.5.3. Interview recruitment

The author presented an overview of the project to all pharmacists and relevant directorates (for example at clinical meetings) in the hospital where prescribers were receiving feedback as part of this research. This was to raise awareness and understanding of the process and their involvement with the project.

All pharmacists involved in delivery of feedback either in chapters 5 or 7 were invited to participate in an interview. A standard e-mail was distributed (Appendix 6) along with a participant information letter (Appendix 7) and consent form (Appendix 8). Following expression of interest, a follow-on e-mail was sent to arrange a mutually convenient time.

For prescriber interviews in chapters 6 and 9, following delivery of feedback ward-based pharmacists provided participant information sheets (Appendices 9 and 10) to prescribers. Where prescribers expressed an interest to participate, standard e-mails (Appendices 11 and 12) and consent forms (appendix 8) were sent by the author to arrange a mutually convenient time for the interview.

Recruitment of pharmacists or prescribers did not pose any great difficulty. At times, interviews with prescribers had to be postponed because of unforeseen changes in their clinical demands, reflecting the working environment of a busy district general hospital. Where interviews had to be rearranged, it was typically within a day.

3.5.4. Interview Schedule

Pilot interviews informed only minor typographical or grammatical changes to the topic guide.

Following standard introductions, participant information sheets were distributed and then discussed to cover the purpose of the interview and likely duration. Consent forms were signed for all pharmacist and prescriber interviews.

Pagers and mobiles were turned off to minimise disruptions during the interviews. For prescribers, this was not possible but disruptions were limited by advising ward staff of their participation beforehand and likely duration of absence. Where the interview was disrupted, the recording was paused and restarted upon return of the prescriber although this only occurred on one occasion with an interviewee in chapter 9.

Topic guides were used to limit interviewer bias whilst affording a systematic approach to data collection, although it is acknowledged that differences in interviewer sequencing of questions may affect responses (Cohen *et al.* 2011). The author was aware of this risk and attempted to maintain

sequencing of questions, whilst also repeating questions that the interviewee may have addressed earlier in discussion.

All interviews commenced by collecting relevant demographic data. The semi-structured interview questions were exploratory and designed to address the relevant research question which, along with the researcher's understanding of the literature (as discussed in chapter 2) informed question design and themes. For example, for the prescriber interviews in chapters 6, the interview would open with general questions of the process to engage the interviewee and get them discussing their experiences of receiving feedback. This would then lead into other key themes to explore the impact on prescribers themselves and their views of receiving feedback from pharmacists. Open-ended questions and further prompting were used to allow the spontaneity for participants to elaborate and articulate views with greater qualitative purpose (Oppenheim 1992). The flexibility of this approach to engage in discussion was also desirable to encourage rapport and facilitate interactive, open conversational exchange from interviewees, (Cohen *et al.* 2011) illuminating what could be hidden by closed questions (Basit 2010).

A similar process was adopted for the pharmacist interviews in chapter 8. The topic guide (Appendix 4) introduced general questions to understand experience and views of delivering feedback, before exploring specific process themes such as timeliness of feedback and time constraints, and finally, impact of delivering feedback on pharmacists themselves.

In chapter 9, the topic guide (Appendix 5) consisted of two phases. Here, the research was concerned with exploring the impact of feedback on prescribing behaviour following feedback on different types of PE. Therefore, opening questions were designed to ascertain previous training in prescribing, PE details and situational factors to determine the type of PE. Interviews in particular, are considered the most effective method to identify error causation (Tully 2012) where participants can describe what happened and why. Initial questions in the topic guide were constructed based on

principles of critical incident theory (CIT) (Flanagan 1954) and the work of other authors who have researched PE causation (e.g. Lewis *et al.* 2014). CIT was a desirable approach to discuss specific aspects of prescribing and the intentions, behaviours and actions of the prescriber as it "does not collect opinions, hunches and estimates but obtains a record of specific behaviour" (Flanagan 1954). Subsequent open questions based on the researchers understanding of the literature and research questions were used to explore the impact of feedback on prescribing practice.

Classification of the cause of each PE followed the taxonomy of James Reason as described in chapter 1, the most commonly adopted approach to investigating error causation (Tully 2012).

3.6. Focus groups

A key research question was to determine pharmacist attitudes and experiences of delivering feedback prior to implementing the intervention. As described in chapter 2, little is known on this subject and again, a qualitative approach was justified. Semi-structured interviews were used to explore pharmacist views of delivering formal feedback in chapter 8 and arguably could have been used at baseline to address the research question. However, a second qualitative method was employed; focus groups.

A focus group is an interview conducted with a group of participants (Basit 2010). They gather rich qualitative data (Neale 2009) for subjects where little is known, generating themes and ideas for further research and quantification.

They are not a group interview where the researcher asks questions of individual group members, but instead are a dynamic interview with the researcher merely facilitating discussion amongst participants (Basit 2010). To this end, the group actively interact to discuss the topic and present a collective view (Morgan 1988). The researcher, as with interviews, poses the

questions (Neale 2009) and keeps the group interactions in check as facilitator.

This requires a clear articulation of the subject matter (delivery of PE feedback) by the researcher with skilled moderation also tantamount to enable participation of all group members (Krueger and Casey 2000), encouraging all to speak without controlling the discussion too much (Cohen *et al.* 2011:437). The researcher can then tease out all relevant information through prompting and stimulating reflection of the subject (Newby 2010:351). As Morgan (1997) iterates, the emphasis diverges away from establishing *what* people think but rather *how* they think and *why* they think that way to generate not simply answers, but the reasoning and rationale behind responses. Example questions in the topic guide included;

- Do you think that prescribers should receive feedback on prescribing errors? Why?
- Do you provide feedback on prescribing errors? How?
- Why do you think delivery of prescribing error feedback might be inconsistent?
- How do you deliver feedback, if any, on prescribing errors?
- What factors make you decide whether you feedback or not on a PE?

These open-ended questions are perfectly suited to be explored by focus groups as they beg for explanations and descriptions as suggested by Krueger and Casey (2000:24), who also suggest that focus groups should be used when;

- You are looking for a range of ideas
- You are looking for differences in perspectives
- You are looking to uncover factors that influence perspectives
- You want ideas to emerge
- You want to pilot test ideas
- You want to gather information for further quantitative studies

- You want to shed light on quantitative data
- You place high value on the voice of the participants

Considering this, focus groups are useful in early case studies to illuminate what is unknown of a subject and participant values, attitudes and opinions (Cohen *et al.* 2011). They can be used pre-emptively to larger studies, clarify results from other methods such as questionnaires or indeed they can be used in their own right (Neale 2009). They allow 'focus' on a particular topic, provided by the researcher, whilst encouraging interaction and the voice of multiple participants to illuminate both a consensus and diversity in opinions (Morgan 1997). Focus groups can be useful for engaging less confident individuals who may be inhibited by interviews but are actively engaged when a discussion is initiated by others (Kitzinger 1994) or where they realise that others share their opinions (Stewart and Shamdasani 1990). Indeed, focus groups allow ideas to be explored and clarified within a group of like-minded people with a 'common communicative ground' (Furber 2010).

For the pharmacists who participated in these focus groups, this 'common communicative ground' is identification and resolution of PEs which should involve some form of feedback and corrective action. They have a shared experience and homogeneity of background in this regard, an important consideration for focus group samples (Morgan 1997).

As pharmacist views and experiences in addressing PEs were likely to vary, this diversity of opinion was ideally suited to be explored, compared and contrasted through use of focus groups (Neale 2009). That said, focus groups were purposely avoided in chapter 8 to explore pharmacist views of the formal feedback process. The author was cognisant that the experiences of pharmacists of delivering the formal feedback may well vary with senior pharmacists for example, potentially having greater confidence in their abilities, which may have inhibited more junior pharmacists to openly discuss their own experiences.

Focus groups have a further advantage in that they are more economical on researcher time and costs (Hyden and Bulow 2003) whilst gathering a large amount of data in a small amount of time (Cohen *et al.* 2011): a clear advantage for the lone researcher. This was an important consideration to gather pharmacist views before commencing the pilot study (Chapter 5) that may have biased the results or at the least reduced the sample pool available to interview.

3.6.1. Focus group study setting

The focus groups were undertaken in a seminar room within the pharmacy department. Careful attention must be afforded to the environment with Krueger *and Casey* (2000) suggesting that only 80% of data analysis comes from the transcripts with the rest coming from the environment. To this end, the author was cognisant to consider group dynamics, interaction and body language to summarise and clarify collective views and opinions. As the questions encourage debate, focus groups were typically longer than interviews.

3.6.2. Focus group sampling

A purposeful sample was used which, as described above, is selectively chosen to meet the purpose of the study (Basit 2010). Therefore, for eligibility for inclusion, pharmacists had to be actively involved in screening prescriptions either on wards or in dispensary and therefore having to intercept and resolve any PEs. This ensured they had the experience to answer the research question. The sample therefore included every pharmacist in the department with the exception of the head of pharmacy who does not have a clinical or dispensary role. This allowed recruitment of pharmacists with a range of experience and seniority.

3.6.3. Focus group recruitment

The author presented an overview of the project at a pharmacy departmental meeting. This was followed by an invitational e-mail (see appendix 13) and participant information sheet (see appendix 14). Where pharmacists expressed an interest to participate, the author liaised with the head of clinical pharmacy services to co-ordinate the focus groups and allow protected time away from the rota to participate.

Recruitment of pharmacists did not pose any great difficulty although logistically, it was at times challenging to arrange mutually convenient times for the focus group participants owing to annual leave or other professional commitments for example.

Morgan (1988) advocate that 4-12 people are recruited for the focus group whilst Fowler (2009) advocate between 6 and 8 individuals. Three to five groups should be used to ensure data saturation is attained (Neale 2009). This should include an oversubscription of participants to allow for potential non-attendance (Morgan 1988).

It has been postulated that focus group participants should be heterogeneous; that is, they do not know each other (Rabiee 2004). Such dynamics can allow more honest and spontaneous views to be expressed whilst limiting any potential seniority bias that may be introduced from a homogenous group. However, equally, homogenous groups can relate to each other and may be more willing to challenge others opinions (Kitzinger 1994). The participants in the focus group are used to departmental and educational meetings where professional candour and challenge are common, and it is the view of the author that using a homogenous group would not impact negatively on the results.

At the time of recruitment there were 32 pharmacists within the pharmacy department eligible for participation. All pharmacists expressed an interest to participate. Four focus groups were facilitated with 6 pharmacists in each

group having a variety of seniority and experience. Group characteristics are discussed further in chapter 4. Participants were selected according to their availability on arranged dates.

3.6.4. Focus group schedule

A similar process to the interviews was followed with standard introductions, focus group overview and signing of consent forms. Pagers and mobiles were turned off to minimise disruptions.

A topic guide (Appendix 15) was used, developed by the author and informed by the literature review, the author's own insight as a clinical pharmacist and research objectives. Participants were sat around a table with junior pharmacists (see chapter 1 for pharmacist grades) seated opposite, and more senior pharmacists nearest to, the author to encourage open discourse from junior pharmacists and limit potential seniority bias. Focus groups commenced with the collection of relevant demographic data and the author making a note of table plans although the author knew the pharmacists in a professional capacity to further aid identification from audio files. The author facilitated discussion following the topic guide in sequence for each focus group. The topic guide included introductory, transitional, key and ending questions (Krueger and Casey 2000). These were designed to collect relevant demographic data and an understanding of how pharmacists intercept and deal with PEs. The guide then progressed to more specific process themes to understand views of delivering more formalised PE feedback.

3.6.5. Limitations

As a pharmacist employed by the host organisation, there is potential for the author's position to influence the results where the interviewee seeks to avoid, impress or reject the researcher questions, a phenomenon described as the Hawthorne effect (Basit 2010). Interviewees may feel compelled to

reveal what they think the researcher needs, or wants to hear (Kvale 2009), a potential authority bias.

Power asymmetry exists in interviews (Kvale 2009). The researcher decides research questions, hypotheses, methods and analytical approaches and will also be asking the relevant questions. Oppenheim (1992) suggests this can create interviewee resentment, generating elements of 'counter-control' (Kvale 2009:34), impeding the depth and authenticity of the interview.

The author was cognisant of these risks and the need to remain empathetic and objective throughout, limiting any potential bias from negative or positive emotions and developing rapport with the interviewee. Rapport can encourage greater candour in response (Basit 2010). More truthful and elaborated responses are likely, for as Oppenheim (1992:89) suggests, rapport "…keeps the respondent motivated and interested…" whilst Bogdan and Biklen (1992:97) suggest that "Good interviews are those in which the subjects are at ease and talk freely about their points of view". To this end, as an experienced pharmacist with a background in pharmacy and medical education, the author considered his position in the hospital as a potential strength and not a weakness as interviewer.

Limitations of specific methods will be discussed further in chapters 4, 6, 8 and 9.

3.7. Quantitative Methods

3.7.1. Section introduction

As outlined at the start of this chapter, the primary research question is concerned with exploring the effect on PE rates. This requires an experimental design to demonstrate any relationship between cause and effect through statistical scrutiny (Basit 2010). Quantitative approaches will be used to address the research aims of chapters 5 and 7 with the qualitative results of chapters 6,8 and 9 used to inform rationale and reason for any

change.   A range of methods can be used in quantitative research to measure the effect of an intervention using pre- and post-testing.   Such experiments can include the use of control and / or interventional groups in either true or quasi-experiments and will be reviewed further below.

3.7.2. Study design

Experiments bring an element of objectivity to research where an independent variable is changed and the effect on a dependent variable is measured (Basit 2010).   In this case, the independent variable is whether formalised, constructive feedback is provided on PEs, whilst the dependent variable is PE rate.

It has been proposed that there are two distinct types of experiment (Basit 2010); True and quasi-experimental.   In true experiments the variables are isolated, controlled and manipulated with random allocation to either control or intervention group (Basit 2010) before pre- and post-testing to measure the effects of the intervention.   If an experiment does not possess these features then it is considered quasi-experimental (Cohen *et al.* 2011).

Quasi-experimental designs are often employed in educational research where for example the random assignment of schools and classrooms is impractical (Cohen *et al.* 2011:322).   In deciding on prescriber allocation in this thesis, random allocation of prescribers and wards was considered impractical where prescribers often cover more than one ward as part of a clinical rotation.   Therefore, a convenience sample was used with wards matched based on comparable patient turnover following discussion with the pharmacy clinical services manager.   Whilst prescriber demographics may vary between wards, the relevant mix of prescriber grades and experience should be comparable.   Considering this, random allocation of prescribers may create limited potential for feedback whilst contextual factors such as specialty, team dynamics or prescribing culture may influence feedback response. There is also the risk of potential diffusion (Basit 2010:33) of effect to control group prescribers and pharmacists, where the benefits of feedback

are discussed, or the process itself influences control group prescribers who work in experimental areas for example. Therefore, unlike randomised clinical trials, it has been argued that randomisation in educational research cannot truly isolate, control and manipulate all variables (Rowe and Oltmann 2016). To this end, a quasi-experimental design is used to address the primary research aim in this thesis.

The process steps involved in experiments have been summarised (Gorard 2003:163) as including;

1. Formulate a hypothesis
2. Assign cases to groups (feedback or normal practice)
3. Measure the dependent variable (prescribing error rate)
4. Introduce the intervention to relevant group (constructive feedback on prescribing error rates)
5. Re-measure the dependent variable (prescribing error rate)
6. Calculate the difference, significance and effect size of any difference

The hypotheses were described at the beginning of this chapter. Considering these steps, the first null hypothesis for example would be that there is no difference in change in PE rates following the intervention period for control and intervention groups. For example, if the intervention group error rate is 20% pre-test and 15% post-test, whilst the control group pre-test error rate is 15% and 10% post-test, the net change is 0%. In this study however, the hypothesis (H_1) is that delivery of feedback on PEs will produce a change in PE rates between groups.

In the above example, prescribers in the intervention group receive constructive feedback and the control group continue with existing standard practice (See figure 7 below).

Figure 7: Overview of experimental study design

Group	Pre-test	Feedback on prescribing errors	Post-test
Intervention group (feedback)	O	√	O
Control Group (normal practice)	O	O	O

Whilst a single pre-test, post-test experimental group could have been used and would be more economical, an uncontrolled design may invalidate any findings (Cohen *et al.* 2011). For example, any change in PE rates may be due to other influencing factors such as prescribers improving over time, or prescribers or pharmacists may work in different ways to others. Additionally, there may well be other extraneous, confounding factors that the researcher cannot predict, account for or control. Therefore, an intervention and control group pre-test, post-test design is used to address the aims of chapters 5 and 7.

The dependent variable, PE rate, is dependent on another factor (Scott and Mazhindu 2009) which in this case is the independent variable, PE feedback.

The pre-test, post-test design allows repeat measurement of the dependent variable following the intervention. This then allows calculation of the change scores in PE rates and allow statistical inferences to be made as discussed in section 3.12.12 below.

3.7.3 Data collection

Data was collected using established methods in this field of research (Dornan *et al.* 2009, Seden *et al.* 2013) and will be discussed here.

PE data can be collected prospectively or retrospectively from case notes and medication charts for example or by other means such as incident

reporting systems. However, the former is more common (Lewis *et al.* 2009) and pragmatically resonates with how prescription errors are typically identified and resolved by ward-based pharmacists.

Healthcare professionals such as pharmacists are most commonly used to collect PE data (Tully 2012). Ward-based pharmacists can collect such data as part of their routine clinical practice and will clearly have greater understanding and context of any prescribing decisions. However, such data collection can be burdensome (Tully 2012), an issue the author is both familiar with and cognisant of. External, trained data collectors have been used in some studies yet data collection is equally labour intensive (Tully 2012) and has associated staff costs that would be beyond the scope of this project. However, it is also important to highlight that pharmacists in the hospital are familiar with undertaking various audits, including PE audits, as part of routine practice. Considering this, a prospective approach to data collection was adopted (See figure 8 below) to determine PE prevalence and reflects data collection methods commensurate with most PE studies (Lewis *et al.* 2009)

Figure 8: Overview of quantitative data collection method

Pharmacists trained in data collection methods

Pharmacists collect prescribing data using standardised audit form over 5 days

Pharmacists return audit forms to researcher

Researcher independently checks and re-assesses error, severity and type
(Any discordant ratings discussed with a third pharmacist)

Data entered into SPSS for statistical analysis per prescription and per prescriber

Results presented in chapter 5 (feasability study) and chapter 7

Pharmacists audited prescriptions prospectively for five days (Monday to Friday) at the same time for both control and intervention wards. This was undertaken at baseline for pre-test data and three months later for post-test data. All pre-test data were collected prior to any delivery of feedback with feedback commencing the following week for the intervention group. This was to limit the effects of any other potential confounding effects on prescribing (Cohen *et al.* 2011). When to re-audit was a practical consideration as re-auditing too close to the pre-test data would be burdensome for the pharmacists. Equally, if re-measured too soon, any effect of the intervention may not be captured where prescribers need time to reflect and amend their prescribing behaviour for example. Conversely, if measured too close to the intervention, it is possible that any effect would be temporary, a 'recency effect' (Cohen *et al.* 2011:328) where prescribers amend their behaviour in response to any feedback yet may revert to previous practice shortly after. In consideration of this, post-testing was undertaken 3 months later before training grade doctors would typically rotate to other specialties. This would allow potential inference into the longer-term effects on prescribing whilst allowing sufficient time for prescribers to receive constructive and contextualised feedback.

All prescriptions were audited including once only, regular, when required medications, and infusion fluids. Where separate charts were used, for example warfarin or vancomycin prescribing charts, these were also audited. Prescriptions were included in data collection where they had not previously been seen by a pharmacist. When a pharmacist has reviewed a prescribed item for a patient they sign the prescription in the designated area. If a pharmacist had already reviewed the prescription, the prescription was not included again unless a new error was identified relevant to that prescription (for example, change in renal function, drug interaction or error not identified by another pharmacist initially), to prevent duplication of data.

A standard data collection proforma was used to collect data (Appendix 16). Pharmacists were familiar with this proforma from annual audits of prescribing undertaken in the hospital. The proforma included information on

the ward, prescriber, prescriber grade, number of items and listed errors where relevant with a description of any error. Where an error was listed, the potential severity and type of error was coded. The proforma used in this thesis was based on that used in the key PE prevalence study (Dornan *et al.* 2009), and modified for error type for ease of categorisation based on a more recent study (Seden *et al.* 2013).

A pilot test was conducted initially with results presented in chapter 5. This design consideration allows the researcher to identify any 'snags' or unanticipated design flaws in the experiment with Cohen *et al.* (2011:326) iterating that such an approach is of 'crucial importance'. However, pragmatically, given the resources required to conduct the study, it is also sensible to conduct a pilot study to determine the feasibility of the project and its potential impact and significance. Answers to these questions will inform the need to conduct a larger study as reported in chapter 7.

3.7.4. Prescribing error severity and type

Whilst the key aim of this research is to determine the impact of feedback on PE rates, it was also considered useful to determine the impact on potential error severity and type of PE. Directly, this can illuminate the potential impact of feedback on different error types. Indirectly, it could inform future avenues of enquiry where for example dosing errors are reduced but writing errors are not, or serious errors are reduced but minor errors are not. Collection of such data requires interpretation on behalf of the data collector to determine both error severity and type of error intercepted.

The author was aware of the potential for inter-rater variation and bias from interpretation of PEs from facilitation of previous PE audits at STHKH, and the wider literature (for example Seden *et al.* 2013). To limit bias, the author provided relevant training on PE classification as discussed in section 3.8, whilst the error type was simplified as described below and the same pharmacists collected PE data at pre- and post-intervention.

In addition, the author independently reviewed each recorded PE, assessing them for concordance with the agreed definitions of a PE, error severity and error type. Where any potential discrepancies were identified, they were discussed with a third, senior pharmacist, with experience in PE audits. The third pharmacist was asked to independently grade the PE. Where there was agreement between the author and pharmacist, the PE was reclassified accordingly. Where there was disagreement, the author and pharmacist discussed the PE further for consensus agreement.

There were four categories for PE severity (Appendix 17):

1. Potentially lethal
2. Serious
3. Significant and;
4. Minor

Error severity was based on that outlined elsewhere (Dornan *et al.* 2009), informed by earlier research (Folli *et al.* 1987, Lesar *et al.* 1990, Lesar *et al.* 1997a, Lesar *et al.* 1997b, Tully *et al.* 2006) and represents the potential impact if the error was not intercepted by the pharmacist.

For error type, the modified classification system reported by Seden *et al.* (2013) was adopted as this was more simplistic, limiting potential for misinterpretation whilst making data collection less burdensome on pharmacists. This system amalgamated twenty-nine categories (Dornan *et al.* 2009) into a simplified list of ten categories (Appendix 18);

1. Dosing errors
2. Writing errors
3. Allergy status errors
4. Duration of treatment wrong / not specified
5. Drug interactions
6. Omission of medication
7. Excessive / unnecessary prescribing

8. Clinical safety errors

9. Lack of clear directions for administration

10. Miscellaneous (no indication, illegible, abbreviated name, incorrect patient etc)

3.7.5. Setting

A description of the hospital used in this case study was provided in chapter 1. All wards, involved in the research had ward-based pharmacists who reviewed inpatient medication charts (kardexes) on a daily basis (Monday to Friday). All inpatient prescribing for control and intervention wards was undertaken on paper charts with electronic systems used for discharge prescriptions. Discharge prescriptions may be processed at ward level by the ward pharmacist or in the pharmacy department. Where any discrepancies are identified, a prescriber is typically contacted to amend the prescription. For the research presented in chapter 5, wards were chosen to provide a comparable mix of pharmacy service, prescriber grades and turnover of patients. For the research presented in chapter 7, a wider range of wards were used including medical, surgical and admissions wards to represent the hospital and variety of specialties, prescribing demands and patient turnover that prescribers are exposed to.

3.7.6. Control group *vs.* Intervention group

Training grade doctors typically spend four months in a specialty before rotating to another area with registrars typically spending longer and consultants usually, but not exclusively, attached to one ward area. For example, prescribers may work across several different wards depending on their specialty. Therefore, prescribers were allocated to control or intervention groups depending on their ward areas. Allocation of wards as intervention or control was negotiated with the clinical pharmacy services manager beforehand. Wards were matched for size, comparable number of prescribers and prescriber grade and turnover of patients. This is discussed further in chapters 5 and 7. Following collection of pre-test data, pharmacists

delivered constructive feedback (as described in section 3.9 below) to prescribers on intervention wards, whilst pharmacists on control wards continued with normal practice.

3.7.7. Sample size

Consideration of required sample size is an important part of research design to ensure that any statistical test can measure difference. A type 1 error, or a false positive, can be made when the level of significance (the p value) is too high. Equally, if the sample size is too small, significant effects may not be detected and this is a false negative result (Cohen *et al.* 2011). Based on the initial research hypothesis, *a priori*, assuming the error rate in the intervention group improves by 5% with a standard deviation (measure of dispersal of a result) of 2.5, and the control group remains the same over time, a sample size of less than six prescribers per group would be needed with a significance of 5% and a power of 80% (calculated via http://biomath.info/power/ttest.htm). This was considered feasible for the pilot and larger study in chapter 7.

In addition, considering the results and effect size (d=1.6) from pilot data in chapter 5, the sample size calculated to demonstrate reproducible results in chapter 7 using the same alpha (0.05) and beta (0.2) values, was less than six prescribers in each group, although larger samples were used.

3.7.8. Limitations

The main weakness of the methods described in this section is the non-randomisation of prescribers to either control or intervention groups. This can raise potential questions over the internal validity of the study design through allocation bias as other variables may be confounding the pre-test data that influences post-test scores. For example, some wards may have more supportive senior prescribers, or the ward based pharmacists may interact with the clinical teams differently that may influence prescribing, for

example attending ward rounds. Any variable not accounted for may be the cause of any change and not the feedback.

However, as described earlier, wards are matched for turnover and number of prescribers and pharmacy service. Equally, randomisation may have equally biased results through diffusion and influenced the decision to adopt a quasi-experimental design. Any variation in practice at ward level is beyond the control of the author, as is response of prescribers to the feedback itself and non-randomisation was considered justified by the author.

The burden of collecting audit data alongside routine practice could limit the total number of prescriptions that are audited. However, as mentioned, pharmacists are used to conducting audits on a regular basis alongside routine clinical practice, whilst it would not be feasible to recruit and train a supernumerary data collector for example.

As pharmacists are collecting and grading errors, there is potential for subjectivity and variance in grading error severity and type. However, as it is a single case study with the same group of pharmacists collecting pre- and post-test data, one would expect any variance to be consistent between pre and post-tests data collection. Equally, pharmacists are familiar with the data collection proforma as part of annual PE audits. Pharmacists were also trained in data collection as described in section 3.8 below with the author also reading and assessing each PE for consistency.

It should be noted that this is only a single case study and the results or model of feedback may not reflect practice in other hospitals or settings. However, equally it should be noted that 84% of PE prevalence and intervention studies are reported as single cases (Lewis *et al.* 2009) whilst STHKH is a typical, large acute hospital in the UK.

Finally, the author is not collecting data on individual drug types or classes. Whilst this would be useful to illuminate if for example there are any

differences in prescribing behaviour for higher risk medications (for example insulin, anticoagulants or opioids), as opposed to other lower risk medications, the author considered this outside the scope of this thesis. The results of this research however could be used to inform further investigations on the effects of feedback on prescribing particular medications or in certain patient populations for example renal patients, paediatrics or care of the elderly settings.

3.8. Pharmacist training

All pharmacists involved in data collection for both control and intervention groups received a ninety-minute training session facilitated by the author. This included review and completion of the data collection tool, and classification of error severity and type. This was supported by scenario based training to contextualise information with appropriate discussion and feedback. All pharmacists were provided with an inter-rater assessment consisting of a range of prescribing scenarios (Appendix 19), pre-rated by the author, for which they had to identify any PE and subsequently grade them for severity and error type. This was assessed by the author and feedback provided to the pharmacist.

For pharmacists involved with the intervention group, a further 2-hour training session was provided to prepare them to deliver constructive feedback. This consisted of discussing the relevant theory, impact and principles of feedback, as described in chapter 2. Tools to support delivery of feedback were also discussed including Pendleton's rules (Lloyd *et al.* 2016b) for example, what constitutes good and poor feedback and use of critical incident theory (CIT) to identify error causation. This was contextualised with simulated videos prepared by the author and education team, demonstrating examples of good and poor feedback. The session concluded with pharmacists participating in a workshop that allowed practice of peer-to-peer feedback on PEs using relevant proformas, and was moderated by the author. Feedback proformas were designed to reflect principles of feedback

described in chapter 2. An overview of guiding principles for each feedback session is presented in figure 9 below.

Figure 9: Overview of a standard prescribing error feedback session

- Prescribing error data collected / identified and resolved by pharmacist
- Pharmacist identifies need to deliver feedback
- Pharmacist initiates written feedback form
- Pharmacist communicates need for feedback with prescriber and negotiates time and location to deliver feedback
- Purpose of feedback outlined (for professional development, reduce prescribing error rates)
- Prescribing error described by pharmacist
- Understanding of risk of prescribing error checked with prescriber
- Pharmacist uses open reflective questions (based on principles of critical incident theory) to identify cause of error
- Pharmacist facilitates identification of solutions to prevent error recurrence
- Prescriber summarises lessons learned
- Pharmacist completes feedback proforma to reflect above
- Pharmacist and prescriber sign feedback proforma
- Prescriber provided with signed copy of proforma and advised to complete reflective entry in training portfolio
- Pharmacist scans and files electronic copy of feedback intervention in secure pharmacy groups folder

3.9. Prescribing error feedback

Following pre-test data collection, pharmacists would prepare feedback reports for their prescribers (Appendix 1). This would include total number of prescriptions reviewed, prescription error rate, total number of items, individual item error rate and breakdown of error by severity and stage of prescription i.e. inpatient or discharge. The report would be delivered verbally and in writing and include good areas of prescribing to build on as

well as areas for improvement, consistent with principles of constructive feedback described in chapter 2. These reports were typically the week following data collection at a mutually convenient time arranged between the pharmacist and prescriber. The prescriber was informed of the purpose of the feedback in advance and that any discussion was confidential.

Following initial feedback, ongoing feedback was delivered, again in writing (Appendix 2) and verbally, for any error classified as significant or above. Feedback on single errors was chosen for logistical reasons; repeated audit and feedback would be labour intensive and unlikely to be timely. Feedback closer to the time of an incident has a greater impact on individuals (Hysong *et al.* 2006) and it has been proposed that feedback be delivered within one month (Ivers *et al.* 2012).

Equally, the severity threshold was chosen for pragmatic reasons. Minor PEs are the most prevalent in epidemiological studies (Tully 2012), and delivery of feedback on every single error would be unfeasible in clinical practice. Equally, it is possible that prescribers may not value feedback on minor errors such as forgetting to date or sign a prescription, risking dilution of any further messages. Considering this, it was decided that efforts of ward pharmacists should be focused on addressing more significant errors. Where relevant PEs were identified, pharmacists were advised that resolution of the error was the priority with timely feedback following at a later, convenient time, that was typically the same or following day.

Feedback forms were signed by the facilitating pharmacist and prescriber. Once complete, a copy of the feedback form was provided to the prescriber for inclusion in their foundation portfolio.

3.10. Research Ethics

Participants should not be harmed as a result of the research and ethical issues including access, consent, beneficence, non-maleficence, human

dignity and confidentiality need to be considered (Cohen *et al.* 2011; Basit 2010).

Informed consent recognises and respects the rights of individuals (Cohen *et al.* 2011) and details the purpose, benefits and risks of the study (Kvale 2009). Consent was obtained in writing prior to commencing interviews as described above, allowing informed decision for participation (Basit 2010), whilst acknowledging the right for 'informed refusal'.

Outlining benefits of research underpins the principles of beneficence. Where participants are aware of potential benefits they are more likely to want to take part (Cohen *et al.* 2011, Oliver 2003). Participant information sheets detailing the purpose and benefits of the research were provided as described above.

Non-maleficence or '*primum non nocere'* is a cornerstone of ethical principles (Cohen *et al.* 2011). No harm was wished upon participants in this study and if any participant in the interviews or focus groups became upset the interview would have been terminated and participants referred to relevant departments. Robust systems are integrated within the hospital to respond to MEs with pastoral support also available through medical supervisors, health work and wellbeing and doctors in difficulty procedures. However, equally, it should be noted that the process of feedback should be no different to that followed in practice where prescribers discuss errors with pharmacists or where referred, the responsible officer.

Prescribers were informed prior to interviewing that confidentiality would be ensured with the sole exception being the disclosure of intentional malpractice or unsafe practice. This was also covered in writing in the participation information sheets (Appendices 9 and 10) although the situation did not arise.

The author was cognisant of the need to conduct all interviews with respect and professional decorum. There is a risk of maleficence where the

researcher appears judgemental or in disagreement. Interviews must be conducted with sensitivity and finesse (Basit 2010) in a non-threatening manner to avoid causing stress (Cohen *et al.* 2011). Equally, human dignity was respected with each participant treated equally as individuals. This involved avoiding labelling them as 'subjects' or stigmatizing them (Cohen *et al.* 2011) for example as less-safe prescribers or less-able pharmacists.

As the research was likely to have impacts on the prescriber and pharmacy workforce, the project was discussed with the medical director, head of pharmacy and head of clinical pharmacy services in advance. For all intervention wards, the author liaised with each relevant clinical director in advance to inform them of the purpose and logistics of the project at ward level and expectations of prescriber participation.

To this end, prescriber and pharmacist participation in the feedback process was compulsory although further participation in any interviews was voluntary.

Relevant hospital and University of Liverpool ethics committees approved each phase of this thesis prior to data collection. The study was logged with the integrated research application system (IRAS) although ethical approval was not required as there was no patient involvement. This dual ethical and research approval also provides added scrutiny and validity to the study design and analysis reported in this chapter. Copies of approval letters can be viewed in appendices 20 and 21.

3.11. Data Protection and archiving

Interviews were audiotaped and stored on the author's personal home drive in the hospital, secured by NHS firewalls, and accessed only by the author. All interviews were transcribed verbatim with the exception of person and place names that were anonymised. The supervisory team had access to anonymised transcripts.

All audit forms were stored in a locked filing cabinet at the author's desk in the pharmacy department of the hospital.

All interviews and audit data will be destroyed upon completion of this PhD by the author.

3.12. Data Analysis

In the following section, the methods used for analysis of qualitative and quantitative data analysis will be described and explored.

3.12.1. Qualitative data analysis

Qualitative data analysis is not a simple task. It can be daunting for the lone or neophyte researcher when faced with volumes of transcripts, making data analysis a complex and arduous process (Basit 2010). Kvale (2009) emphasises the importance of contextualising data with transcriptions likely to capture a messy tome of data requiring refinement (Ritchie and Lewis 2003) before they become meaningful (Bell 2005). Considering this, qualitative analysis requires a systematic and rigorous approach, an approach that is equally labour intensive and time-consuming (Pope *et al.* 2000).

All interviews and focus groups were transcribed verbatim with the exception of anonymising person and place names. Where participants paused, laughed or appeared defensive for example, this was recorded in the transcript to capture relevant non-verbal behaviour.

All coding was undertaken manually. Whilst software tools (i.e. Ethnograph / NVivo) are available to facilitate coding of qualitative data (Ritchie and Lewis 2003), their application is in organising and retrieving data (Gale *et al.* 2013); they do not analyse data as argued elsewhere (Weitzman and Miles 1995:3), "…Computer's don't analyse data; people do". Considering this, manual coding was employed with pen and paper to develop the requisite coding

skills. Importantly this also allowed complete focus on the data analysis and not familiarisation with new software, for as Saldana (2013) suggests, the complexity of computer software programmes can become overwhelming.

There are various approaches to qualitative data analysis including those that develop theory from generated data (grounded theory), study of language and interaction (discourse analysis), study of experience and meaning (phenomenology) and thematic or content analysis for example (Cohen *et al.* 2011, Basit 2010). Here, analysis can be employed using either inductive (derived from data) or deductive (known before or emerges part way through analysis) approaches to analysis (Pope 2000). However, most researchers use a combination of approaches (Rabiee *et al.* 2004). Topic guides, researcher insight or knowledge of the literature will inform some themes and outcomes but not all, meaning that some analytical themes can be predicted *a priori* but that others will emerge and be refined *a posteriori*. This echoes the approach adopted in this thesis with a framework method applied to thematic analysis to analyse interview and focus groups transcripts.

The framework method is a widely-used approach to qualitative analysis (Furber 2010) in healthcare and sits within a broad family of thematic or qualitative content analysis (Gale *et al.* 2013). It is a flexible tool, used for many approaches but is used most commonly for the thematic analysis of semi-structured interviews (Gale *et al.* 2013) or focus groups (Rabiee *et al.* 2004).

The framework method follows a structured and systematic approach to data analysis that is conducive to handling what can be a large, complex and unyielding amount of data (Rabiee 2004).

This approach involves five key stages as outlined by Ritchie and Spencer (1994):

1. Familiarisation
2. Identifying a thematic framework
3. Indexing
4. Charting and mapping
5. Interpretation

Gale *et al.* (2013) propose a preliminary stage of the analytical process being 'transcription' as it is an early opportunity to become immersed in the data.

The author transcribed all interviews and focus groups personally and attempted to transcribe any preceding interview prior to the next to inform further facilitation, and understanding of the research subject.   Timely transcription minimises the potential of post-hoc abstraction (Kvale 2009:178) although this was not always possible.

Familiarisation involves fully immersing yourself in the data.   This was achieved through listening and re-listening and reading and re-reading the transcripts to systematically identify and understand emergent major themes (Furber 2010).   Following familiarisation, the author began the coding process, reading each transcript line by line, annotating descriptive codes and themes in the margins of transcripts whilst constantly comparing each interview or focus group transcript.   This abstraction and conceptualisation allows appreciation of the data as a 'whole'.

As pertinent themes emerged, the second stage involved sifting and sorting of the data into similar contextual themes.   This produced categories and sub-categories for an initial thematic framework, developed through constant comparison of transcripts. Initial themes were largely descriptive, informed *a priori* both from the literature, and the research aims and objectives and topic guide.   Further themes and codes emerged *a posteriori* from participant views and recurrent themes (Pope *et al.* 2000) that the researcher could not predict (Gale *et al.* 2013).   Initial frameworks were discussed with the research supervisors who independently analysed transcripts to ensure no

themes were invisible to the researcher. Any discrepancies were resolved for an analytical consensus through discussion.

For the third stage, the emergent thematic framework was applied to transcripts to 'measure the fit' (Ritchie and Lewis *et al.* 2003), annotating transcript margins with the relevant code and theme. This indexing allowed further immersion in the data and illuminated further inferences through refinement and conceptualisation of meanings and relationships between coding units. This is a more inductive and interpretive approach requiring logic and intuition. This refinement identified further codes whilst others were merged and allowed encapsulation of the data as a whole. This non-linear process is typical of the framework approach with each stage overlapping and merging with the next (Ritchie and Spencer 1994) whilst allowing themes to develop from both the research questions and participant narrative (Rabiee *et al.* 2004). Repeat rounds of coding were applied until theoretical data saturation was achieved, that is, no further emergent themes were identified.

The fourth stage involves charting and mapping the framework against relevant extracts with text lifted (copied and pasted) from the original transcript and placed into the conceptualised framework. This process reduced the data into manageable volumes to allow progression to the final stage. Relevant thematic frameworks are presented in chapters 4, 6, 8 and 9. Data was finally analysed, interpreting, comparing and contrasting themes and codes within and across participants in relation to the research objectives for meaning and explanation.

3.12.2. Quantitative Data Analysis

The author inputted all data per prescriber and per prescription into a database in statistical package for the social sciences (SPSS) v22. SPSS is a widely used (Basit 2010) and accessible software application for applied statistical analysis and contains relevant functions for the statistical analyses described below. Columns of data included ward number, prescriber

number, prescriber grade, pre/post-test, intervention or control group, number of items, number of errors and calculated error rate. For each prescription, further data were input to determine if the prescription was error free or not, the error severity and finally, error type. Data were checked for inaccuracies manually with cross reference to compare number of errors with reported severity and error type for each prescription line.

Both descriptive and inferential statics are important to describe and make inferences from available data. In the following sections the statistical techniques used throughout this thesis will be presented and described.

3.12.3. Descriptive Statistics

Descriptive statistics are exactly that: they describe, present and summarize data, reducing it for the reader to understand (Cohen *et al.* 2011, Scott and Mazhindu 2009). No inferences are implied or predictions made, they simply present the data which can be displayed in various ways, typically divided into two broad types; measures of central tendency and measures of variability (Scott and Mazhindu 2009).

Error free prescriptions were calculated as a percentage by dividing those prescriptions that were error free, by the total number of prescriptions. A complete prescription could include one or more prescribed items for each patient per prescriber and is considered useful to indicate the number of patients at risk from a PE (Seden *et al.* 2013). Similarly, PE rates were calculated as a percentage by dividing number of identified errors, by number of items prescribed. The central tendency will therefore be reported as error frequency and percentage at the prescription level. This will be repeated at an individual prescriber level. Relevant statistics will be supported with the use of bar charts, histograms, scatterplots, boxplots and tables to visually present the data. Measures of dispersion provide insight as to the level of variability within a data set and can be reported as standard deviations (degree to which values differ from mean) and confidence intervals and will be used to describe relevant quantitative data in this thesis.

3.12.4. Inferential statistics

In contrast to descriptive statistics, inferential statistics are concerned with making predictions and testing for significance of any results to determine what the descriptive statistics actually mean (Cohen *et al.* 2011), and their applicability to a wider population. A p-value provides evidence of statistical significance for an experiment to reject the null hypothesis.   The most common value is <0.05 (<5%) which indicates there is less than a 5% chance that the result has occurred by chance. A two-sided significance of 5% ($p<0.05$) was used for the research in this thesis as is standard practice in most statistical tests (Cohen *et al.* 2011).

Selection of appropriate tests is vital yet one that can be daunting and difficult, especially for first time researchers (Scott and Mazhindu 2009). There are decision trees and flow charts that can help guide researchers in the correct choice of statistical tests (for example see Scott and Mazhindu 2009 or Cohen *et al.* 2011) with the premise and filtering questions understandably consistent. These questions include:

1. Is the data parametric or non-parametric?
2. How many groups are there?
3. Are the groups independent or not?
4. Are you looking for differences between groups or associations between variables?

Parametric data assumes normality of data, that is, data follows a normal or Gaussian distribution (Cohen *et al.* 2011).   Parametric data is therefore continuous, interval or ratio data, and informs use of parametric tests that are considered more robust and powerful (Basit 2010). Examples of parametric tests include t-tests, analysis of variance (ANOVA), analysis of co-variance (ANCOVA) and Pearson correlation tests. Conversely non-parametric data is typically ordinal (such as a numerical scale 1-10) or nominal data (categorical data) requiring the use of non-parametric tests such as Mann-Whitney, Kruskal-Wallis, chi-squared, and Spearman rank tests (Cohen *et al.*

2011, Basit 2009, Scott and Mazhindu 2009).

For number of groups, statistical tests are usually divided into those that measure differences between two groups (for example t-tests) and those that measure differences between more than two groups (for example ANOVAs). For the third question, the treatment and control groups used in this thesis are independent of each other. The author is exploring difference in change scores for PE rates and the groups will either receive feedback, or not, they cannot be in both groups. If for example, the test design was one group with pre and post testing, they would then become dependent.

For the final question, the research questions and hypotheses inform choice of statistical test and typically state differences or associations between variables.

Considering these questions, test design and hypotheses, independent t-tests, chi-squared tests and Pearson correlations were the most appropriate tests for the quantitative data and will be described further below.

3.12.4.1. Independent t-tests

It is possible that both control and intervention groups may improve over time. Therefore, it is the difference in change in PE rates that the author is interested in. Statistical tests that could be used to measure this effect include independent t-tests on change scores (post-test error rates minus pre-test error rates), analysis of covariance (ANCOVA) and repeated measure analysis of variance (ANOVA). These should be considered further as it is reported that gain score analysis and ANCOVA for example, can produce conflicting results, an outcome known as Lord's paradox (Knapp and Schafer 2009, Lord 1967).

It has been argued that ANCOVA is the test of choice for pre-test post-test analyses. Post-intervention PE rate would be the dependent variable, the intervention the independent variable, and the pre-test PE rate the covariate.

Here, the ANCOVA controls for pre-test differences (Dimitrov and Rumrill 2003) to control variance, an obvious advantage of this approach.

Assumptions to performing ANCOVA include those of the t-test (see below) in addition to a linear relationship between pre-test and post-test scores, homogeneity of regression slopes and homoscedasticity of variance between and within groups. Where these assumptions are violated, the reliability of the results becomes questionable whilst creating difficulties in interpretation of any result. As described above, a non-randomized sample is used for control and intervention groups in this thesis. It is argued that ANCOVA treatment effects can be seriously biased in non-randomized designs with erroneous conclusions made (Blance *et al.* 2007) where the relationship between baseline and post-test error rates is unknown for example. In this study, where the baseline PE rates and any subsequent change is due to an interaction with the environment, Lord's paradox may be invoked leading to difficulties in causal inferences.

Additionally, when comparing a treatment and control group, it is likely that there will be heterogeneity in regression slopes (Brogan and Kutner 1980) violating a further ANCOVA assumption.

For a repeated measures ANOVA, it is argued that results can be misleading where the F test for the treatment effect is conservative, as pre-test scores are not affected by treatment (Dimitrov and Rumrill 2003). Additionally, in comparison to ANCOVAs, ANOVAs require more assumptions to be met in comparison to t-tests. That said, where the F statistic is correctly reported for time/intervention, it is mathematically equivalent to the square of the t-value (Knapp and Schafer 2009) suggesting that the simpler t-test could be used.

Finally, it is argued that use of change scores is less reliable than the likes of ANCOVA which has greater power to report significant results (Vickers 2001). In addition, change scores may be negatively correlated with pre-test values (Knapp and Schafer 2009) where reductions in error rates are

observed for example. However, there are also sensible arguments for use of independent t-tests on change scores. Chiefly, t-tests are relatively simple with fewer assumptions (Brogan and Kutner 1980) and they are ubiquitous, influencing their widespread use (Knapp and Schafer 2009). It is also suggested that change score analysis is acceptable when ANCOVA assumptions are violated or the baseline variable, PE rate, is comparable between groups (Vickers 2001). Whilst it has been shown that ANCOVA has greatest power to detect differences (Dimitrov and Rumrill 2003), it should be noted that it is with large sample sizes (Blance *et al.* 2007). In this study, sample sizes were less than 40 and so the statistical power of ANCOVA would therefore be reduced (Blance *et al.* 2007), whilst t-tests have the advantage of application to small groups (De Winter 2013). Most importantly, t-tests address the research hypothesis in this thesis whereas ANCOVA would more accurately address a different research hypothesis; "There is a change in post-test PE rates not predictable from pre-test PE rates". It is also worth highlighting that having a percentage change score is a value that is easily interpreted by any target audience for this research. Therefore, considering this, independent t-tests on change scores were used in this thesis.

The author hypothesizes that;

H_1 "There is a difference in mean change in PE rate between the intervention and control group"

The test design and hypothesis supports use of an independent t-test to determine if there is a difference between the mean change of the two independent groups (Cohen *et al.* 2011:642). In this study, the author uses the independent t-test to determine the effect of feedback on PE rates and percentage of prescriptions error free per prescriber.

For the t-test, the null hypothesis, H_0, is;

"There is no difference in mean PE rate change between intervention and

control groups"

The null hypothesis, H_0, will be accepted where the resultant p-value is >0.05 and the alternate hypothesis, H_1, accepted if the p-value is <0.05.

To be able to perform the independent t-test, various assumptions need to satisfied including;

- There is one dependent variable measured on a continuous scale (PE rate)
- There is one independent, categorical variable consisting of two groups (intervention, control)
- There is independence of observations within and between groups
- There is an approximated normal distribution
- There are no significant outliers
- There is homogeneity of variance

For the latter three assumptions, normality can be determined by inspection of histograms and probability plots, assessing for normal distribution or skewness. In addition, the Shapiro-Wilk test provides a measure of normality and its value can be determined in SPSS and, where the p-value is > 0.05, normality can be assumed.

Outliers will affect distribution and variance and inspection of box and probability plots can reveal if any significant outliers are present. Finally, homogeneity of variances can be determined by examining the Levene test with a p-value >0.05 indicative of equal variances.

Where these assumptions are violated, a non-parametric equivalent test (e.g. Mann-Whitney U test) could be used (Scott and Mazhindu 2009:151). However equally, t-tests are robust to deviations of non-normality (Posten 1978), especially with sample sizes greater than thirty (Pagano 2004:339). In addition, where non-normality is identified, the researcher can attempt to transform data depending on its skewness although it should be

acknowledged that an approximated normality is only necessary, and the independent t-test is relatively insensitive to deviations from normality.

Similarly, outliers can be removed or modified and data re-tested with and without the modification to determine if the t-test procedures produce significant results for both datasets.

Finally, where equal variances are not assumed and the Levene test is <0.05, it is recommended that Welch's t-test is reported. However, again the t-test is robust to unequal variances where the sample sizes of each group are similar (Posten *et al.* 1982), as in this study, with uneven sizes defined as a greater than 1.5 fold difference (Morgan *et al.* 2004).

3.12.4.2. Calculating effect size

It is increasingly common to report effect sizes within the literature to quantify the difference between groups and, in this regard, it is more useful than a p-value. One test that is commonly used for this purpose is Cohen's d (Cohen *et al.* 2011:617) where;

$$d = \frac{|M_1 - M_2|}{s_{pooled}}$$

Here, the mean difference between groups 1 and 2 is divided by the pooled standard deviation where;

$$s_{pooled} = \sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2}}$$

For S_{pooled}, S_1 is the standard deviation for group 1 and S_2 the standard deviation for group 2. Similarly, n_1 is the sample size for group 1 and n_2 the sample size for group 2.

Once d is calculated, the reported value allows inference into the size of the effect with a d of 0.2 to 0.5 a small effect, 0.5 to 0.8 a medium effect and > 0.8 a large effect.

3.12.4.3. Chi squared tests

Chi square ($\chi 2$) tests are commonly used in univariate analysis (one variable) to compare frequencies (items and errors) and to investigate difference between groups (Cohen *et al.* 2011:651). $\chi 2$ is used to measure the difference between an observed and expected result based on the null hypothesis;

H_0: "There is no difference in distribution/frequency of prescribing error / type / severity of error between groups"

Where a statistically significant difference is identified, $p < 0.05$, the alternate hypothesis will be accepted;

H_a: "There is a difference in distribution/frequency of prescribing error / type / severity of error between groups"

Chi squared ($\chi 2$) test of homogeneity were used in this study to measure frequency of error type and severity within groups for pre- and post-test data. Chi squared test of independence, also called chi squared test of association, were used to determine frequency of PEs both within and between groups. The latter can support and validate the use of t-tests where baseline error frequencies are similar.

A two-tailed *p*<0.05 was considered statistically significant.

Assumptions of the chi-square test include 80% of cells having cell counts of at least 5. Otherwise the exact test statistic should be reported (Cohen *et al.* 2011:654).

As with the t-test, effect size can be reported as phi (φ) where;

$$\varphi = \sqrt{\frac{\chi^2}{n}}$$

Where $\chi2$ is the chi-squared value and n is the number of observations. A result of 0.1 indicates a small effect, 0.3 a medium effect, and 0.5 a large effect (Cohen *et al.* 2011:654)

3.12.4.4. Pearson correlation coefficient

In addition, the author was looking to determine if there was any association between change in PE rate (continuous data) and number of feedback sessions. This was described as;

H4: "There is an association between number of feedback sessions and change in prescribing error rates"

Pearson correlation coefficient, represented as r, is a commonly used to test for associations with continuous or interval data (Cohen *et al.* 2011:631). In this thesis, it is used to determine the strength and direction of the relationship between two variables (error rate and number of errors received feedback on). Here, if PE rate reduces with number of feedback sessions, r will be negative, if it increases it will be positive and if it is zero, there will be no relationship.

Assumptions of Pearson's correlation coefficient include paired data, a linear relationship, no significant outliers and bivariate normality. Where these assumptions are violated an alternative non-parametric test such as Spearman's rank order correlation test can be used.

3.12.4.5. Spearman rank coefficient

This test is the non-parametric equivalent to the Pearson correlation coefficient (Cohen *et al.* 2011:631), determining how two variables can

predict each other, with correlation reported from -1 to 1 (Neideen and Brasel 2007).

3.13. Chapter summary

This chapter has explored the research methods and methodologies used throughout this thesis. These include the use of interviews and focus groups for qualitative methods to explore the views and opinions of participants in the studies. Quantitative approaches were also described using prescribing audits for control and intervention groups to determine impact of feedback on PE rates. Finally, data analysis methods were described including thematic analyses using the framework approach for qualitative data, and relevant descriptive and inferential statistics for quantitative data. Subsequent chapters will now focus on the results of this thesis with chapter 4 exploring the attitudes and opinions of pharmacists to delivering feedback prior to formalising the process and introducing the feedback intervention.

Chapter 4. Pharmacist focus groups

4.1. Chapter Introduction

This chapter describes the attitudes and opinions of twenty-four hospital pharmacists of intercepting and delivering feedback on PEs. As reported in chapter 2, little is reported in the literature to help understand these views.

The primary research aim of this chapter was to:

> Explore and determine pharmacists' experiences of delivering prescribing error feedback

Focus groups are used to collect the in-depth qualitative data required to address the research aim. Eight key themes are used to highlight PE feedback practices prior to implementing the intervention and pharmacist attitudes towards delivering more formalised PE feedback.

4.2. The focus groups

Pharmacists were recruited as described in chapter 3. All eligible pharmacists (33) expressed an interest to participate although not all could commit to the arranged dates of the focus group interviews. All focus groups were conducted in a seminar room within the pharmacy department throughout August 2014. All pagers / mobile phones were turned off to prevent interruption. Additionally, a notice was placed on the room door to prevent interruption.

Prior to commencing the interview, the purpose of the study was covered again and both verbal and written consent obtained. A topic guide (Appendix 15) was used to explore key themes whilst ensuring consistent issues were discussed. All focus groups were digitally recorded and lasted between 1 hour 6 mins and 1 hour 12 mins.

4.3. Data analysis

All focus groups were transcribed verbatim by the author, the sole exception being to anonymise person and place names. Transcriptions took an average of six to eight hours per focus group, a timeframe consistent within the literature (Rabiee 2004).

The author listened, re-listened, read and re-read the transcripts to correct any typographical errors and for early immersion in the data. Both supervisors (SDW and SVOB) independently read each transcript. Transcripts were discussed between focus groups by the research team to consider similarities and variations of findings.

Focus group transcripts were coded manually line-by-line and analysed thematically using the framework approach as described in chapter 3. Emergent codes were informed by the topic guide, research aim and the author's knowledge of the literature. Codes were sorted into similar contextual themes. Initial themes and codes were discussed at regular meetings with SDW and SVOB. Discrepancies were resolved through discussion for an analytical consensus. The resultant initial thematic framework (Appendix 22) was then applied to the transcripts with further revisions as new meanings emerged from the data. The final thematic framework was then applied and relevant transcript extracts copied and pasted under the codes for analysis and meaning.

4.4. Results

Twenty-four pharmacists were recruited (16 female and 8 male) with six pharmacists in one of four focus groups. A range of pharmacist grades (6 to 8) and experiences were recruited (see table 5) reflecting the skill mix within the department. More junior pharmacists were seated opposite, and more senior pharmacists nearest to, the author to encourage open discourse from junior pharmacists (Shenton 2004).

Table 5: focus group participants

Focus Group (duration)	Pharmacist Number	AfC Band [a]	Years Qualified	Gender
1 (1hr 6 mins)	1	7	2	Female
	2	8c	25	Male
	3	8a	6	Female
	4	7	3	Female
	5	8a	8	Female
	6	8a	20	Male
2 (1hr 12 mins)	7	6	2	Female
	8	8a	33	Female
	9	7	2	Female
	10	6	1	Male
	11	8a	15	Female
	12	8a	15	Male
3 (1hr 7 mins)	13	7	2	Male
	14	7	3	Female
	15	8a	9	Female
	16	7	10	Male
	17	6	1	Female
	18	6	1	Female
4 (1hour 8 mins)	19	8b	20	Female
	20	6	1	Female
	21	7	40	Female
	22	8b	28	Male
	23	7	8	Female
	24	8b	23	Male

[a] See chapter 1 for an overview of pharmacist grades

The final thematic framework included eight major themes with additional secondary codes determined from the focus groups (see table 6). The results will be summarised under the eight key themes below. Example

quotations to illustrate the results were chosen by the author and agreed with the supervisory team (SDW and SVOB) beforehand.

Table 6: Thematic framework for pharmacist focus groups

Theme	Code
Delivery of feedback	Inconsistent
	Formal vs. informal
	Communication of error
	Incident reporting
	Correction *vs.* feedback
Impact of feedback	Patient safety
	Time saving
	Information seeking behaviour
	Feedback seeking behaviour
Prescription error	Error severity
	Error repetition
	Timely feedback
Work environment	Time pressures
	Location
	Contacting prescriber
	Blame *vs.* no-blame culture
	Pharmacy service
	Out of hours
Feedback facilitator	Staff group
	Job satisfaction
	Expert knowledge
	Emotional intelligence
	Interpretation of error

	Pharmacist training
Working relationships	Rapport
	Team integration
	Hierarchy
	Anxiety / reticence
Education and training	Independent learning
	Constructive feedback
	Reflective practice
	Positive *vs.* negative
System improvements	Electronic prescribing
	Prescriber training
	Clinical governance
	Ward based
	Shared vs. individual learning
	Facilitator training

The results will now be discussed under the following key themes:

1. **Delivery of feedback**
2. **Impact of feedback**
3. **Prescription error**
4. **Work environment**
5. **Feedback facilitator**
6. **Working relationships**
7. **Education and training**
8. **System improvements**

In general, all pharmacists participated openly and engaged with the topics of discussion. Limited follow up questions were required by the author.

Three groups appeared to be mostly positive about the need for formalised feedback although one focus group (focus group 4) expressed greater reticence and apprehension towards the process.

Pharmacists consistently agreed that PE feedback was essential with various benefits of the process proposed. There were inconsistencies in how feedback was delivered between and across focus groups with various reasons for these inconsistencies reported.

Pharmacists agreed that they would be credible PE feedback facilitators although focus group 4 questioned why it should be them and not another doctor for example. Anxieties surrounding the process were reported with concerns surrounding any potential negative impact on prescriber working relationships expressed.

All groups advocated that PE feedback should be educational, supporting prescriber development.

The results will now be presented for each theme using relevant quotes.

4.4.1. Delivery of Feedback

Five key codes were included in this category: Inconsistent practice, Formal *vs.* informal, communication of error, incident reporting, and error correction *vs.* feedback.

a. Inconsistent practice

Pharmacists acknowledged that the current processes of PE feedback were opportunistic and inconsistent, whilst feedback may not be delivered at all.

P6: *"It's ad hoc there is no formal system and so there will be inconsistencies."*

Reasons for inconsistent approaches included lack of formality of any feedback process and differences in pharmacist practice or pharmacy service, for example attendance on ward rounds, or departmental meetings.

P5: *"You know, you're not told how to do it and so a lot will depend on the individual to feedback so that will be variable as well, we'll all feedback differently."*

It was also reported across groups, that response to PEs depended on the perceived severity of the error.

P5: *"It depends on the severity; if it was serious I would probably challenge them and say why have you done that, is there a reason why you thought to do this? But then if it was something quite minor then I would probably just write it on the list (jobs list) and ask them to change it."*

b. Formal vs. informal

It was unanimously acknowledged that PE feedback was essential and should be formalised for consistent practice. Two pharmacists (P6 and P14) advanced this recommendation by arguing that they had a professional obligation to provide PE feedback otherwise they may be complicit in future PEs.

P14: *"If they are making the error consistently and someone comes to harm from it and you have been clocking the error for six months and you never told them about that error then are you complicit in that error? Are you part of that error because you have picked it up for six months and not told them and that one time you let it slip the patient is harmed? Whereas if you had told them six months ago could you not then argue that … not that you've done your bit but that you have tried to make a difference."*

Pharmacists additionally suggested that formalisation of the process would not only ensure consistent delivery of PE feedback, but raise expectation that feedback will be delivered.

P14: *"If it was a formalised approach then it wouldn't be maybe your pharmacist is going to approach you it will be they are going to approach you to discuss an error."*

c. Communication of feedback

Pharmacists acknowledged that face-to-face feedback was the preferred format to support individualisation of feedback and interactive dialogue. Equally, how the feedback is delivered is important with rapport clearly influencing communication.

P4: *"I think it's easier to deliver feedback also when you are standing face to face with someone than when you're on the phone."*

Pharmacists reported that other methods of feedback such as e-mail or telephone were less desirable. It was suggested that the asynchrony of e-mail communication and potential misinterpretation of messages could limit the impact of feedback that was not delivered face-to-face.

P11: *"I do mine sometimes over the phone and I don't know, maybe it's my mannerisms, but sometimes I'll go oooo you've really just taken that the wrong way from me. I didn't mean that, so I've obviously gone in guns blazing because I'm busy, and they're busy, and becomes a bit like… they can't see me, they don't know me and they possibly hear the aggression."*

d. Documentation of error

Pharmacists agreed that PEs should be documented for communication and governance purposes. However, there were inconsistencies with what was documented, if at all, and by what medium. Pharmacists advocated that PEs

should be documented in the clinical notes but described variations in practice such as writing on medical charts, leaving post-it notes or writing in doctors' jobs books. Some pharmacists suggested they rarely, if at all, reported PEs in the notes.

P22: *"I have to be honest I don't know the last time that I documented anything in the notes. I'll annotate drug charts or I'll leave notes stapled to them to say you need to do this."*

Some pharmacists reported that their practice varied depending on the ward they were covering and the relationship they had with prescribing staff.

P13: *"If I'm on an unfamiliar ward I'm more likely to document things in the notes whereas on my ward I have no problem with going up to someone and feeding back directly."*

Several pharmacists across focus groups challenged these inconsistencies and suggested that feedback should be communicated face-to-face and documented in the clinical notes to ensure prescribing jobs were acted on.

P12: *"Yeah, well some people just write on the kardex too and I don't agree with writing on the kardex. It's got to be in the notes otherwise they may not read it or just ignore it."*

e. Incident reporting

Pharmacists expressed that a PE that caused or has the potential to cause harm should be reported to support trending of data.

P14: *"In an ideal world you would datix all of these near misses and then look for the issues."*

However, it was acknowledged that this rarely occurred as the system was cumbersome and the volume of PEs too great.

P1: *"I'll hold my hand up and say that I don't fill in as many as I should Ermmm… they take time and they're complicated forms and they're lengthy, not user friendly."*

Additionally, it was considered that incident reporting systems were punitive or that the message never reached the prescriber, outcomes that were considered countermeasures to what should be an educational process. Pharmacists also reported a sense of apathy and futility in reporting errors because they are unsure what happens or if the individual involved receives any feedback.

P10: *"Well I don't know, does a datix [incident reporting system] ever get back to the doctor or is it designed to look for trends to see if there is common error or a system failure? But does anybody actually feedback to the doctor."*

f. Error correction *vs.* Feedback

A prominent theme throughout all focus groups was what constituted feedback and whether pharmacists delivered feedback or simply got errors corrected. Some pharmacists thought the two processes were the same:

P11: *"It really depends on your definition of feedback. Is it just going and getting it changed, corrected?"*

However, other pharmacists astutely recognised that the two are not synonymous but different processes altogether where the focus is on identifying what happened and what they can do to prevent error recurrence.

P15: *"I think feedback also includes some sort of thought process for the doctor to help them think about how they're going to prevent that error happen again."*

Pharmacists reported that correction of errors occurred more often reflecting the immediacy of workload pressures. Equally, where the prescriber is unavailable or unidentifiable, then another prescriber would be asked to amend the prescription. Advancing on this, some pharmacists questioned the need to provide feedback if the PE has already been corrected:

P19: *"If you are feeding back to a consultant and they have written Tazocin [penicillin antibiotic] eight hourly and they have an eGFR [estimated Glomerular Filtration Rate] of ten and I go and say change the dose then I'm not going to go and make an appointment with their secretary and say right, do you remember that Tazocin that you wrote last week! It's just nonsense it doesn't make any sense it just seems to be hammering home a point that you have already addressed."*

Pharmacists reported routinely amending prescriptions for minor PEs to save time where the prescriber was unavailable or to avoid disrupting the doctor where the prescribing intention was clear.

P12: *"Well you know, if it's a TTO [To take out discharge prescription] or requisition coming down to pharmacy then you probably wouldn't ring the ward and you'd probably just annotate it yourself and if you're on a surgical ward where the juniors float on and off then it's going to be harder to contact them isn't it."*

Equally however, pharmacists acknowledged that they should not be doing this and it was unlikely to alter prescriber practice and could increase pharmacy workload.

4.4.2. Impact of Feedback

Four key codes were included in this category: Patient safety, time saving, information-seeking behaviour, feedback-seeking behaviour.

a. Patient Safety

Pharmacists agreed that feedback could reduce PEs and improve patient safety. Some pharmacists advanced on this by suggesting that by not delivering PE feedback, patient care is compromised.

P4: *"firstly you have to get the prescription right and without feeding back to them you can't get it right."*

b. Time saving

Pharmacist proposed potential indirect benefits of feedback including more efficient practice and time savings, outcomes that could allow them to focus on other patient-centered activities. However, some pharmacists advanced on this and proposed that their workload required a focus on short term goals and priorities such as processing prescriptions.

P4: *"It saves time in the long run but not in the short run and we all sort of work in the short run because we work to a deadline all try and get through the day and complete our jobs by 5 o'clock, and we don't have the time to do the formal feedback."*

c. Information-seeking behaviour

Several pharmacists suggested that feedback could encourage prescribers to ask them more questions to inform prescribing either during any feedback or prescribing process itself.

P3: *"Or if you give them feedback on a particular area then before they prescribe that again they will be like oh can I just ask you … so I find then that they will question before they prescribe."*

Some pharmacists suggested that this was because they could demonstrate their knowledge and raise awareness of their roles at ward level.

P10: *"I think that's important because that's when they really start asking you stuff when they know that you actually know something."*

d. Feedback-seeking behaviour

It was suggested by several pharmacists that prescribers are receptive to feedback and seek feedback as part of their training requirements. This was in contract to the reported pharmacist apprehensions of the process. One pharmacist suggested that prescribers are trained differently to pharmacists and received feedback on their practice throughout their formative careers.

P12: *"They are used to having feedback and used to meeting with people in an educational setting and having face to face discussions about problems."*

4.4.3. Prescription error

Three key codes were included within this category: Error severity, Error repetition and timely feedback.

a. Error severity

Pharmacists advocated that feedback would be more appropriate for more serious PEs. However, the importance of minor errors was recognised especially where the cumulative effect on pharmacist time could be considerable. Equally, pharmacists suggested that any impact of feedback could be diluted if it was delivered for every single PE, a process that could be detrimental to prescriber perceptions of pharmacists.

P5: *"I think that you should just be feeding back on serious errors; otherwise, they are just going to think oh here's (pharmacist) with her green pen again [colour ink that pharmacists use in the organization] and so we need to make that distinction between what's serious and what's not."*

Supporting the inconsistent practice reported, pharmacists described individual and subjective thresholds for responding to PEs. Severe errors are generally corrected immediately, with minor errors resolved by other means.

P3: *"Depending on error severity then on ward round something like renal dose or IV (intravenous) change I would ask them to do it on ward round but if it was a matter of just writing up meds (medications) I would ask them in the afternoon after the ward round and say go to bed this, this, and this and they need their regular meds prescribed but I just feel it's not done unless its documented."*

b. Error repetition

Pharmacists in all groups agreed PE feedback should reduce error repetition. Equally, they proposed that repetitive PEs, irrespective of severity, should be fed back to the prescriber. Advancing on this, pharmacists suggested that processes should be in place to escalate poor performance that was not improving.

c. Timely feedback

The need for timely feedback was considered critical to highlight the importance of safe and appropriate prescribing practice. Additionally, pharmacists suggested that timely feedback was essential to facilitate memory recall, not only of the prescription, but the situation and potential contributing factors.

P24: *"Being able to remember any mitigating factor on that day is absolutely valid you know, there may be contributing factors that you may forget about so you need to know as soon as possible."*

4.4.4. Work environment

Six key codes were included within this category: Time pressures, location, contacting prescriber, blame *vs*. no-blame culture, pharmacy service, out of hours.

a. Time pressures

Increasing demands and time pressures were cited as key drivers for any task completion and were proposed as barriers to delivery of PE feedback.

P3: *"It's not always feedback; sometimes it's just can you change this, like you know time issues."*

Despite outlining the need for PE feedback, some pharmacists suggested that other tasks would take priority over any feedback.

P18: *"Do you want to sit and document that error or do you want to sit and check everything else that that doctor has prescribed and make sure they haven't given any piptaz [piperacillin/tazobatam] to a penicillin allergic patient. Because if they've missed that even though it's on the allergy status do you not want to check everything else?"*

Advancing on this, one pharmacist questioned whether the resource implications of feedback would be less efficient than continuing with the status quo to simply correct PEs.

P19: *"If you're talking about a trade-off between doing this and correcting errors, would that be realised?"*

These views were not shared by the majority of pharmacists who suggested that they would find the time for such an intervention and that PE feedback should be a key responsibility.

P13: *"Even if it means that you don't see a kardex or two or some other things that are further down your priority list so that that can get jumped right to the top."*

b. Location

The ward environment was considered most appropriate to deliver PE feedback. Pharmacists suggested that this would facilitate face-to-face delivery of feedback and negotiation of convenient times to feedback. Additionally, ward-based PE feedback would have the advantage of being delivered by a pharmacist who should know the prescriber involved and have established rapport.

P18: *"If you're on the ward and it's your ward doctor…they're immediately available to you in person so it's not a telephone conversation and you get much better communication between the two of you and it's a much better process then."*

Other locations such as the pharmacy dispensary were considered less appropriate due to greater time pressures, limited communication and potential lack of rapport with the prescriber.

c. Contacting prescriber

A prominent theme described was difficulties in identifying and contacting prescribers: barriers that would limit any potential PE feedback.

P15: *"If you can't identify the signature then you might be wasting a lot of time."*

Pharmacists described taking reasonable efforts to contact prescribers but where they were unable to identify or contact the prescriber, they would often get another to amend the prescription or amend it themselves as reported

earlier. Pharmacists acknowledged that this would not be an issue for their own prescribers whose signatures they would recognise.

d. Blame *vs.* No-blame culture

Pharmacists expressed that a "no-blame" culture was paramount for any PE feedback. This supported the earlier suggestion that incident-report forms were inappropriate for PE feedback. In part this was because pharmacists felt it should be a clear educational process. There appeared to be some apprehension in delivering feedback that could have punitive measures for a prescriber.

P13: *"I'd certainly be less inclined to because I don't want to get the person in trouble."*

e. Pharmacy service

Across groups, pharmacists considered that PE feedback could be a reasonable extension of their roles and that they would be appropriate facilitators. However, some pharmacists outlined that it was not their responsibility to deliver PE feedback:

P4: *"there is nothing in our job description that talks about giving feedback and I don't think that is anywhere near the top priorities of what you need to do on the ward."*

Three other pharmacists (P4, P18 and P19) advanced this by suggesting other, more senior prescribers should be delivering the feedback.

P18: *"Their consultant is responsible for their prescribing so should they not be involved in their feedback because if they don't know that's such and such is making the mistake consistently in their name so the consultant is accepting responsibility for what that F1 does so the consultant should know what the F1 is doing."*

It was suggested that limited time on wards can influence rapport with prescribers, and limit potential for delivery and receipt of timely feedback. Where wards have no pharmacist cover, pharmacists reported limited potential for PE feedback. Equally, for ward-based pharmacists, these factors were considered less of a concern underlining the suggestion that a ward-based pharmacist is the most appropriate facilitator as reported below.

P2: *"If you're not there all the time it makes rapport more difficult. The medics, nurses and physio staff are on there all day and if you're just popping onto the ward for half an hour at a time it makes it difficult for you to be viewed as part of team and you're just a visitor. It's very difficult to establish any sort of rapport with a doctor that you may only see for 5 minutes or so. If you're seeing the same guys day in day in out it's a bit different than if you see them for example every third day."*

Pharmacists recognised that despite potential time savings, there would be resource implications and that protected time would be desirable to deliver feedback.

f. Out of hours

The work environment presented further barriers to feedback out of hours where it is more difficult to contact a prescriber, there are limited pharmacists working and the priority focuses on processing prescriptions.

4.4.5. Feedback facilitator

Six codes were included within this category: Staff group, job satisfaction, expert knowledge, emotional intelligence, interpretation of error and pharmacist training.

a. Staff group

All pharmacists agreed that anyone who identifies a PE could deliver PE feedback. Some pharmacists questioned why more senior prescribers should not deliver PE feedback although others countered that feedback could become punitive where a senior prescriber or line manager for example delivers feedback.

All pharmacists agreed that they were probably best placed to deliver feedback. It was suggested that this was because prescribers would be more open to feedback from pharmacists who may be perceived as experts in medicines use, whilst it was also their perceived role to intercept and correct PEs.

P13: *"Because at the end of the day we are experts on medicines. We are the ones identifying medication errors so we are best placed to feedback why that is significant or insignificant because we have a thorough understanding of the error."*

Pharmacists were unanimous in advocating that ward-based, as opposed to dispensary based, pharmacists were best placed to deliver PE feedback. This was because they will understand the patient and situational context and have established working relationships with the prescriber, which they considered important for any feedback process. It was also suggested that having a single ward-based facilitator would allow monitoring of trends and responses to feedback for individual prescribers whilst mitigating any potential anxiety surrounding the process.

P22: *"The other thing is you have a limited number of people feeding back to an individual then you are more likely to pick up if there is a problem with that in individual because potentially if one prescriber is being contacted once a week by every pharmacist with an error then that's thirty errors a week. But for us, it's one error a week which doesn't flag up anything at all."*

b. Job satisfaction

Pharmacists reported that feedback could improve their job satisfaction where it was received positively and considered useful. In contrast, feedback that was poorly received could be destructive to further facilitation of PE feedback. Some pharmacists (P1, P4, P23) reported frustration and indignation where their efforts to deliver feedback have been dismissed.

P4: *"It depends on the response that you get when you give it. If you give it to a doctor who is receptive and thankful then actually I'll think I'll do that again but if you come up against a barrier and someone just goes oh its wrong and crosses it off and dismisses you although the error isn't there anymore you sort of feel like you've inconvenienced them and haven't provided constructive feedback at all because they've just literally brushed you aside."*

c. Expert knowledge

Pharmacists suggested that they have expert drug knowledge and that this provides them with a credibility to deliver PE feedback. Some junior pharmacists advanced this discussion, describing how certain pharmacists were perceived as more credible and utilised more because of their expert knowledge.

P10: *"Like I know there are some pharmacists that doctors will just go up to them because they know their stuff so they're perceived in a better light."*

Some pharmacists also expressed apprehension about delivering feedback on a medication that they were unfamiliar with. Some suggested that they would be happy for others to deliver the feedback in these situations and that poorly delivered feedback could adversely affect the feedback process.

P14: *"If it's your ward or your clinical area or you know a lot about that drug in particular then yeah. If it's something that you are a bit questioning of*

yourself in the first hand, then if you sort of approach it in this oh maybe it's this or this and you don't have this authority then maybe they might not take it that seriously."

d. Emotional intelligence

Pharmacists reported that feedback should be individualised to support the process.   There is potential to upset prescribers and this requires an emotional intelligence and facilitator flexibility to change approach depending on the prescriber response.

P19: *"You can judge it face to face can't you? If you are upsetting somebody then you can change tact."*

e. Interpretation of error

Pharmacists reported that there are likely to be variations in interpretation of errors between pharmacists and prescribers that could lead to inconsistencies in what feedback is delivered.

P6: *"I also think that there is a perception that we as pharmacists see errors more seriously than doctors do. You know, if you were to sit the two professions down, because bare in mind they don't just make errors in prescribing they are making errors in diagnosing, surgical procedures… and so in the bigger scheme of things making prescribing errors aren't taken that seriously even though they may be making a serious prescribing error."*

f. Pharmacist training

Pharmacists reported variations in willingness to both communicate with and feedback to prescribers depending on undergraduate and professional training.   Several experienced pharmacists (P2, P8, P11, P22) acknowledged that they trained in an era when it would be unusual to

challenge a prescriber, write in the clinical notes or provide feedback on prescribing but that expectations have changed in more recent times.

P8: *"When I first qualified as a pharmacist it was before pharmacy was out there about the wards. It took a lot of confidence to phone a consultant up and tell them they had done something wrong."*

Advancing this point, pharmacists reported that they have received little or no training on communication skills or communicating with prescribers specifically, either as an undergraduate or qualified pharmacist. This was despite reporting greater expectations of hospital pharmacists. Pharmacists were unanimous in the need for training to support any feedback process.

P5: *"I think it may be expected but we're not trained at any point to feedback on errors either at undergrad or even through your diploma as a professional to feedback on errors. You know, you're not told how to do it and so a lot will depend on the individual to feedback so that will be variable as well, we'll all feedback differently."*

4.4.6. Working relationships

Four key codes were included within this category: Rapport, team integration, hierarchy and anxiety / reticence

a. Rapport

Pharmacists unanimously agreed that rapport, through established working relationships, enhanced communication with prescribers and was integral for both delivery and receipt of PE feedback. Without rapport, pharmacists suggest they may be less confident and more apprehensive about the process, re-iterating the suggestion that the feedback facilitator should be ward-based.

P11: *you need that rapport don't you to be integrated into the team and have the confidence to go up to them and say you have made a mistake and it should be this.*

b. Team integration

Pharmacists reported that feedback has the potential to enhance team integration through improved communication. Such outcomes were suggested to support further rapport building and could raise the profile of pharmacists further by raising their profile and role awareness.

P23: *"Well the more that we are doing on the wards will raise our profile on the wards. Like if I find an alendronate once daily and then speak to the patient to find out what day they take it and cross out the days. If I discussed this with the doctor every time then they wouldn't think oh they didn't just graffiting all over the kardex in that green pen and they are actually doing something."*

c. Hierarchy

Hierarchical issues were reported by pharmacists with a notable apprehension at approaching consultants with feedback on their prescribing, particularly for more junior pharmacists. This in part, was secondary to a consultant's status as head of the team and subject experts. When consultants make a PE, some pharmacists reported getting a more junior prescriber to amend the prescription for this reason.

P11: *"I think also, maybe, I don't know but the grade of the pharmacist. You know, I wouldn't mind so much but there are consultants where I would be like oh here we go. But I would do it… but I don't know how that would be for a new band 6."*

Some pharmacists described situations where consultants dismissed their concerns, although experiences appeared to vary depending on the grade of the pharmacist.

P14: *"There is a consultant who I wouldn't walk up to in a million years because I don't want to get shouted at and I would speak to anyone but that person."*

Senior pharmacists reported having more favourable and positive interactions with consultants with one pharmacist suggesting this is because they have trained alongside them as junior grades supporting the value of rapport as reported earlier.

Several pharmacists reported that prescribers would be more receptive to feedback from pharmacists because they are not part of their hierarchy and hence the feedback is not considered punitive.

P2: *"We're not part of their team so we can feedback into any part of that without it being viewed as top down."*

d. Anxiety / reticence

There was a notable apprehension and hesitancy towards delivering PE feedback by pharmacists. Pharmacists were concerned that feedback may be perceived negatively or punitively, or they may be viewed as pedantic, outcomes they considered could damage working relationships.

P18: *"You know I don't want them thinking every time I go up to them what have I done. Just make it so that it's not the only interaction I have with them is telling them they have done something wrong"*

Previous negative experiences of delivering any feedback were also telling with defensive prescribers leaving lasting impressions on pharmacists.

P4: *"Whereas you get other people who really don't care what they've prescribed or what error they've made they just don't care and so it doesn't matter what feedback you've given them. To be honest you're probably going to give them less feedback because it isn't having any impact at all because of how they have received feedback so poorly previously. I think there is a lack of respect in some instances and I just think well I'm not going to approach you. There are instances where there is a lack of respect for our profession where we're seen as the green pen people who just annoy them. It's a minority of people who have the perception but when you come across those individuals it has an impact on how you deliver feedback as a whole."*

4.4.7. Education and Training

Four key codes were included within this category: Independent learning, constructive feedback, reflective practice and positive *vs.* negative

a. Independent Learning

Pharmacists were consistent in reporting that feedback should be an educational process to support development of safe and appropriate prescribing.

P12: *"The only way they can learn is to have stuff fed back to them, it's the current way that they are educated and it's the way that they learn."*

b. Constructive feedback

Pharmacists reported that constructive feedback was required to identify solutions to problems and create a more meaningful learning experience.

P12: *"They don't want to be told to do something they want to be told to do something and why."*

c. Reflective Practice

Pharmacists reported that PE feedback could facilitate reflective practice and identify why PEs are occurring. It was reported that reflection allows change in behaviour where the error causation is more than a simple knowledge deficit.

P20: *"Well with education it might be a knowledge error whereas with reflection it might be you have made an error because you are too busy or you have been stressed out or something like that."*

d. Positive *vs.* Negative

Some pharmacists considered the need for positive feedback essential to limit the process becoming a negative experience. Other pharmacists countered that negative feedback can be constructive if delivered correctly, and that positive feedback could be condescending with limited value. Additionally, it was suggested by some pharmacists that absence of feedback could be positive itself where there is an expectation that prescribers received feedback on PEs.

P12: *"But feedback doesn't have the word negative in it does it? Feedback is feedback."*

4.4.8. System improvements

Five codes were included within this category: Electronic prescribing, prescriber training, clinical governance, shared *vs.* individual learning and facilitator training

a. Electronic prescribing

Some pharmacists reported that electronic prescribing could facilitate feedback on PEs through seamless data collection and prescriber identification.

P7: "I just remember in our old place that we would document all of the errors on a different tab on the electronic system, and every month the senior pharmacist would feedback to all of the doctors, you know they'd get an e-mail and get a percentage of all of the errors that they have made."

b. Prescriber training

It was felt that prescribers needed further training on medication errors with foundation training, journal clubs or ward based teaching suggested as potential platforms.

P17: *"They could get a whole presentation on errors; you know get a presentation on the most common errors"*

Feedback was considered a reactive process with some pharmacists suggesting local ward-based inductions could inform prescribers of context specific PEs before they make them.

P16: *"That is definitely a good idea. Because there are common patterns of mistakes that are common on every ward. We can have a go and prevent them from happening."*

c. Clinical governance

Pharmacists proposed that regular prescribing audits were required to support the feedback process. However the logistics of this was questioned with suggestions that a more robust and seamless process, distinct from the

incident reporting system, was required. This would allow trending of errors and seamless capture of data per prescriber.

P4: *"like if we had a pharmacy only database, not a datix, but pharmacy only for prescribing errors that took a maximum of 2 minutes to complete so you put in one, what the error was, who made it and we had to put in who made it... If we could identify the prescriber and we could do this, it would allow the feedback to be a lot more simple."*

d. Shared vs. individual learning

Some pharmacists suggested that group feedback at a specialty or even hospital-wide level could facilitate shared learning. Some junior pharmacists felt this approach could reduce any anxiety around delivering or receiving individual feedback.

P10: *"Yeah, not necessarily speaking to them, maybe just a poster that you stick up you know and feedback on these have been the common errors this month"*

Others suggested that this approach may not be effective and that individual feedback was essential.

P8: *"I think that if you feed it back every time then they'd be more aware and actually think more when they are prescribing. They won't just think well if I do it wrong then pharmacy will just pick it up."*

e. Facilitator training

The need for training on delivery of PE feedback was recommended. Pharmacists advocated that such training would support the process and a consistency in approach whilst mitigating potential anxieties.

P15: *"I think as well because there is not guidance out for us and if there is no guidance for us then we are all free to do whatever we wish with our feedback."*

Scenario based teaching was proposed to demonstrate exemplary feedback on a range of errors allowing pharmacists to model their behaviour accordingly.

P12: *"What you should have, probably, is some face to face scenarios, workshops where you deal with different errors, different prescriber responses to being fed back so that you know you have to feedback the errors and that there in a timely way you have to deal with them."*

4.5. Chapter discussion

The aim of this chapter was to explore the PE feedback practices and attitudes of pharmacists towards delivering formalised PE feedback. The focus group interviews have provided the rich qualitative data needed to address this aim. The need for individualisation of PE feedback was outlined, that it should be constructive and timely and delivered by ward-based pharmacists.

Before delivery of the intervention described in chapter 3, PE feedback practices were inconsistent, opportunistic and informal. Additionally, it was reported that prescriptions were frequently amended by pharmacists, findings consistent with results elsewhere (Abdel-Qader *et al.* 2010, Franklin *et al.* 2011, Bertels *et al.* 2013). These issues highlight missed learning opportunities for prescribers to learn from their errors.

PE correction was more commonly occurring than any PE feedback. Whilst such error correction could be considered directed feedback (Archer 2010), it does not resonate with the principles of effective feedback described in chapter 2. Where constructive feedback is not provided, error correction may be received mindlessly and limit its learning potential (Bangert-Drowns

et al. 1991). Mismatches between prescriber confidence and competence have been reported previously (Ryan *et al.* 2014) and low self-awareness of prescribing issues (Sullivan *et al.* 2013), from lack of constructive feedback may exacerbate such gaps in performance. Where constructive feedback is provided, junior doctors have reported previously that their response to and learning from error was optimised (Kroll *et al.* 2008).

The need for formalized PE feedback was recognized by pharmacists to ensure consistent approaches to PEs. Formalization of the process as part of routine pharmacist practice could raise expectations of staff to deliver and receive feedback where the priority of feedback is raised to equal that of resolving any error.

However, apprehensions were reported from pharmacists towards delivering feedback. This was understandably influenced by time pressures and workload but equally, previous studies involving feedback have reported limited impact on pharmacist's time (Sullivan *et al.* 2013, Gordon and Bose-Haider 2012), suggesting feedback could be non-intrusive and feasible. Additionally, where feedback improves prescribing practice, the potential to reduce prospective errors can be seen. One study suggests PEs can take 15 minutes to resolve with significant operational costs (Sullivan *et al.* 2013). Where the time saved correcting PEs is greater than the time spent delivering feedback, there may well be net time savings for prescribers and pharmacists.

The potential for reporting of errors to tarnish working relationships with prescribers has been reported previously (Ross *et al.* 2013a). Pharmacists did not want their only prescriber discussions to be about PEs with thresholds for delivering PE feedback proposed. These are sensible recommendations and reflect the design of the feedback intervention described in chapter 3.

Additionally, apprehensions reported by some pharmacists may have been grounded in previous experiences of prescribers dismissing their comments

or feedback. Similar outcomes have been reported previously in primary care settings (Avery *et al.* 2012) with feelings of frustration and isolation reported by pharmacists, where their input was dismissed or received defensively by GPs.

Pharmacists considered themselves credible facilitators of PE feedback echoing reports elsewhere (Bertels *et al.* 2013). Effective feedback is influenced by whether the facilitator is a colleague (Ivers *et al.* 2012), has observed practice and if it is delivered as part of everyday practice (Cantillon and Sargeant 2008). This can increase motivational behaviour (Gordon and Bose-Haider 2012) and supports the results reported in this chapter that ward-based pharmacists in particular are best suited to deliver PE feedback, where they review and intercept PEs at ward level. Pharmacists have been highlighted as a 'main defence' in intercepting PEs (Franklin *et al.* 2011), whilst junior doctors have reported anticipating pharmacists would intercept their PEs (Ross *et al.* 2012). Pharmacists reported similar views in this study and if interception of PEs is accepted practice of a pharmacist, then PE feedback could be a logical extension of their practice.

There were wide variations in how PEs were communicated with prescribers with the prescriber not always made aware of their error. These are missed learning opportunities and it could be argued that there is an element of wilful neglect where the error recurs and a patient is harmed. Poor communication between health care professionals is considered a contributing factor towards MEs (Dean *et al.* 2002).

In this chapter, pharmacists reported some apprehensions in approaching prescribers, a "communication apprehension" described in the literature as "… fear or anxiety associated with either real or anticipated communication with another person or persons." (McCroskey 1984)". An earlier study (Baldwin, McCroskey and Knutson 1979) suggested that 30% of pharmacists seek to avoid communication whenever possible. More recently, pharmacists have been described as aloof (Elvey *et al.* 2013) or perceived as having poor social skills (Hean *et al.* 2006). Such perceptions may be

less to do with pharmacist communication skills, and more to do with role-awareness, with pharmacists suggested as anonymous characters elsewhere (Elvey *et al.* 2013). Where pharmacists are communicating via post-it notes, the medication chart or even primarily in the clinical notes, there is a risk of them being perceived as anonymous. Equally, if PE feedback can change pharmacist-prescriber interactions, then perceptions of pharmacists may change.

Delivery of constructive feedback is a skill and one that requires training. In this chapter, pharmacists have expressed unpreparedness to deliver feedback despite, in some cases, being in educational and management roles. These views may have been influenced by the limited training reported in communicating with prescribers. Pharmacy is a science-based discipline with pharmacy graduates typically not engaging with doctors until their pre-registration year (See chapter 1). The need for enhanced communication skills training for pharmacy students has been outlined previously (Smith and Darracott 2011).

The NHS is about people, and people are prone to human error. Interpersonal communication is an essential skill for pharmacists (Wiedenmayer *et al.* 2006, Mackellar *et al.* 2007) to correct and resolve PEs, with one report outlining that pharmacists "must be knowledgeable and confident while interacting with other health professionals." (WHO 1997).

Good communication is a prerequisite for safe prescribing (Routledge 2012) and if pharmacists are to be used as PE feedback facilitators, training should be provided to improve the quality of feedback and enhance pharmacist–prescriber interactions. Bangert-Drowns *et al.* (1991) suggest that feedback can 'promote learning if it is received mindfully, but it can inhibit learning if it encourages mindlessness', iterating the importance facilitator skills.

Facilitator training for the research in this thesis is described in chapter 3. The training was designed to provide pharmacists with the skills, confidence and self-efficacy to communicate clear and objective PE feedback: skills that

can drive further feedback-seeking behaviour (Bok *et al.* 2013).

Feedback should be timely for accurate memory recall and reflection, with feedback closer to the time of the incident having a greater impact on individuals (Hysong *et al.* 2006). Ivers *et al.* (2012) suggest that feedback should be within one month for performance feedback. However, given the daily volume and frequency of prescriptions, it would seem logical that more timely feedback would be prudent with pharmacists suggesting less than a week for feedback to be effective. This supports recommendations in the literature that feedback closer to the time of the incident has a greater impact on the individual (Schramm *et al.* 2011, Jacques *et al.* 2011) and should be a gold standard for successful feedback (Hysong *et al.* 2006).

Individualized feedback, delivered face-to-face can allow clarification of any feedback points, creating a more social interaction and "a full circle of shared responsibility" (Sullivan *et al.* 2013). Furthermore, feedback that is specific and targeted is considered more effective (Ivers *et al.* 2012), supporting the need for individualization of feedback as reported in this chapter.

Constructive feedback is an educational process, a clear non-punitive approach endorsed in the literature (Hysong *et al.* 2006) to make feedback actionable. In this chapter, incident reporting was considered punitive and inappropriate for feedback with potential to create tensions between professionals. Comparable inter-professional tensions from reporting of errors via formal systems has been reported previously (Williams *et al.* 2013), with pharmacists preferring to speak to a doctor as opposed to completing an incident form, views shared by participants in this chapter.

Pharmacists were divided on the need for positive feedback. The need for positive feedback is likely influenced by whether individuals have a performance-oriented behaviour or learning- oriented behaviour (Hysong *et al.* 2006, Kluger and DeNisi 1996), underscoring the need for a flexible approach to feedback delivery. Equally, systematic reviews (Ivers *et al.* 2012) suggest that feedback aimed at reducing behaviours (i.e. prescribing

errors) are more effective than those aimed at improving a behaviour.

4.6. Implications for this research

The focus groups have showed that there are inconsistencies in what, if any, feedback was provided on PEs supporting the need for a more formalised, constructive and consistent approach to feedback as described in this thesis.

Pharmacists believe that they are credible facilitators of PE feedback and would value a more formal approach to PE feedback in STHKH. Importantly, pharmacists expressed a willingness to deliver more feedback to prescribers.

Pharmacists proposed that PE feedback should be individualised, timely and delivered by a ward-based pharmacist who works with the prescriber who has made any error. These recommendations are consistent with empirical evidence as described in chapter 2.

Positive feedback is desirable and has informed the feedback intervention with opportunity for positive feedback when delivered for overall prescribing as described in chapter 3.

There were some anxieties reported over delivering formalised feedback. This supports the need for training of pharmacists in delivery of feedback to mitigate apprehensions and raising awareness of prescribers to the initiative. An overview of facilitator training is described in chapter 3. The results of the pilot study and prescriber views will be presented to the pharmacists as early as possible to further raise the awareness of any benefits and value of the process.

4.7. Strengths and Limitations

This qualitative study has presented the in-depth views of pharmacist practices for providing feedback PEs. It is the first known research drawing

exclusively on this methodology to contribute to what little is known on the subject.

This is a case study involving the opinions of individual pharmacists in a single setting. Therefore, results cannot be generalised although as described in chapter 1, STHKH is a typical large acute hospital with a standard hospital pharmacy service and so the findings will be of relevance and most likely applicable to similar organisations. Equally, the purpose of the study was to determine the views of pharmacists in STHKH prior to implementing formal feedback, and this has been achieved.

Participant numbers could be considered small although they are consistent with recommendations in the literature (Fowler 2009 and Neale 2009) for data saturation.

The author knew the pharmacists involved in a professional capacity and it is possible that this may have influenced their responses. The author was aware of these risks and maintained objectivity throughout and encouraged all participants to express their views. Additionally, follow-on questions from the author allowed clarification of pharmacist responses although such 'member checking' (Shenton 2004) was used reservedly to limit disruption of the group discussion.

The range of pharmacist grade and experience in each group was considered a strength, although it is possible that more junior pharmacists were unwilling to challenge more senior pharmacist views. Such 'social desirability' bias may adversely influence the trustworthiness of data (Shenton 2004), a limitation the author was aware of. To mitigate this, more junior staff were sat facing and less experienced staff sat to the side of the author to allow more direct engagement of junior staff.

Finally, coding is a subjective and interpretive experience and it is possible that the author has not identified or interpreted inferences from the data accurately or completely. However, this risk was mitigated by the author

having previous experience of qualitative research and second coding by the research team (SDW and SVOB).

4.8. Chapter Summary

A key aim of these focus groups was to understand the experiences of hospital pharmacists of delivering feedback on PEs. This chapter has presented participant details, qualitative data collection, and analysis methods and results.

The results reported in this chapter suggest that feedback practices are currently inconsistent and informal. Pharmacists would value and welcome a more formalised approach and outlined potential benefits for patient safety and working practices. Potential barriers to the process were outlined including workload and time pressures, prescriber response and lack of training.

Notable apprehensions concerning the process included potential adverse effects on prescriber relationships. The need for facilitator training was outlined and could help to mitigate these apprehensions.

Chapter 5 will now explore the impact of PE feedback on PE rates in a pilot study.

Chapter 5. Feasibility study

5.1. Introduction

This chapter reports the impact of feedback on PEs to provide insight into the primary research question:

What is the impact of feedback on prescribing error rates?

Where the hypothesis described in chapter 3 was:

H_1: "There is a difference in mean change in prescribing error rate between the intervention and control group"

Whilst this is an initial pilot study over four hospital wards, it explores the potential impact of feedback to inform if the intervention can be effective and support the need for larger studies. It will also contribute to what little is known on the subject in hospital settings as described in chapter 2. An overview of data collection and analysis will be described followed by presentation of the results. A combination of descriptive and inferential statistics are used to determine if there is a statistically significant difference in change in PE rates between groups following delivery of feedback. The chapter will then conclude with a discussion of findings and a chapter summary.

5.1.1. Sample size

Four wards were audited, two with doctors receiving feedback (intervention wards) and two wards with existing practice (control wards). Choice of wards were negotiated with the clinical pharmacy services manager in advance as data collection and delivery of feedback would impact on pharmacy service. All wards were medical and similar sized, with comparable prescriber numbers and grades (Table 7), and patient turnover (See table 8).

Table 7: Number of each prescriber grade included in intervention and control group analysis

Prescriber grade [a]	Number	
	Intervention	Control
FY1	4	4
FY2	1	2
CT/ST	3	4
Consultant	2	2
Total	10	12

[a] See chapter 1 for an overview of prescriber grades

Table 8: Ward characteristics for control and intervention groups

Ward	Ward type		Number of beds	Approximate patient turnover (patients per week)
	Intervention	Control		
1	Medical	Medical	32	40-50
2	Medical	Medical	32	60-80
3	Medical	Medical	32	50-60
4	Medical	Medical	32	40-50

A total of 22 prescribers were included, with 10 in the intervention group and 12 in the control group. Prescribers were included in data analysis if they had prescribing data at both baseline and post-intervention. In addition, prescribers on the intervention ward had to have received feedback at least once from a ward-based pharmacist to be included. This was confirmed by checking for evidence of a completed feedback form in the secure electronic folder in pharmacy. Prescriber details are presented in table 9.

Table 9: Prescriber and ward characteristics for intervention (feedback) and control (normal practice) groups

Prescriber	Grade	Gender	Intervention or control group	Ward	Ward type	Number of feedback sessions (including overall)
1	FY1	Female	Intervention	2	Medical	11
2	FY1	Female	Intervention	2	Medical	10
3	FY1	Female	Intervention	1	Medical	5
4	FY1	Female	Intervention	1	Medical	8
5	FY2	Female	Intervention	2	Medical	4
6	CT2	Female	Intervention	1	Medical	12
7	CT1	Female	Intervention	2	Medical	9
8	ST3	Male	Intervention	1	Medical	3
9	Consultant	Male	Intervention	1	Medical	2
10	Consultant	Male	Intervention	2	Medical	2
11	ST7	Male	Intervention	2	Medical	0
12	FY1	Male	Control	3	Medical	0
13	FY1	Female	Control	3	Medical	0
14	FY2	Female	Control	3	Medical	0
15	CT1	Male	Control	3	Medical	0
16	CT4	Male	Control	3	Medical	0
17	Consultant	Male	Control	3	Medical	0
18	Consultant	Male	Control	3	Medical	0
19	FY1	Female	Control	4	Medical	0
20	FY1	Male	Control	4	Medical	0
21	FY2	Female	Control	4	Medical	0
22	CT1	Female	Control	4	Medical	0
23	CT2	Female	Control	4	Medical	0

5.1.2. Data collection

Pharmacists were trained in data collection methods beforehand as described in chapter 3. Additionally, pharmacists on the intervention wards were trained in delivery of constructive feedback as described in chapter 3.

Pre-intervention data was collected over five consecutive days in September 2014. Pharmacists collected prescribing data prospectively recording: ward area, prescriber name, number of items prescribed and, where identified, the number, type and severity of PEs. Prescribing data was collected using the proforma in appendix 16.

Following data collection, ward pharmacists prepared prescribing feedback reports to deliver feedback on overall prescribing to prescribers based on their wards. This was followed by further feedback on any PE where the severity was classified as significant or greater (See appendix 17). This process continued for a period of 3 months before re-auditing over a further five consecutive days in December 2014.

One doctor, prescriber number 11, was excluded from data analysis as they had not prescribed any medications in the post-intervention period for comparison of PE data.

5.1.3. Data analysis

All data from pre-test and post-test audit periods was inputted into SPSS v.22 for data analysis. PE rate was calculated by dividing total errors by total number of items. Error free prescription and prescribing error rates were calculated as described in chapter 3.

Results were calculated for the mean PE rate with standard deviation and 95% confidence intervals reported. As discussed in chapter 3, chi-squared tests were used to compare error frequencies at the prescription level between and within groups. Independent t-tests were used to determine the impact on PE rates (continuous data) at the prescriber level between groups.

5.2. Results

5.2.1. Impact of feedback on overall prescription error rates

A summary of overall prescribing data for control and intervention groups is summarized in table 10 and figures 10-12 below.

5.2.1.1 Pre-test prescribing data

A total of 303 prescriptions were audited, 170 of which were error free (56.1%), with 1292 items prescribed and 244 PEs identified, an overall PE rate of 18.9%.

There were 149 prescriptions in the intervention group, with 81 error free (54.4%). There were 641 prescribed items with 123 PEs (figure 10), an overall PE rate of 19.2%.

There were 154 prescriptions in the control group, with 89 error free (57.8%). There were 651 prescribed items with 121 PEs (figure 11), an overall prescribing error rate of 18.6%.

5.2.1.2 Post-test prescribing data

A total of 376 prescriptions were audited, with 204 error free (54.3%). There were 2664 prescribed items and 329 prescribing errors identified, an overall prescribing error rate of 12.4%.

There were 211 prescriptions in the intervention group, with 141 error free (66.8%). There were 1677 prescribed items with 90 PEs (figure 10), an overall PE rate of 5.4%.

There were 165 prescriptions in the control group, with 63 error free (38.2%). There were 987 prescribed items and 239 PEs (figure 11), an overall PE rate of 24.2%.

Table 10: Overview of prescribing error data for overall prescribing in intervention and control groups

Group	Pre-items	Pre-errors	Pre-error rate %	Post-items	Post errors	Post-error rate (%)	Difference in error rate Pre - post	Chi-square and p-value
Intervention	641	123	19.2%	1677	90	5.4%	-13.8%	$\chi^2(1)$ = 83.8, <0.005, φ = 0.182
Control	651	121	18.6%	987	239	24.2%	5.6%	$\chi^2(1)$ = 4.7, p=0.03, φ = -0.048
Total	1292	244	18.9%	2664	329	12.3%	-6.6%	

Figure 10: Bar chart illustrating prescribed items and errors for the intervention group before and after the intervention period
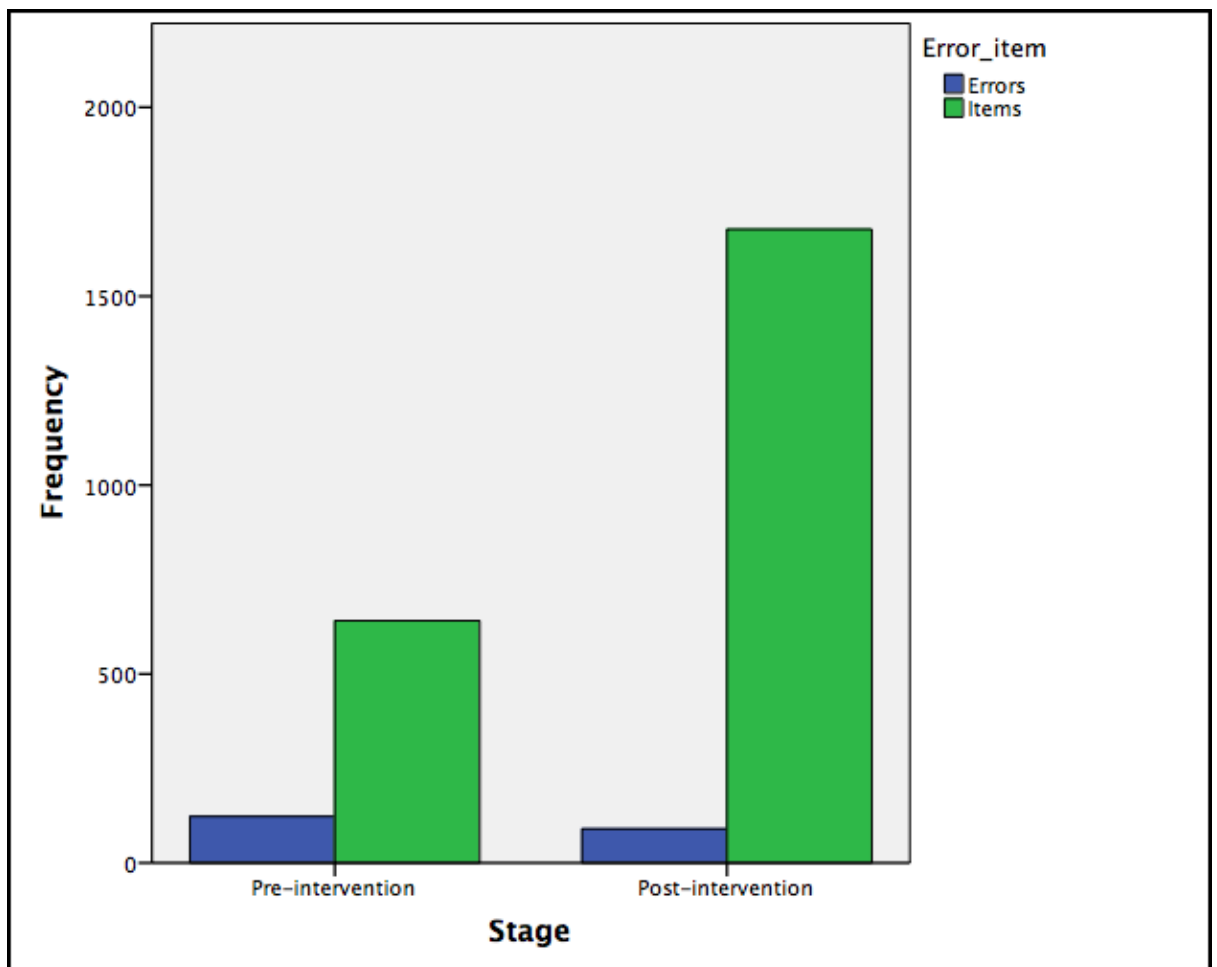
Figure 11: Bar chart illustrating prescribed items and prescribing errors for the control group before and after the intervention period
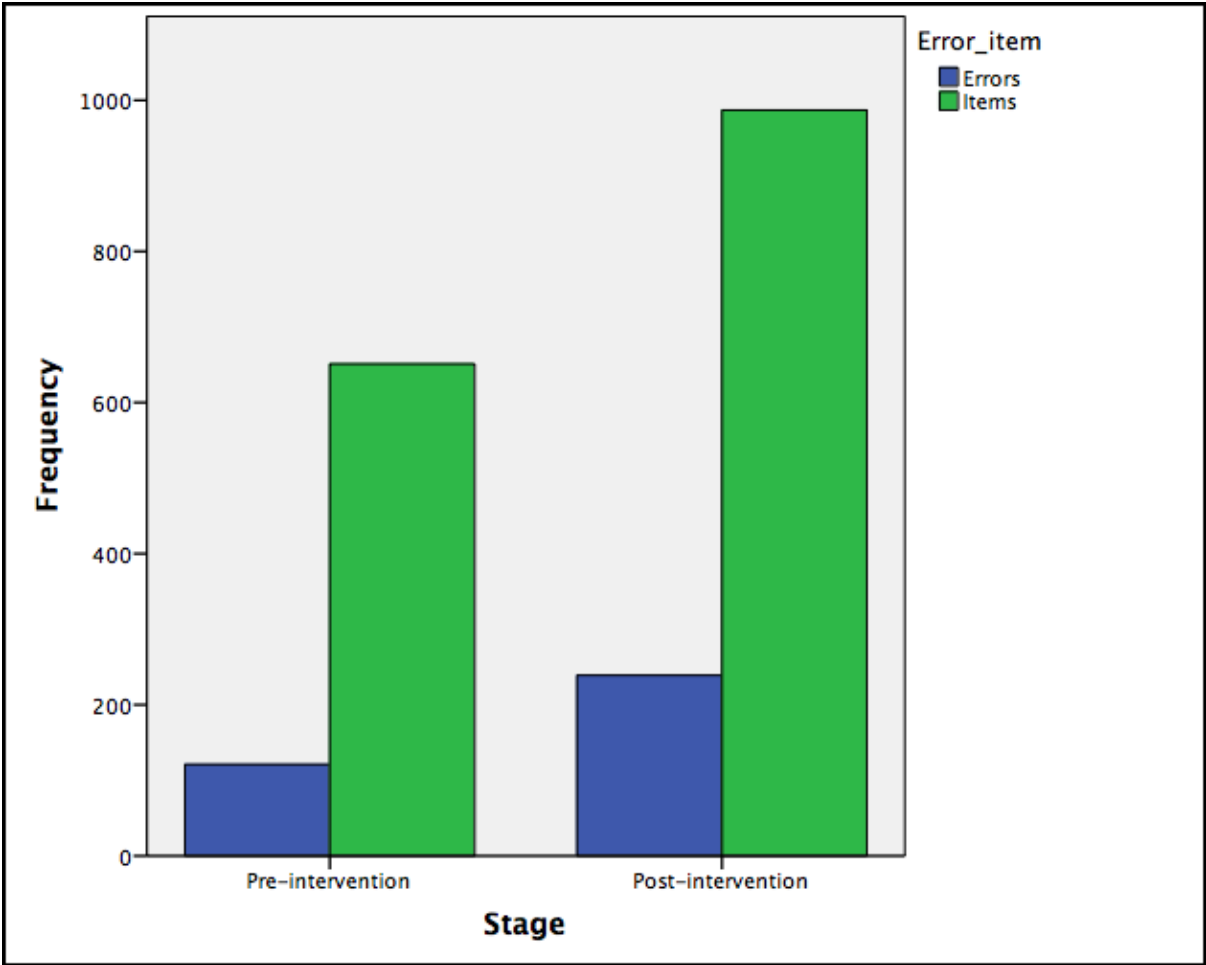
Figure 12: Bar chart illustrating prescribed items and prescribing errors for the intervention and control groups pre-intervention
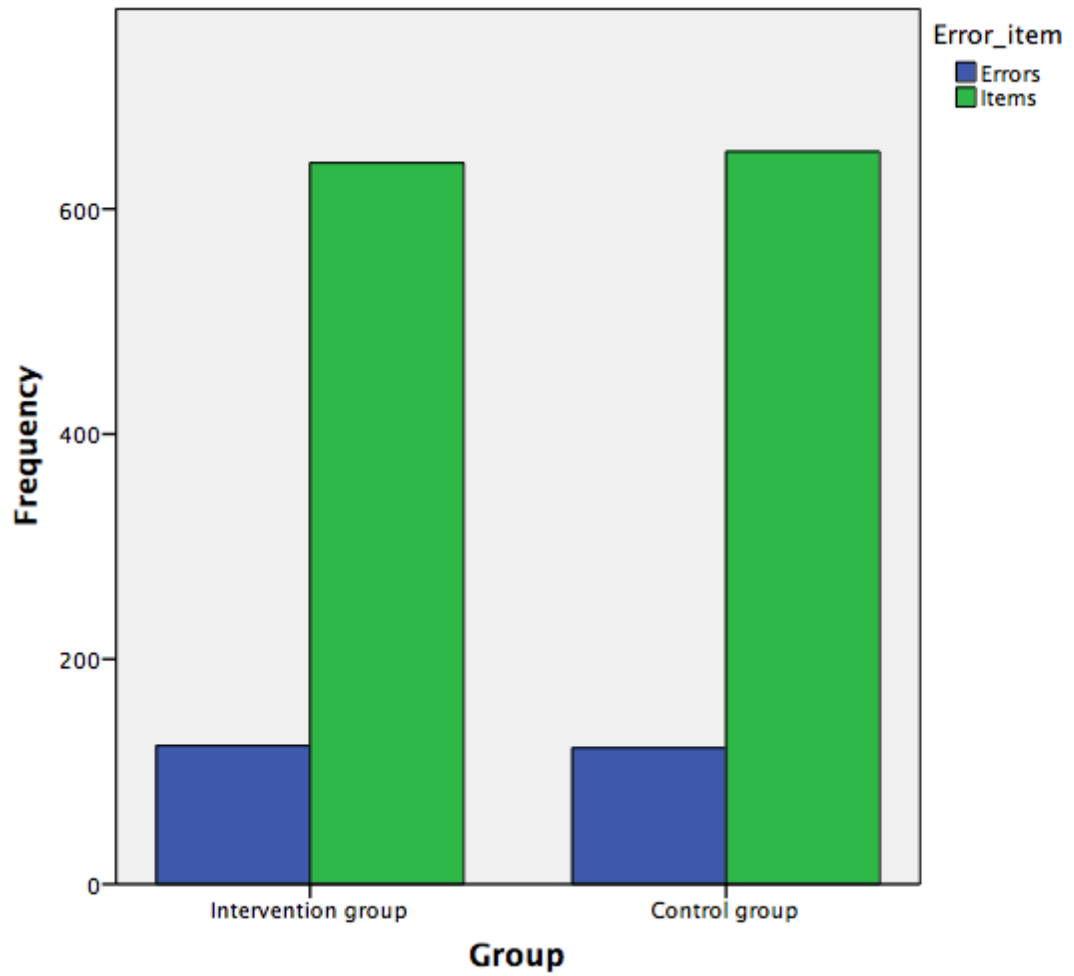
Figure 13: Bar chart illustrating prescribed items and errors for the intervention and control groups post-intervention
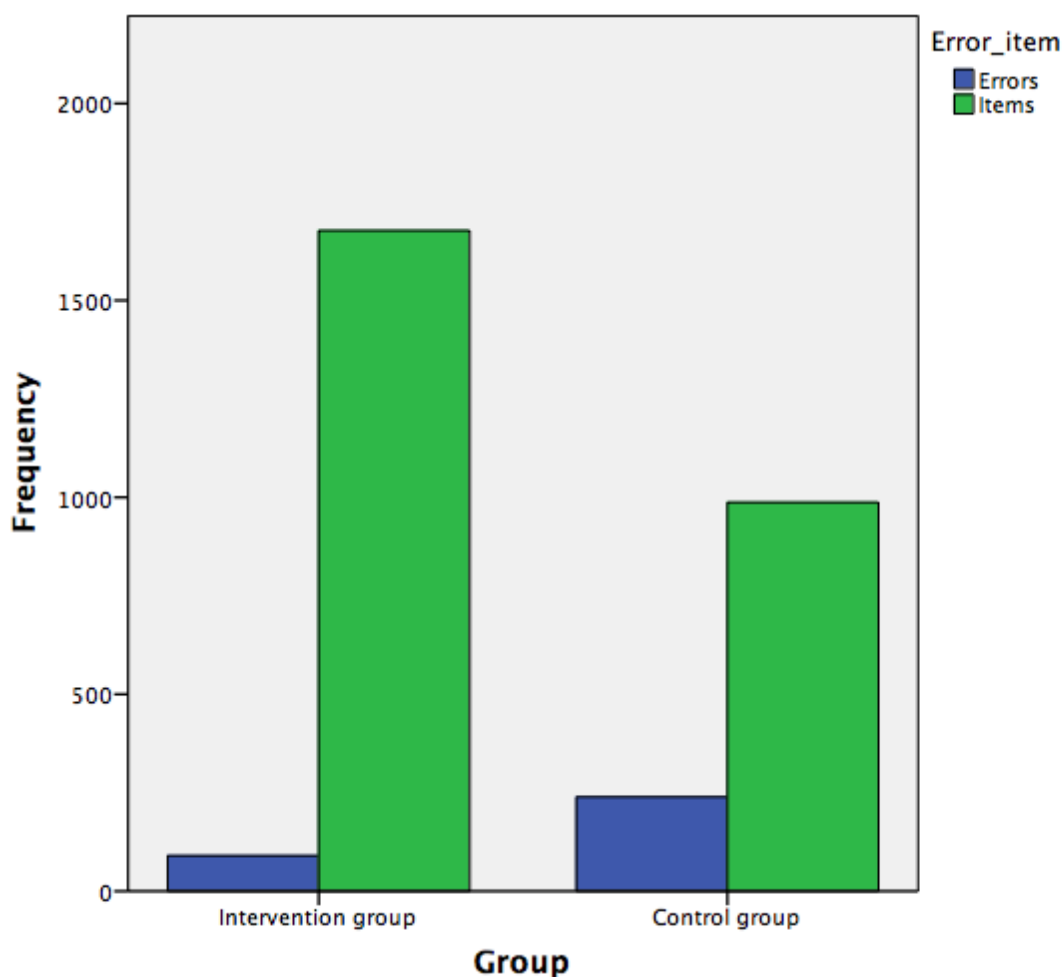
5.2.2. Impact on overall prescription error rate

Descriptive statistics indicate that the PE rate changed between pre- and post-intervention with a mean reduction in the intervention group and a mean increase in the control group. Frequency of errors pre- and post-intervention were compared using the chi squared test. Here the null hypothesis is;

H_0: There is no difference in the frequency of prescribing errors within/between groups

Assumptions of the chi-squared test include independence of observations, categorical data (i.e. group and error occurrence) and that all expected cell

counts are greater than five as described in chapter 3. In this chapter, all reported chi-squared tests had cell counts greater than five.

At baseline (figure 12), there was no statistically significant association between error frequency and group (intervention or control), $\chi^2(1) = 0.052$, $p = 0.819$, $\varphi = 0.06$. Therefore, the null hypothesis is accepted, error frequency did not differ between groups at baseline.

Post intervention (figure 13), there was a statistically significant association between group and frequency of prescribing errors, $\chi^2(1) = 153.4$, $p = <0.005$, $\varphi = -0.226$. Therefore, the null hypothesis is rejected, error frequency did differ between groups post-intervention.

Within group analysis suggested there was a statistically significant association between error frequency and pre-post testing for both intervention ($\chi^2(1) = 83.8$, $p = <0.005$, $\varphi = 0.182$) and control groups ($\chi^2(1) = 4.7$, $p = 0.030$, $\varphi = -0.048$). Therefore, the null hypothesis is rejected, error frequency did differ within groups following the intervention period.

Whilst these results indicate that there is a difference between the two groups following delivery of feedback, the primary research question is concerned with determining if there is a difference in the mean change in PE rates between the two groups. Independent t-tests were used to determine this as outlined below.

5.2.3. Impact on error free prescriptions

Similar results were reported for error free prescriptions. There was no significant difference between groups at baseline ($\chi^2(1) = 0.102$, $p=0.75$, $\varphi = -0.015$) with a significant difference reported post-intervention ($\chi^2(1) = 9.37$, $p=0.0022$, $\varphi = 0.127$).

Within group analysis suggested a significant difference in error free prescriptions post intervention for the control group ($\chi^2(1) = 4.353$, $p=0.037$, φ

=0.096), although there was a non-significant difference in the intervention group ($\chi^2(1)$ =1.381, p=0.240, φ = -0.049).

5.2.4. Impact on overall prescriber error rate

A summary of overall prescribing data with the prescriber as the unit of analysis for both control and intervention groups at baseline and post-test is summarized in table 11 below.

Change scores were calculated by determining the difference between post-intervention PE rates and pre-intervention PE rates. This allowed comparison of the mean change in PE rates.

An independent t-test can be used to test the null hypothesis:

H_0: There is no difference in the mean change in prescribing error rates between the intervention and control groups following delivery of feedback to the intervention group

Population sample

Ten prescribers were included in the intervention group, one prescriber (number 11) was excluded as post-intervention prescribing data was not available for comparison.

Mean baseline PE rates were 23.1% (SD 18.0%, 95% CI 10.3 to 36.0) and 11.6% (SD 15.6, 95% CI 0.4 to 22.8) post intervention.

There was a mean reduction in PE rate in the intervention group of 11.5% (SD 13.0, 95% CI -20.8 to –2.3).

Eleven prescribers were included in the control group (one excluded as an extreme outlier).   Mean baseline PE rates were 17.7% (SD 9.2%, 95% CI 11.5 to 23.8) and 23.5 % (SD 6.2, 95% CI 19.4 to 27.7) post intervention.

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There was a mean increase in PE rate in the control group of 5.9% (SD 8.4, 95% CI 0.27 to 11.5).

Table 11: Overall prescribing data per prescriber for control and intervention groups

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post errors	Post-error rate (%)	Change score (%)
1	82	7	8.5	568	27	4.8	-3.7
2	188	39	20.7	279	12	4.30	-16.4
3	4	1	25	193	7	3.63	-21.4
4	126	23	18.3	121	7	5.8	-12.5
5	34	4	11.8	210	7	3.3	-8.5
6	143	32	22.4	161	12	7.5	-14.9
7	57	14	24.6	119	7	5.9	-18.7
8	1	0	0	1	0	0	0
9	3	2	66.7	6	2	33.3	-33.4
10	3	1	33.3	19	9	47.4	14.1
11	17	9	52.9	n/a	n/a	n/a	n/a
12	60	6	10	36	3	8.3	-1.7
13	69	11	15.9	194	43	22.2	6.3
14	151	35	23.2	91	21	23.1	-0.1
15	85	15	17.7	131	26	19.6	2.1
16	49	5	10.2	50	15	30	19.8
17 *	2	0	0	3	3	100	100
18	1	0	0	5	1	20	20
19	50	15	30	95	26	27.4	-2.6
20	83	15	18.1	55	14	25.5	7.4
21	19	6	31.6	117	32	27.4	-4.2
22	13	3	23.1	46	14	30.4	7.4
23	69	10	14.5	164	41	25	10.5
Total	**1292**	**244**		**2664**	**329**		

* Prescriber 17 was excluded from analysis as they were an extreme outlier affecting distribution of data as discussed below.

5.2.4.1. Independent t-test assumption testing

As described in chapter 3, various assumptions must be met to determine if the data is suitable for performing independent t-tests. These assumptions are normality of distribution, absence of outliers and homogeneity of variance.

Shapiro-Wilk tests suggest normality of distribution with a p-value >0.05 for the intervention group (p=0.946) and non-normality for the control group (p=0.000081). However, inspection of the histogram (Figure 14) suggests an approximated normality for the control group. Inspection of the normality plots (Figures 15 and 16) also suggested an approximated normality with one severe residual departing below the normal line influencing non-normality. This was further supported by inspection of the box plot (Figure 17) suggesting one extreme outlier (prescriber 17) in the control group.

Figure 14: **Histogram of distribution of change scores for overall prescribing in control and intervention groups**
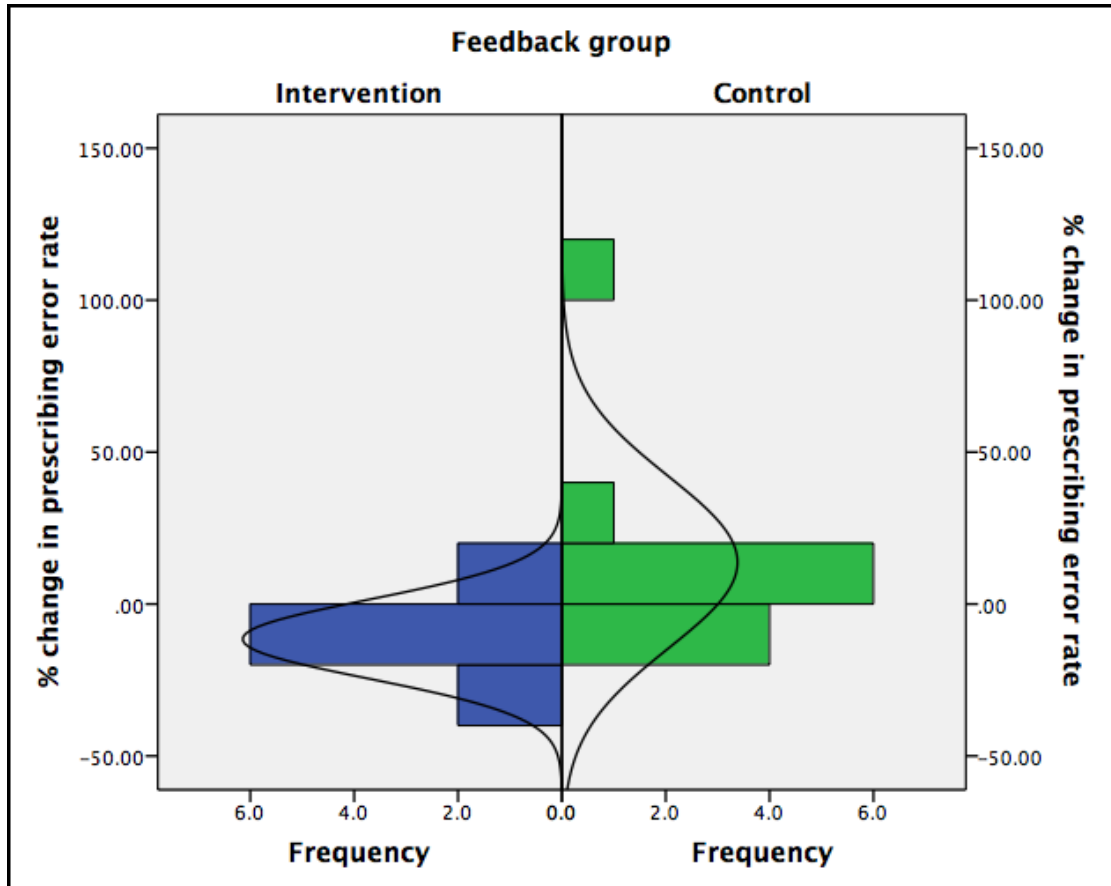
Figure 15: Probability plot for change in overall prescribing error rates for the intervention group

Normal Q-Q Plot of Change_rate
for Group= Intervention
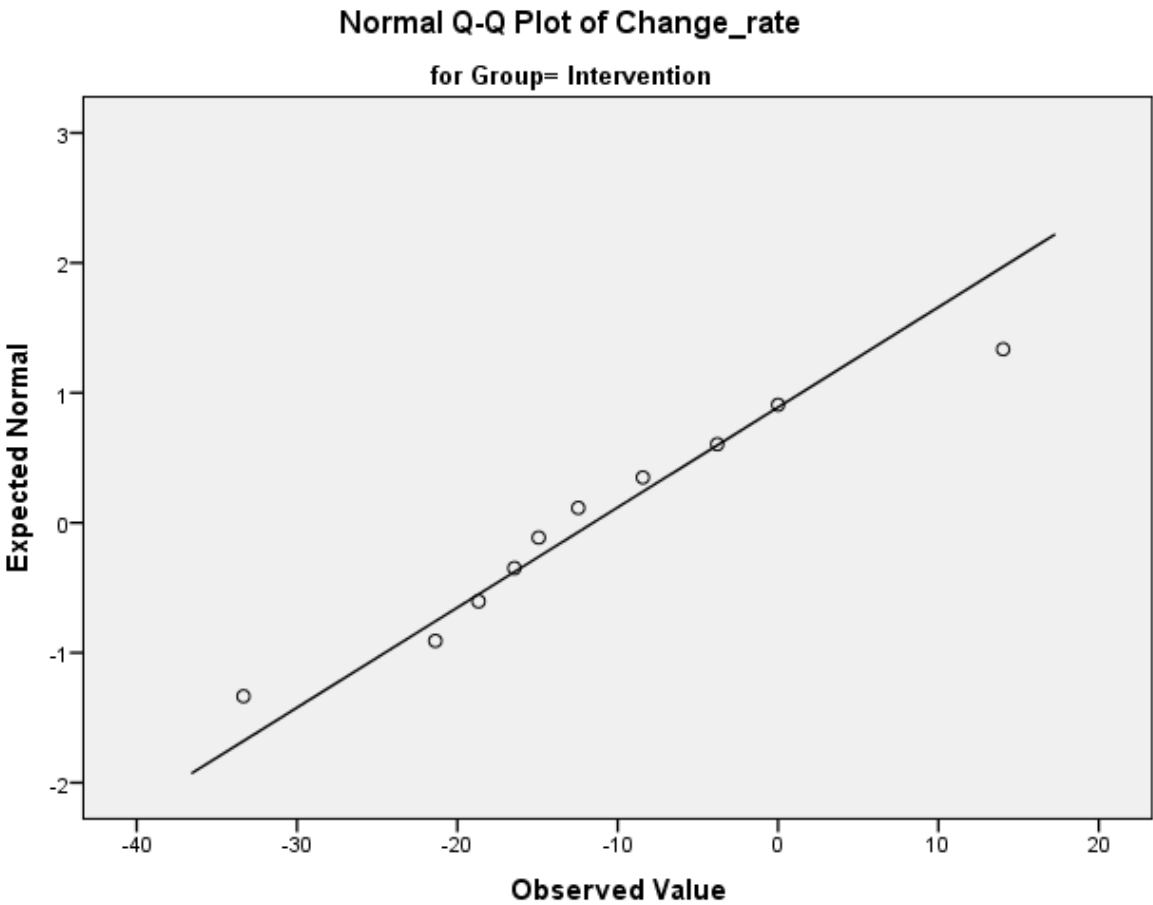
Figure 16: Probability plot for change in overall prescribing error rates for the control group

Normal Q-Q Plot of Change_rate
for Group= Control
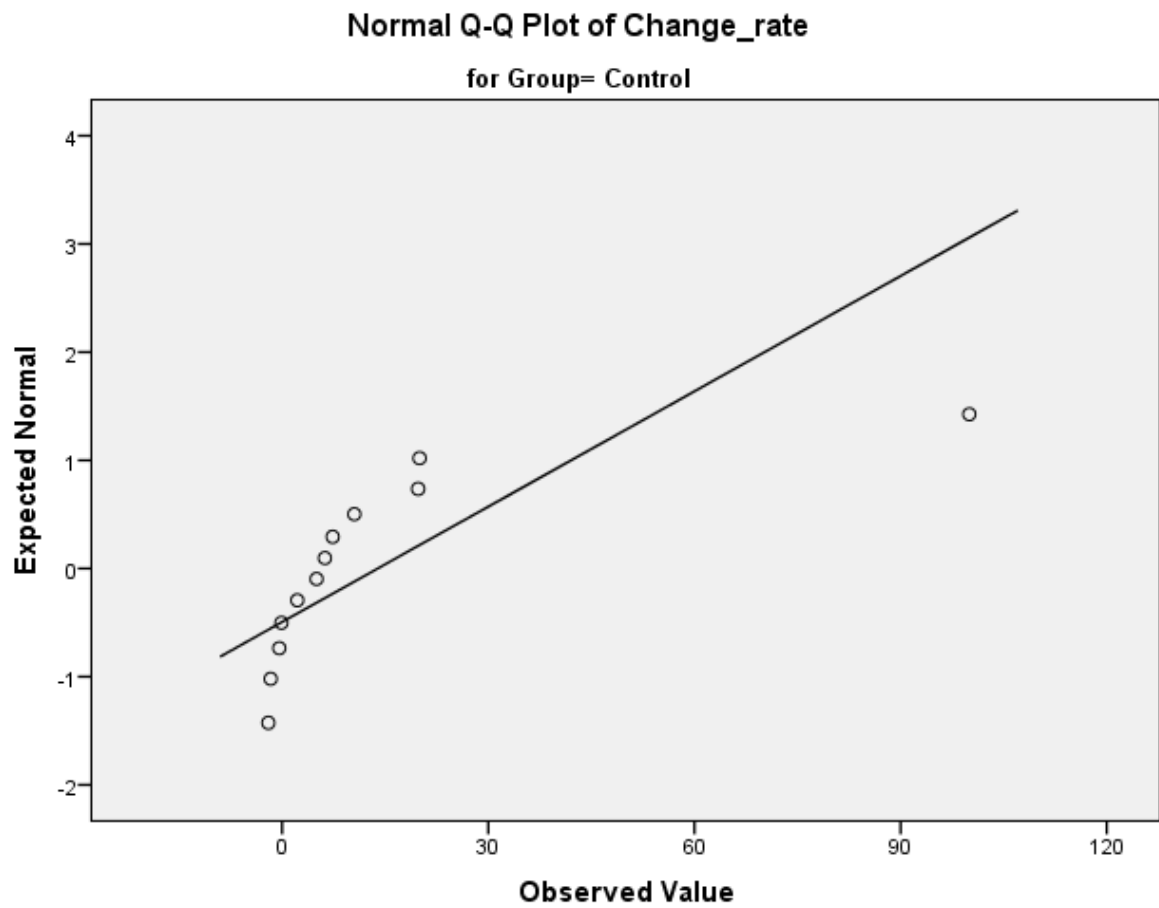
Figure 17: Boxplot for change in prescribing error rates for overall prescribing
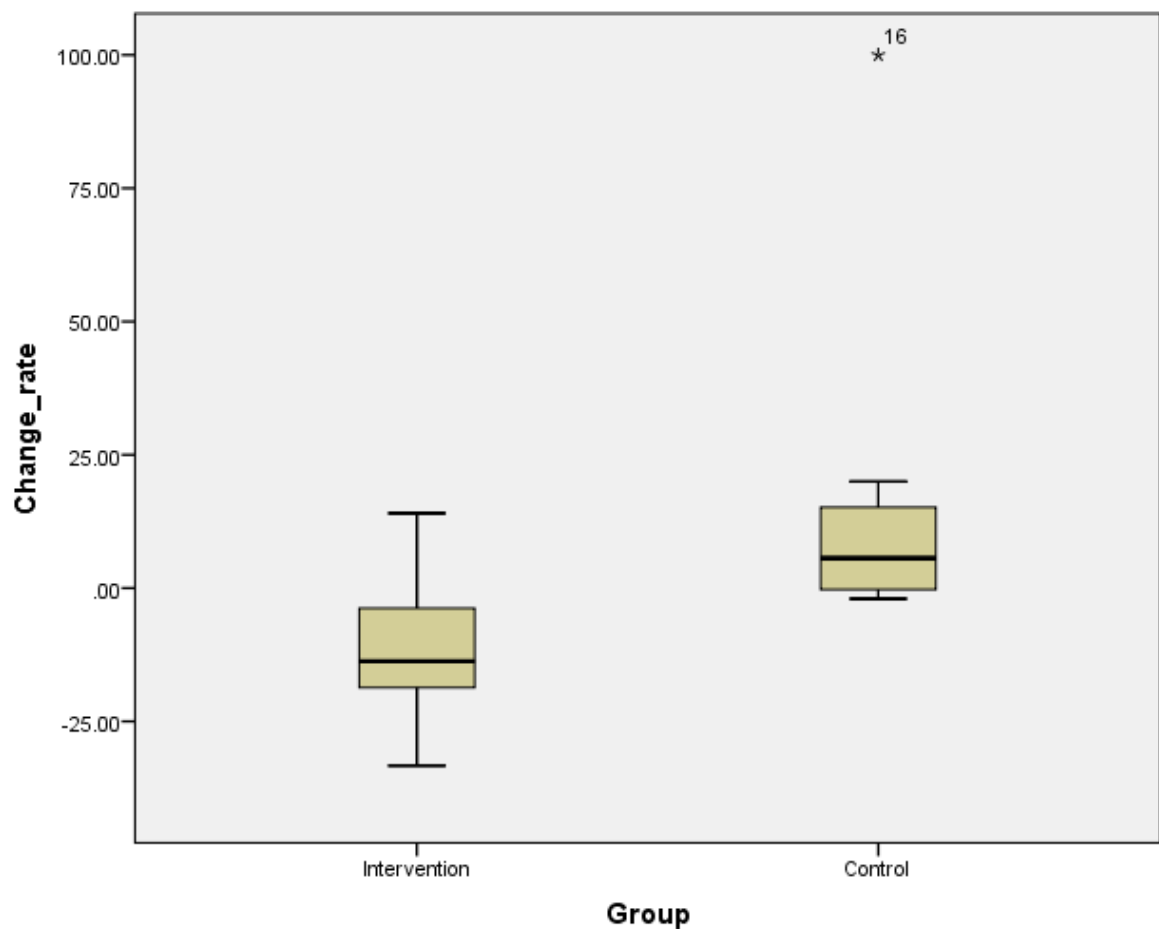
Whilst t-tests are robust to deviations in normality and outliers as discussed in chapter 3, the analysis was performed without the outlier (prescriber 17) before attempting further data manipulation such as data transformation for skewed data.

Eleven prescribers were therefore included in the control group. The adjusted mean change in PE rate in the control group without the outlier was an increase of 5.9% (SD +/-8.4, 95% CI 0.3 to 11.5).

Removal of prescriber 17 (data point 16) revealed a normal distribution with Shapiro-Wilk values of 0.946 for the intervention and 0.221 for the control groups.

This was supported by inspection of the histogram (Figure 18) below whilst the probability plot (see figure 19) revealed a normal distribution with a few residuals above and below the normality line. No outliers were identified from inspection of the revised box plot (see figure 20 below).

Therefore, initial assumption testing was satisfied and the t-test performed. A sensitivity test can be performed to compare outcomes with and without the outlier.

Figure 18: Histogram of distribution of change scores for overall prescribing in control and intervention groups without the identified outlier
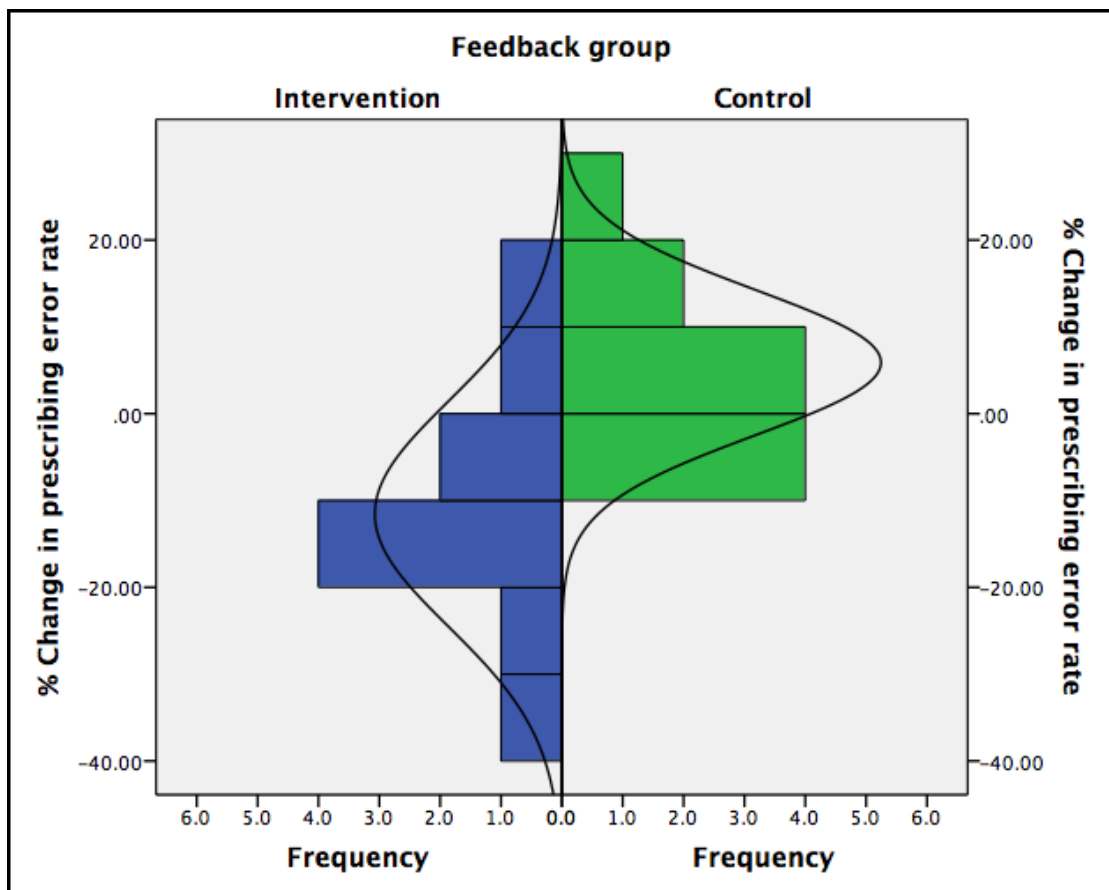
Figure 19: Probability plot for change in overall prescribing error rates for the control group without identified outlier

Normal Q-Q Plot of Change_rate
for Group= Control
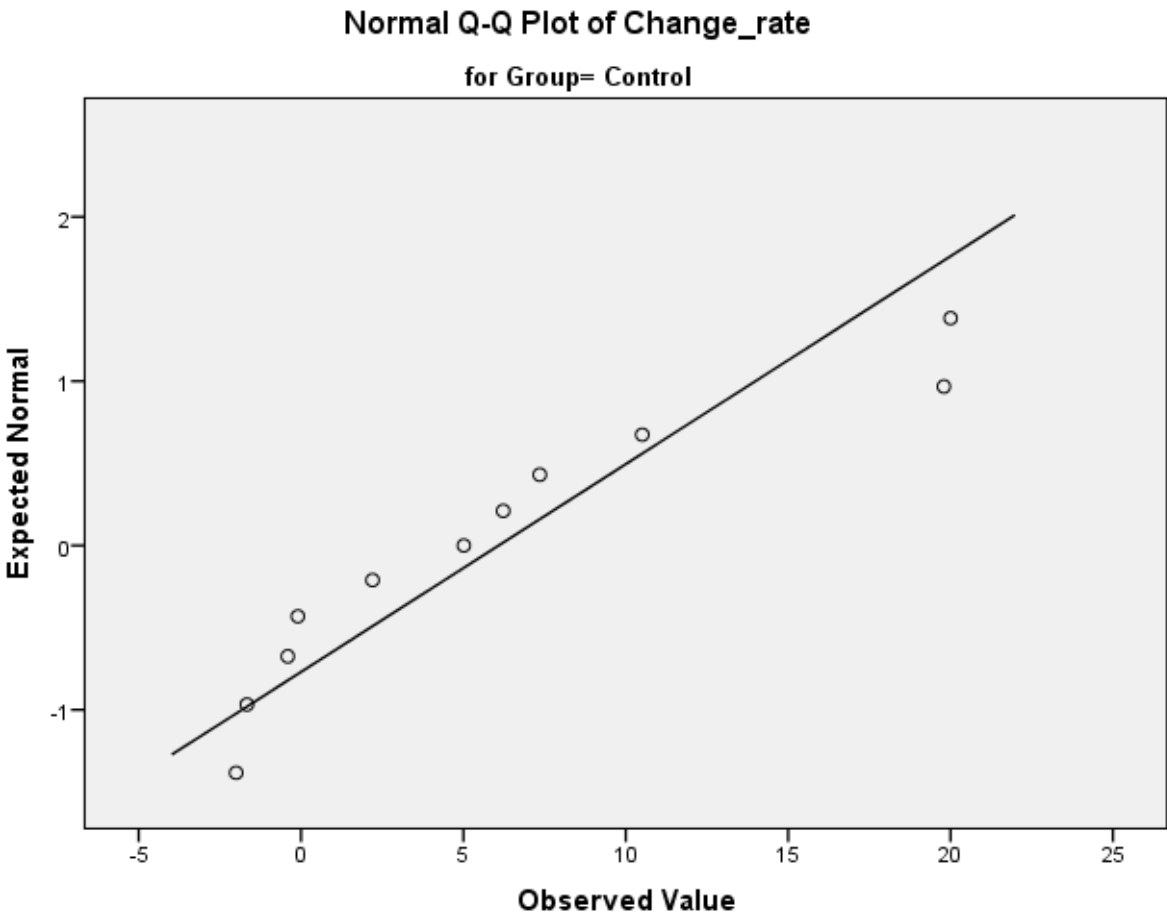
Figure 20: Boxplot for change in prescribing error rates for overall prescribing without identified outlier
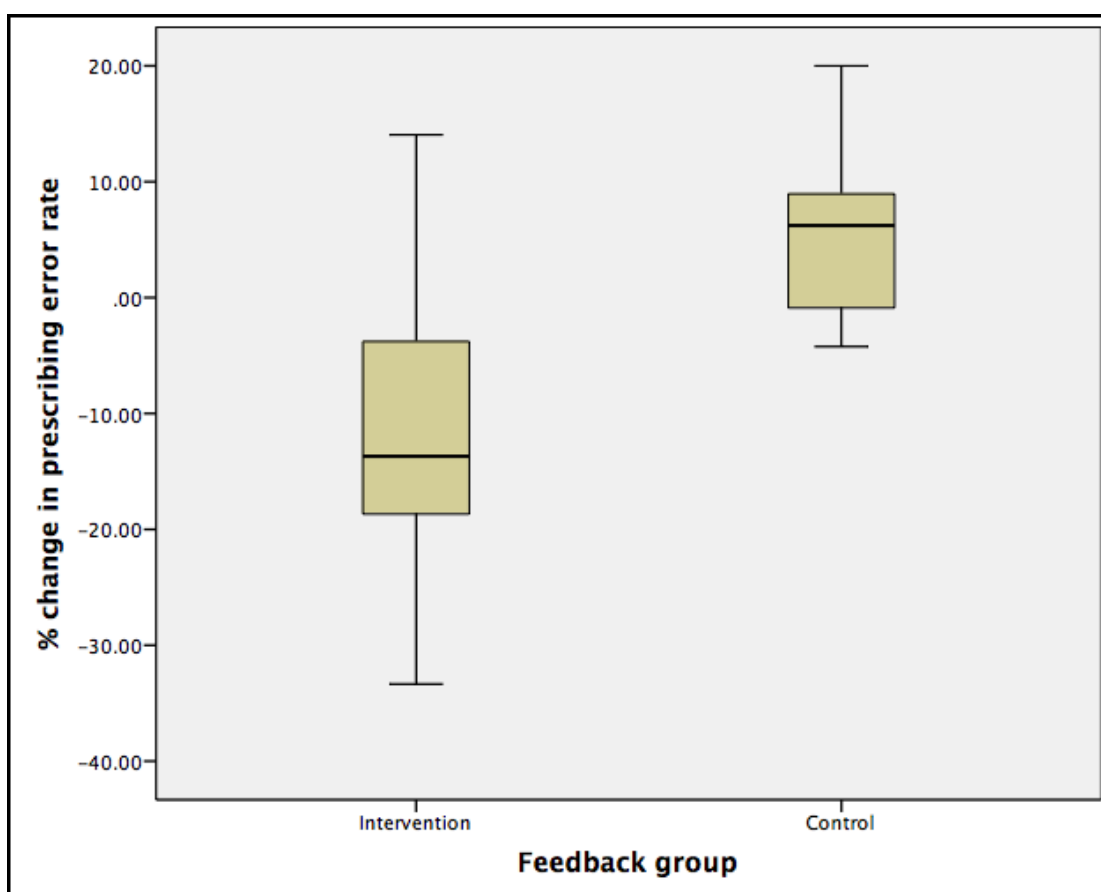
Homogeneity of variance

Homogeneity of variances was demonstrated by Levene's tests (p>0.05 at 0.3) and this assumption was met.

5.2.4.2. Independent t-test results for prescribing error rates

PE rates were statistically significantly lower in the intervention group compared to the control group. Mean difference of 17.4% (SD 4.7, 95% CI, -27.3 to –7.6), t(19) = -3.694, p<0.05 (0.00154), effect size (d) = 1.60 (large). Therefore, the null hypothesis is rejected, mean change in PE rates do differ following delivery of PE feedback.

Removal of outliers for overall prescribing

The t-test was also performed with the outlier (prescriber number 17).

There was homogeneity of variances as demonstrated by Levene's score >0.05 (0.374). Mean difference as determined by the independent t-test was statistically significant favouring the intervention group with a mean difference of -25.28% (SD 9.73, 95% CI = -45.58 to -4.97) $t(20) = -2.597$, $p<0.05$ (0.017242). Results were still significant justifying exclusion of the outlier.

5.3. Summary of results

PE rates have been reported for intervention and control groups pre- and post-intervention. Baseline PE frequencies were similar between groups ($p=0.819$) with significant differences post-intervention within and between groups. Prescribing error frequencies were significantly lower for the intervention, and significantly higher for the control group following the intervention period. Comparing mean change in PE rates between groups, PE rates were statistically, significantly lower, in the intervention group compared to the control group with a mean difference of 17.4% ($p<0.05$).

5.4. Chapter discussion

As this is a pilot study, it is not the intention of the author to discuss the results of this chapter in detail as this area will be revisited and discussed further in chapter 7. Instead, a brief overview will be presented followed by consideration of potential limitations of the research presented in this chapter.

The results of this chapter suggest that PE feedback can positively influence prescribing. Whilst this is a pilot study with relatively small numbers of prescribers, the results are promising.

PE rates are comparable to those published elsewhere (Franklin *et al.* 2011, Reynolds *et al.* 2016) although they are higher than the average reported in the seminal EQUIP study (Dornan *et al.* 2009). The PE rate increased in the control group, increasing the size of change in PE rates between groups. This could be explained by a lack of feedback and awareness of PEs, whilst it is possible that local prescribing etiquette could lead to suboptimal prescribing becoming routine or acceptable practice (Charani *et al.* 2013, Mattick *et al.* 2014, McLellan *et al.* 2016).

Empirically, feedback is suggested to have small to moderate effects on practice (Ivers *et al.* 2014). In this chapter, the effect size was reported as large. This could be related to the higher than average (Dornan *et al.* 2009) PE rates with Ivers *et al.* (2012) suggesting that feedback is most effective when "the health professionals are not performing well to start out with". Indeed, if this is a tenet of feedback outcomes, then one might expect greater reductions from prescribers who are performing below average than those who are performing above average.

Lack of feedback on PEs could be considered a latent error with prescribers reporting minimal feedback on their prescribing previously (Dornan *et al.* 2009, Dean *et al.* 2002, Mattick *et al.* 2014). Feedback has been identified as a priority in clinical settings for developing appropriate diagnostic decision making (Elstein 2009). Given prescribing is a clinical skill, such outcomes could translate to prescribing (Mattick *et al.* 2014). The need for delivery, or active seeking of constructive feedback to inform and educate prescribing competency is advocated in best prescribing principles (Lum *et al.* 2013, Likic and Maxwell 2009) and the results of this chapter support this recommendation.

The results from this chapter suggest that a feedback intervention, designed to reflect the principles of effective feedback, can improve prescribing practice. These results can be used to motivate pharmacists to deliver

further feedback, demonstrating the impact of their efforts and endeavours, whilst supporting the wider application of the intervention across STHKH.

Whilst the results suggest the intervention can reduce PE rates, it is unknown if the results are reproducible. Unintended consequences may have influenced prescribing. Prescribers were not aware of the audit periods, although the intervention group were aware that they would receive feedback, potentially creating a 'Hawthorne effect' where participants perform better as a result of change or being singled out, and so not necessarily as a result of the intervention (Franke and Kaul 1978). A feedback avoidance (Bok *et al.* 2013, Teunissen *et al.* 2009) has also been reported elsewhere with prescribers more engaged with prescribing to avoid any negative judgements. Considering this, it is unknown if it is the feedback or another outcome of the feedback process, that has influenced prescribing practice. This theme will be revisited in chapters 7 and 8.

Error causation is complex and it is unknown if the potential for harm is reduced from latent conditions or error provoking factors, or from sterilisation of the prescribing process where these conditions are managed. The impact on the facilitators and recipients of feedback is also unknown and these themes will be explored in later chapters. In the previous chapter, pharmacists expressed anxieties over the process pre-intervention and questioned the value of the feedback, and it is unknown if these concerns have manifested with the service delivery. To this end, further qualitative studies will explore the impact on prescribers, pharmacists and prescriber behaviour in chapters 6, 8 and 9 respectively.

5.5. Limitations

The study presented in this chapter is not without limitations. The ward characteristics do not reflect the mixed ecology of a large district general hospital. The pilot wards were homogeneous and did not include surgical, admissions, acute areas or care of the elderly wards for example. Considering this, it is unknown if the same effect can be reproduced or

replicated elsewhere although the ward areas used in this chapter represent a range of pharmacists, prescribers and prescribing situations encountered on any typical ward. Equally, it is unknown if pharmacists could deliver feedback to a larger cohort of prescribers across the entire organization. However, given clinical pharmacy ward services are comparable across the hospital; this should not be a significant barrier.

Participants were non-randomized. This study design and the reported outcomes may therefore be influenced by other unknown factors such as local induction, education, working practices or prescribing culture affecting internal validity. That said, wards were matched for size, number of doctors with comparable grade distribution and expected turnover of patients to limit such bias, although the potential impact of social or environmental differences cannot be discounted. Equally, the possibility of a 'Hawthorne effect' influencing the intervention group cannot be discounted, and makes interpretation of the true effect of the feedback intervention uncertain.

Despite wards having similar activity for patient turnover, there was a disparency between prescribed items reviewed post-intervention for intervention (1677) and control (987) groups. The number of items was also greater than that collected at baseline, and it could be that pharmacists collecting data were more motivated in the intervention group because of delivering feedback. Equally, there may have been variances in patient turnover between audit periods although wards were matched for size and turnover. Whilst this could potentially influence results, it should also be acknowledged that the control group still had over twice as many errors whilst the combined descriptive and inferential statistics demonstrated statistically significant reduction in PEs.

Additionally, the results of this chapter have not specifically reviewed the impact of feedback on different prescriber grades, stage of prescription (for example inpatient or discharge prescribing) error severity or error type. Equally however, this was not the true *raison d'etre* of this chapter: the purpose was exploratory to determine if feedback was effective. The results

have answered this question and informed the need for a larger cohort study that will be presented in chapter 7 with further in-depth analyses.

Finally, feedback should be a social exercise, co-constructed between facilitator and recipient. Results in this chapter indicate PE feedback can be effective but the impact on prescribers and pharmacists, and the reasons for changes in prescribing behaviour have not been illuminated and will be explored in later chapters.

5.6. Chapter Summary

This chapter has presented the results of a pilot study exploring the impact of a feedback intervention on prescribing, and contributes to what little is known in this subject field. Statistically significant reductions in PE rates were reported following the intervention period, although further research is necessary to explore why these changes occurred and if they are reproducible. There is promise for wider application in STHKH and similar settings in the NHS. The following chapter will return to qualitative methodology to explore prescriber views of receiving feedback to understand the impact of the process at the individual prescriber level.

Chapter 6. Prescriber experiences of, and attitudes towards receiving prescribing error feedback

6.1. Chapter introduction

This chapter describes the experiences, opinions and views of ten doctors towards receiving formalised PE feedback. Little is known on this subject as described in chapter 2. Semi-structured interviews are used to explore these views in-depth in this chapter.

The primary research aim of this chapter was to:

> Explore and determine prescribers' experiences of receiving formalised prescribing error feedback

An overview of the interview process will first be described followed by analysis of the data with relevant comments to illustrate the results. Six key themes are reported from analysis of the interviews and are used to present prescribers' experiences of the feedback intervention. This will be followed by a discussion and summary of the findings.

6.2. Semi-structured interviews

Semi-structured interviews were used to elicit the in-depth views of participants as described in chapter 3. Prescribers were recruited as described in chapter 3 with pharmacists providing participant information sheets to prescribers (Appendix 9). Where prescribers expressed an interest to participate, a follow up e-mail (Appendix 11) was sent by the author. Eleven prescribers were eligible to participate where they had received formalised feedback from a pharmacist at least once during the pilot study in chapter 5. Interviews took place between October and December 2014.

Prescriber interviews were undertaken in a private location either in an interview room on their ward, in their office, or an interview room in pharmacy at a time to suit them. All pagers / mobile phones were turned off to prevent

interruption where possible. For junior staff, consultants and ward managers were informed of the interview time to limit potential disruptions.

The purpose of the interview was covered prior to commencing the interview and both verbal and written consent obtained. A topic guide (Appendix 3) was used to explore key themes whilst ensuring consistent issues were discussed. The semi-structured interview approach allowed further follow-up questions to clarify and expand on prescriber responses as described in chapter 3. Interview duration ranged from 18 minutes to 34 minutes (Table 12).

6.3. Data analysis

All interviews were digitally recorded and transcribed verbatim by the author, except to anonymise person and place names. Interviews took an average of 2 hours to transcribe.

The author listened, re-listened, read and re-read the transcripts to correct any typographical errors and for early immersion in the data. Electronic copies of the transcripts were forwarded to the research supervisors (SW and SOB) for independent analysis. Transcripts were discussed with the research supervisors and emergent codes and themes compared and contrasted. Data saturation (See chapter 3) was considered achieved by interview 7.

Interviews were coded manually line-by-line and analysed thematically using the framework approach as described in chapter 3. Emergent codes were informed by the topic guide and the author's understanding of the literature. Further codes emerged from the participant interviews that were not predicted including 'raised discretionary effort', 'patient context', 'hierarchy' and 'information seeking behaviour'. Codes were sorted into similar contextual themes and discussed at regular meetings with the PhD supervisors. Any discrepancies were resolved through discussion for an analytical consensus. The initial framework (Appendix 23) was applied to the

transcripts and refined with each interview and successive rounds of coding to produce a final thematic framework (Table 13). Relevant quotes were then copied and pasted into the framework for analysis and interpretation.

6.4. Results

Ten prescribers (seven female, three male) were recruited with a range of prescriber grades. Prescriber grade ranged from FY1 to consultant, reflecting the distribution of personnel on the ward. For anonymity, each prescriber is identified by a unique code, R1-R10 (Table 12). All training grade prescribers, who prescribe most prescriptions, were interviewed except for one who was unavailable during the recruitment phase.

Table 12: Participant information recruited for interview [a]

Prescriber number	Participant code	Gender	Prescriber grade	Interview duration
1	R1	Male	ST	24 mins
2	R2	Female	FY1	31 mins
3	R3	Female	FY1	24 mins
4	R4	Female	FY2	21 mins
5	R5	Female	FY1	34 mins
6	R6	Male	Consultant	20 mins
7	R7	Female	CT	24 mins
8	R8	Male	Consultant	17 mins
9	R9	Female	CT	29 mins
10	R10	Female	FY1	19 mins

[a] see chapter 1 for an overview of each grade

The final thematic framework included six major themes and secondary codes (see table 13). The results are summarised under these key themes below. Example quotations to illustrate the results were chosen by the author and agreed with the supervisory team (SDW and SVOB) beforehand.

Table 13: Thematic framework for prescriber interviews

Theme	Code
Feedback process	Impact of feedback
	Formal *vs.* informal
	Non-intrusive process
	Proforma
	Error severity
	Timely feedback
	Prescriber grade
	Correction *vs.* feedback
	Prescription stage
Work environment	Time pressures
	Location
	Pharmacy service
	No-blame culture
	Prescriber identification
	Out of hours
Feedback facilitator	Recognised role
	Expert knowledge
	Rapport
	Patient context
	Error interpretation
	Hierarchy
	Communication of error
	Teamwork
Education and learning	Educational process
	Positive *vs.* negative
	Constructive feedback

Theme	Code
	Personal development
	Reflective practice
	Portfolio
Prescriber impact	Error awareness
	Error reduction
	Discretionary effort
	Information seeking behaviour
	Feedback seeking behaviour
	Emotional Impact
	Time Saving
System improvement	Trust-wide process
	Protected time
	Evidence of error
	Electronic feedback
	Shared Learning
	Learning Aids
	Induction

The results will now be discussed under the following key themes;

1. Feedback process
2. Work environment
3. Feedback facilitator
4. Education and learning
5. Prescriber impact
6. System improvement

In general, all prescribers engaged openly, discussing the feedback process and the impact on themselves. Further probing or question clarification was

required compared to focus groups interviews but this reflects the one-to-one nature of interviews.

All prescribers were effusive about the feedback process, proposing only one limitation: whether the process was sustainable for the pharmacists involved. All prescribers agreed that everyone should receive feedback on their prescribing although the consultants felt that it was more relevant for junior grades who were in training posts.

6.4.1. Feedback process

Nine codes were identified within this category: impact of feedback, formal vs. informal, non-intrusive, proforma, error severity, timely feedback, prescriber grade, correction vs. feedback and prescription stage.

a. Impact of feedback

All prescribers welcomed and valued the feedback process. Benefits of PE feedback for patient safety were reported as a priority although prescribers acknowledge the process supported their professional development to learn from prescribing mistakes. Other potential benefits from enhanced teamwork, efficiency gains and reduced litigation were also reported.

R9: "As a team I feel like that if I don't put the duration, then the nursing staff don't want to give it, the pharmacist asks the nursing staff and ask us and it makes the patient not get their medication in an appropriate time."

b. Formal *vs.* Informal

Prescribers reported that formalising feedback was an improvement to the current system of informal feedback. The process ensured feedback was consistent

R4: "I think having the formalisation has meant that we are actually receiving consistent feedback, in my previous year we didn't really have any formal feedback or informal feedback."

Trainee grade prescribers outlined that they were now expecting feedback on a routine basis and that this created a culture where feedback was accepted openly.

R4: "The fact that it becomes a normality means then people are much more open to receiving and delivering feedback as opposed to people closing up because they don't like it and are not used to it."

Prescribers consistently advocated that receiving feedback away from routine clinical duties increased the impact of the intervention, making it more memorable. Equally, some trainees suggested that receiving PE feedback in general was memorable as it was not part of routine practice.

R9: "It's formal. It's more impact because verbal I get that every day you know like (Pharmacist) or (Pharmacist) I get verbal feedback from them everyday and it's beneficial. Obviously, that's not formal and I can't quite remember what was discussed so I like formal feedback."

However, prescribers reported that pharmacists incorporated the process into their daily routine activities and that this reduced the formality of and apprehension towards any feedback, whilst helping to establish rapport between them. Such an informal approach was also considered more conducive to the busy nature of their working environments.

R4: "Well what I think is good and has worked well is formal but also informal. It's almost like a friendly basis and you created a relationship with the pharmacists in that way instead of making it a formal feedback teaching session every week. You never know how the ward goes you know someone gets sick and you miss that session so that's the session for the week gone. But having it whenever you can get the chance and sit down in

that way would probably work better for the way that ward is and the way that everything is a bit chaotic."

c. Non-intrusive process

Prescribers reported that work pressures could be potential barriers to receiving feedback. However, feedback was considered brief, an important aspect of the process as it was not disruptive to their workload.

R4: "The message was the same and if anything it just meant that in my mind I wasn't thinking oh this is going to drag on for 15 minutes. You know I can give that 5 minutes of my time so now let's do it now."

Advancing on this, prescribers felt that feedback was a high impact intervention that demanded investment of their time.

R7: "I think it is a very useful intervention with little impact on our workload… it's a high impact intervention for us that I haven't had before."

d. Proforma

Prescribers reported that use of proformas (Appendices 1 and 2) to record and deliver the feedback provided a structure to the feedback and allowed benchmarking to peers. The proforma appeared to contribute to the formality of the process with one prescriber reporting that they were expecting the 'sheet' after a PE was corrected. The proforma was also suggested to encourage reflection and made the process more memorable.

R5: "Having the paper copies helps to reinforce things so I think that helped. The percentages were good and gave you an overview and allowed you to compare yourself to others."

Some doctors reported including a copy of the proforma in their own learning portfolios.

R7: "It has actually been useful for the portfolio, so you have evidence for your portfolio… everything that is documented like that is quite useful I think."

e. Error severity

It was acknowledged that all PEs are important but that the focus of feedback should be on more serious PEs. This appeared to be a practical recommendation given the potential volume of minor errors but equally because minor errors may not be memorable if the immediate risk cannot be perceived.

R10: "I think only when they are significant errors that I would pick up on the risk because then I would be more careful the next time that I am prescribing something then I need to think about this."

It was accepted however that raising these initially as part of the overall feedback, was reasonable and appropriate.

R4: "Well I was receiving feedback on errors from minor all the way up to significant I think and the minor ones could have been put in the overall thing. The significant ones definitely should have a one-on-one feedback session. Although the minor ones did highlight to me how often you can make minor mistakes, so it is good to know about that and I think that should only be done up to an extent."

f. Timely feedback

Prescribers reported that feedback was delivered in a timely manner. This was considered essential for reflection, memory recall of the patient and situation, and to limit the potential from harm from PE repetition.

Whilst prescribers acknowledged that immediate feedback is not always practical, it was suggested that feedback should be delivered within a few days to a week otherwise the learning potential might be limited.

R8: "If you have done a prescription and there is an error in the prescription process and it is fed back in a timely manner maybe a day or the next day or something like that then it is still fresh in your mind whereas if you get it a week later then it loses its relevance and also from the patient's point of view it hasn't been corrected and is still going on which is dangerous in terms of treatment. From my point of view, it's easier to pick up earlier on when the prescription is still fresh in your mind."

g. Prescriber grade

It was acknowledged that all prescribers require PE feedback although it was suggested that more junior grades would benefit most. This was because they were in training grade positions and were involved in most prescribing. This underscores the educational focus of feedback reported later.

R8: "The level of benefit may vary between the trainees and the consultant. It will vary depending on the role that you are in, but in my opinion the greatest benefit will be for the juniors but it will be beneficial for the consultants."

In contrast, one prescriber suggested that more senior prescribers would perhaps benefit as much as trainees, as they prescribe less and so are more likely to make errors.

R5: "It should be all grades too, junior right up to consultant. I think as you become more senior then you are prescribing less so you are more likely to make mistakes and so having that highlighted to you might make you think a bit differently too rather than not being informed about your mistake and just continuing to prescribe in that way because bad habits can creep in."

h. Correction vs. feedback

Prescribers reported key differences between the intervention and previous PE feedback practice. Previous practice often involved pharmacists getting a prescription amended which is received mindlessly or changing it themselves without contacting the prescriber.

R9: "Because it's so easy when people just say can we change it to this because it's actually bd [twice daily] instead of od [once daily] and I'll say yeah instead of going into why [the error occurred]."

Prescribers reported that the feedback intervention now followed usual practice and allowed consolidation of learning and focused discussion on the PE. This facilitated memory recall and was more likely to prevent error repetition, with some prescribers suggesting that an understanding of the error makes it more memorable than being aware of the error.

R1: "The more complex it is the more you are likely to understand and remember it. For example, prescribing that PPI with clopidogrel [an antiplatelet medication] or you know remembering the meaning puts it into context as opposed to just changing it."

i. Prescription stage

Prescribers appeared to refer more to discharge prescribing when considering improvements in their practice.   They acknowledged that PEs were probably more likely to occur at discharge because multiple items were being prescribed, or they had many discharge prescriptions to complete.

R5: "I think that (Pharmacist) has said most of my mistakes were on TTO's. At the start I was really rushed doing TTO's when on the ward round. So I have tried to do them the day before or I'll come in early so that I can pre-empt who is going to go over the next couple of days and you can sit down and go through them then."

Additionally, it was suggested that errors were more likely to occur when they were prescribing for a patient they were unfamiliar with and that there was a tendency to rush prescriptions. Feedback appeared to change this behaviour with more time dedicated to completing and checking discharge prescriptions.

R3: *"It's definitely helped with my TTO's because I'm quite dyslexic I often just click on the first one but then sometimes I click on the wrong one so I know that I have to double check my kardex [medication chart] quite closely before submitting [to pharmacy]."*

6.4.2. Work Environment

Six codes were included in this category: Time pressures, location, pharmacy service, no-blame culture, prescriber identification and out of hours.

a. Time pressures

Time pressures were a cited barrier to receiving feedback. Pressures of clinical commitments created difficulties in finding a convenient time to receive feedback. However, as reported earlier, prescribers recognised the benefits of feedback to both patient safety and their own workload and outlined that the process was a worthwhile investment of their time. As reported earlier, an 'informal' approach seemed to be adopted by pharmacists to accommodate the dynamic nature of the ward environment, whilst the sessions were also brief to limit impact on workload demands.

R4: "*Sometimes it is very busy on the ward so for the pharmacist to try and grab us for a minute has been quite tricky I know the pharmacist who has been giving me the feedback she would try and come and give me feedback but it was so chaotic they said oh I'll come back later… now I don't know if*

you can give a protected time slot to that it would be difficult….we did manage to get around it and we made the sessions quick."

b. Location

Prescribers reported that they may not receive feedback if they made a PE out of hours for example on another ward, although they acknowledge that these would be captured if the process was consistent across the hospital.

R1: "I do most of my prescribing on-call, in A&E or (admissions wards) with the acute admissions but that will be caught when it is rolled out."

Prescribers were happy to receive feedback on their wards as part of routine practice. However, most felt that feedback should be delivered in private to limit any potential embarrassment, whilst also allowing them to focus entirely on the feedback.

R9: "In a room like this is fine so long as it is away from the work base so people can't listen to what is happening and you are discussing your 40% error rate!"

In contrast, one consultant suggested that their feedback could be delivered on the ward round for the benefit of all.

R6: "Also, if it's a consultant or registrar or the consultant gets feedback on the ward rounds when he is going around with juniors then you are explaining it to the juniors and the entire team would benefit from it. So, it's a generic feedback when everyone learns."

c. Pharmacy Service

Prescribers questioned if the process was sustainable for pharmacists, especially where there is limited pharmacy ward services.

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R6: "It boils down to whether the pharmacist has the time to be there to identify the errors and provide the feedback after the ward rounds."

Several prescribers suggested the process is influencing how pharmacists were more proactive with prescribing issues and communicating these more effectively.

R4: "You often find that pharmacists have had some input and no one has read it and its a few days later."

d. No-blame culture

Prescribers reported that feedback was delivered objectively and without judgement with a clear developmental purpose. This was considered important to reduce apprehensions about the process and avoid it being perceived punitively. The informal approach that pharmacists adopted to feedback delivery appeared to support this further.

R1: "You know that people are not out to get you as opposed to being out to get you if they were behind a desk."

e. Prescriber identification

Some prescribers highlighted that you cannot always identify a prescriber's signature which would limit potential for feedback to be delivered consistently across the hospital.

R7: "Most people don't even write their name, it's just a signature and you cannot read it and I wouldn't know who it was to be honest. I think the signature thing … I think that you should just write your name to be honest because it is needed for identifying people."

f. Out of hours

Trainee grade prescribers reported that they were more likely to make a PE outside of normal working hours where workload and time pressures were greater, and that this risk would persist despite PE feedback.

R5: "Of a weekend it all goes out of the window because you are so busy. You are getting bleeped every 30 seconds to prescribe this or re-write this kardex and normally when a nurse asks me to prescribe something I'd just like to sit down and think do they actually need it? Look it up in the BNF but sometimes of a weekend you can't and you probably make more mistakes really."

6.4.3. Feedback facilitator

Eight codes were included in this category: Recognised role, expert knowledge, rapport, patient context, error interpretation, hierarchy, communication of error and teamwork.

a. Recognised role

Pharmacists were unanimously considered credible facilitators of PE feedback and that the ward pharmacist in particular, should deliver PE feedback. This was influenced by their perceived expert knowledge whilst others considered PE feedback to be part of a pharmacist's role.

R2: "If you have gone out of your way to find me I might think it was more serious whereas with your ward pharmacists, it doesn't feel like they have gone out of their way, it's just what they do, it's part of their job."

Other healthcare professionals were acknowledged as being able to deliver feedback but that pharmacists were best placed to do so as they objectively review prescriptions.

R2: "If it was from other prescribers I think I would feel like well you're just as bad! I would probably take it really seriously if it was from a consultant but take it on the chin from another junior."

b. Expert knowledge

Facilitator credibility appeared to be related to expert knowledge or respected opinion leader. Prescribers were effusive that pharmacists have expert drug knowledge which provides an objectivity to the feedback. Additionally, prescribers reported that a pharmacist's knowledge facilitated greater explanation and clarification of prescribing points, outcomes considered critical for later memory recall as reported earlier.

R9: "With pharmacists it's not just feedback on this should be bd it's more complex its feedback on many different things I suppose it's more things to do with our prescribing as opposed to one prescription. You know the nurses will say this should be given at a certain time whereas pharmacists will be focusing on the safety."

However, in contrast two prescribers suggested that a lack of immediate knowledge from the pharmacist could affect their potential credibility, and working relationships.

R5: "Where has (other pharmacist) gone now? We have (new pharmacist) now who looks everything up so I just phone (other pharmacist) still!"

c. Rapport

Rapport was a prominent theme with prescribers outlining the importance of good working relationships to both receive and deliver PE feedback. Whilst it was suggested that any pharmacist could deliver PE feedback, prescribers were unanimous in outlining that it should be from their own ward pharmacist for consistency, and whom they know and work with.

R4: *"I think that if had been several different pharmacists giving the feedback it might have felt different because you feel that you are being bombarded with all of these different people. Having the same pharmacist give the consistent feedback made it positive. Whereas if it was different people, it could have easily become negative because at one point it was quite a lot."*

Ward based facilitation of PE feedback was reported to reduce anxieties of the process whilst indirectly, encouraging greater rapport and communication with their ward based pharmacists.

R4: *"It's almost like a friendly basis and you created a relationship with the pharmacists in that way instead of making it a formal feedback teaching session every week."*

d. Patient context

Prescribers advocated that an understanding of the patient context was important for delivery of feedback. It was suggested that this would support facilitation of feedback by being part of the team, having observed practice and understanding relevant situational context. This supports the proposal that whilst anyone can deliver feedback, it should be from the ward pharmacist.

R10: *"I think the best position would still be the ward pharmacist because they are the ones who know our patients. Especially with (Pharmacist) and (Pharmacist) working with them as part of a team, they are very good they make sure that everyone's medication is reviewed and I feel that they have such a good background on that patient's medications because they are the ones who will call up the GP's and look into the system and flag it up oh this person has a previous adverse reaction. And this patient used to be on these medications do you need to review it do you need to restart it."*

e. Error interpretation

Inter-professional differences in definition and interpretation of prescribing were reported. Whilst this had potential to cause conflict, the facilitative approach to feedback allowed clarification and explanation of prescribing issues.

R2: "It's opinion, like what's a contraindication, what shouldn't be used together or what's in the BNF or the patient could have tried all of these different things and that's the only thing that works for them so like specifically using different opioids and stuff."

f. Hierarchy

Hierarchy was a prominent theme when considering PE feedback. Pharmacists were considered outside of a prescriber's hierarchy which reduced the potential for feedback to be received punitively. Prescribers acknowledged that receiving feedback from a consultant could be more fear provoking whilst nurse-led feedback may not be as authoritative and supports earlier recommendations that pharmacists are best placed to deliver PE feedback.

R1: "If it is coming top down from a consultant to a junior doctor then it is more fear provoking. Pharmacist – junior doctor basically are on the same level. Coming from a nurse it still feels like it is coming upwards but then you learn from day one as a junior doctor to always listen to the nurses and show them respect. I think pharmacy is definitely on the same level as junior doctors so I don't think there is any problem there."

g. Communication of error

Face-to-face delivery of feedback, supported by the written proforma, was considered the most appropriate platform for delivery of feedback as it allows social interaction and questioning and explanation of the feedback.

R9: "Face to face would be best. I can then ask questions straight away. I find face-to-face much easier with supportive evidence of the error as well."

Where this was not possible, it was suggested that other means of communicating, such as e-mail or by telephone, could be used, but were more likely to be ignored or misinterpreted.

R1: "Face-to-face is by far the best. You can't ignore it. E-mails you just delete. These days we get so much spam that it's just delete, delete, so face-to-face is so much better. It's much harder to ignore if someone is talking to you, especially with rapport, we are social animals and respond much better if it's face-to-face."

h. Teamwork

Prescribers consistently reported that pharmacist-led PE feedback was enhancing prescriber-pharmacist communication and interaction.

R7: "I think that you feel like you are more part of team when you get that because we actually work quite closely."

Supporting earlier reports that feedback was raising awareness of pharmacists, it was suggested that pharmacists are engaging more with the prescribing with greater verbal communication noted.

R10: "I think so because we then communicate a lot because having discussions, apart from writing in the clinical notes and leaving notes on kardexes, so you tend to speak a lot more in terms of their medications."

6.4.4. Education and Learning

Six key codes were included in this category: Educational process, positive vs. negative feedback, constructive feedback, personal development, reflective practice and portfolio.

a. Educational process

Doctors were unanimous in advocating that PE feedback was an educational process to facilitate reflection and learn from their mistakes, and as essential for their professional development.

R10: "Feedback was good because I need to learn. For example, the first time I had feedback, I didn't know that ciprofloxacin reduces your threshold for seizures and that was in a patient with known epilepsy and that was up to me."

In some cases, feedback was suggested to bridge the gap from undergraduate studies to professional practice. Some prescribers iterated that they were trainees and in a learning post with feedback required to identify training needs and drive their learning.

R8: "They are training and … when they are training and going from area to area and there are certain medicines that are used in certain specialties so there will be more interactions and they need to be aware. That is where knowledge gaps are when you are training."

Pharmacists were reported to provide teaching during feedback sessions. Additionally, some prescribers reported that one of the pharmacists provided further teaching sessions on specific subjects as a by-product of the feedback.

R4: "She [pharmacist] has provided teaching for us on warfarin, steroids, and inhalers because through the feedback we were telling her that we don't really understand which inhalers to use when or which one."

As reported earlier, the educational outcome of feedback helps differentiate it from error correction.

b. Positive vs. negative feedback

Doctors were divided on the need for positive feedback. Some suggested that it was as valid as negative feedback:

R1: "Positive is just as good… as valid as negative you need that balance because you want to know what you are doing right as well as wrong and that will gain you more confidence in prescribing and that you are a safe clinician."

Others suggested that negative feedback, delivered constructively, was all that was required with absence of feedback perceived as positive itself. Quantification of error rates appeared to be valued for benchmarking their practice to others and providing targets for improvement.

R7: "It reassures you if you're not getting loads of stuff brought back to you, so you are prescribing safely and clearly. I mean I know it sounds silly but you know…. you know that you are doing it in a sensible way."

c. Constructive feedback

Prescribers consistently reported that feedback was delivered constructively. Advancing on the previous code, some prescribers reported that it was the constructive element of feedback that was more important for the educational process, to encourage reflection and change future practice.

R6: "It has to be constructive feedback on errors but if its constructive feedback you are not only correcting that error but preventing future errors as well."

d. Personal development

Supporting the educational outcomes of feedback, prescribers reported that feedback was important to drive their personal growth and professional practice. Training grade doctors advanced this by iterating that they are 'in training', and that feedback was necessary to support their development.

R9: "Yes absolutely after all I am still a junior doctor so I think that this is excellent for junior doctors so that you know what you are doing wrong and can improve it."

e. Reflective practice

Some prescribers reported that feedback facilitated reflection by providing opportunities to do so away from the demands of their clinical duties.

R8: "It certainly makes you reflect on the situation when you prescribed and just reflect on whether you had all of the information available. It makes you reflect on whether you could have done the prescription differently or next time if you don't have all of the information may be delegated that task to someone with the appropriate information to do that prescription."

f. Portfolio

Evidence of the feedback was welcomed by prescribers for inclusion in their training portfolios, supporting earlier themes that feedback should be educational, encourages reflection and supports professional development.

R9: "I was going to include the example of lansoprazole [a stomach acid suppressing medication] and lamotrigine [an anti-convulsant] as one of my

reflections and it's going to be part of our e-portfolio as well because as well as reflecting on it we reflect on it as part of the portfolio."

6.4.5. Prescriber impact

Seven key codes were included in this category: Error awareness, error reduction, raised prescriber discretionary effort, information seeking behaviour, feedback seeking behaviour, emotional impact and time saving.

a. Error awareness

Prescribers were consistent in acknowledging that feedback raised their awareness of their own errors, and of the impact on other team members. In some cases, prescribers were surprised by how it easy it to make a PE and outlined that feedback was important to reduce the risk of them making similar PEs.

R4: "I didn't realise before this feedback how easy it is to make at least the minor errors on a daily basis and not know about it, because no one has told you about. Even with the more significant errors, you wouldn't necessarily have been told about it. So, I don't know over the past year how many significant errors I've been making because not until this project have I ever been fed-back about any errors, so I think that it was really important for my own awareness of prescribing to have the feedback."

Prescribers reported an increased awareness of why they were making PEs:

R8: "It gives you an insight into why you wrote the prescription the way you did."

b. Error reduction

It was unanimously considered that PE feedback could reduce PEs through education and raised awareness of PEs.

R8: "Having the feedback will certainly help you to not make the same mistake again, or not do the same error in your life."

Errors that were considered as significant or above were considered less likely to recur although it was acknowledged that errors were always likely to occur because of human error.

R2: "I missed off someone's valproate from their TTO which I could do that again, and I wouldn't know and that's an accident I haven't omitted that item on purpose that's an accident."

c. Raised prescriber discretionary effort

Prescribers consistently reported increasing their effort whilst prescribing following their feedback. This appeared to be motivated by personal development to improve, the desire to avoid any risk of embarrassment from the PE, an awareness that their prescribing was being monitored, and benchmarking to their peers.

R1: "Knowing that someone is going to look at it and provide you with feedback means that you take those extra seconds to check through and make sure it is right."

Some prescribers reported double checking their prescribing in addition to taking more time with any prescribing task.

R9: "I'm very much aware that I need to look at prescriptions properly and not just look at it quickly because with it being computerised it is so easy to just type in LAM or any then it just comes out and I then look at it and think well the dose looks the same."

Others reported making more of a conscious effort and taking pride in their prescribing as opposed to the prescribing process being a routine task.

R2: "Like today, I prescribed rifampicin and really thought about what I was going to do with the warfarin whereas before I think that I would have just prescribed it and that's because I remember having a discussion with (Pharmacist) about inducers and inhibitors and stuff so we went through them all and decided what we could do with them in the future and that's as a result of feedback."

d. Information seeking behaviour

Prescribers reported actively seeking prescribing information more frequently as a result of feedback. This supports the earlier reports of greater teamwork, enhanced communication and established rapport.

R3: "I ask loads of questions now… I mean poor (Pharmacist on ward) now!"

e. Feedback seeking behaviour

Prescribers reported that they would like feedback to continue for their ongoing development.

R3: "I would want to receive feedback in my next rotation in surgery definitely."

It appeared that the process was discussed amongst prescribing peers with prescribers on other wards enquiring when they would receive their feedback.

R2: "I spoke to some of my colleagues on [other ward] and they want to know what they are doing wrong."

f. Emotional impact

Trainee grade doctors reported an initial sense of anxiety towards the process, especially if their PE rate was going to be high.

R2: "I mean sometimes you worry like if your error rate is going to be really high."

One prescriber reporting feeling "awful" after making a PE, but that the constructive and informal delivery mitigated these worries.   Another prescriber expressed a sense of fear of making a serious PE.

R3: "I'm constantly in terror of making a really bad prescribing error."

However, prescribers consistently advocated that the process provided reassurance that there was a safety net to intercept PEs, whilst some suggested absence of feedback itself was reassuring.

R7: "It reassures you if you're not getting loads of stuff brought back to you, so you are prescribing safely and clearly. I mean I know it sounds silly but you know…. you know that you are doing it in a sensible way."

One consultant suggested they were happy that the process was improving the safe and appropriate prescribing of medications on their ward.

R9: "As a clinician then I am happy that the prescribing and administration of medicines on the ward is much better."

g. Time saving

Prescribers consistently advocated that they were being contacted less to amend PEs, which may have been as a result of feedback.

R4: "It makes a big difference to my workload and the amount of questions that I am having."

As reported above, less feedback provided a reassurance that their prescribing was safe and appropriate. Prescribers recognised that this can reduce their workload considerably allowing time to be focused on other tasks instead of correcting PEs.

R7: "It saves time and makes you far more efficient and proficient."

6.4.6. System improvement

Seven key codes were included in this category: Trust-wide process, protected time, evidence of error, electronic feedback, shared learning, learning aids and induction.

a. Trust-wide process

Prescribers were unanimous in recommending that formalised PE feedback continues. The need to develop as a prescriber with each rotation, patient and clinical speciality was reported with feedback essential to support this process.

R4: "It's important because on different wards there will be different themes of medication errors for medications that you are prescribing more regularly and so if I now went to a cardiology ward I might not be as confident in my prescribing of drugs again and so I think that it is important in that respect."

Regular audits to demonstrate change in prescribing and reflect clinical rotations was proposed if the process was sustainable for pharmacists.

R10: "I think that an audit would be good on a regular basis sometime mid-placement because foundation doctors you have three different placements so mid-placement would be good because then you know that in the last two

months on a new ward and I have done this and this and this and then I have to next two months to improve before being reviewed again."

b. Protected time

Prescribers suggested that protected time would be useful but equally questioned the practicalities of arranging 'appointments' between demanding work schedules.

R9: "Well, at the moment, it's not fitted into a daily schedule like ward jobs. It's not formalized like teaching you know the nursing staff doesn't know that we have feedback or the consultant doesn't know that we have a feedback session. So, I guess that it would be quite nice if there was a specific session."

c. Evidence of error

Three prescribers reported that supporting evidence of the PE would support reflection on the situation. This appeared to be for PEs identified out of hours or at discharge by another pharmacist in dispensary, as any PE at ward level would be available for viewing.

R2: "I think that actually seeing or looking at the error would be useful and allow you to reflect more as opposed to just being told about it."

d. Electronic feedback

An electronic system of PE feedback was proposed by two prescribers to allow remote access as they rotate around areas. It was also suggested that an electronic form would be easier to upload to their portfolios.

R1: "Maybe you need something to follow you through where you have a log in and it follows you around that you can log in."

e. Shared learning

The potential for shared learning was described across interviews, particularly for more serious errors. Some prescribers reported sharing their PE feedback with others, whilst other prescribers suggested feedback should also occur at a ward or specialty level for example.

R3: "I've shared amongst other doctors on this ward but not outside, you don't go around comparing serious errors!"

R8: "There are team training days or teaching days like what we had this afternoon and it may be that once every few months or once in a quarter you could put together a presentation of what the common errors are."

f. Learning aids

One prescriber suggested that for PE themes, educational sessions or prescribing support aids would be useful for quick reference. These suggestions resonate with some of the teaching sessions provided by one pharmacist as an outcome of delivering feedback.

R3: "Drug Interactions, like with clarithromycin…..it would be quite useful to have like a stepped list … of drug interactions that would be really useful for the nurse's station. Would that be possible?"

g. Induction

Building on the previous code, it was reported that certain PEs are likely to be unique or prevalent in each ward area. Local ward inductions were proposed to raise awareness of these issues and prepare training grade doctors as they rotate between each area, a proactive approach that would complement any PE feedback.

R8: "Integrating it into their induction programme. You are drawing their attention to say please look out for theophylline interactions, please look out for warfarin interactions so that junior doctors look at their prescriptions and make necessary amendments themselves before waiting for the feedback."

6.5 Chapter discussion

The aim of this chapter was to explore the experiences of prescribers of receiving pharmacist-led PE feedback. The semi-structured interviews have provided the rich qualitative data needed to address this aim whilst informing the need for the larger study in chapter 7. All prescriber grades interviewed in this chapter both valued and welcomed feedback on their prescribing. This echoes reports elsewhere (Franklin *et al.* 2007, Bertels *et al.* 2013) and is an important acknowledgment for transferability of the intervention to other areas of STHK and elsewhere.

Reported benefits included improved prescribing and patient safety, whilst time saved not correcting errors was a welcome outcome. Real-time audit and feedback has been suggested to foster a blame-free 'culture of safety' (Ursprung *et al.* 2005) elsewhere and here, prescribers expressed a reassurance that both their prescribing was improving, and that they would receive feedback to support their professional development. This reassurance extended to an understanding of the role of a pharmacist as a safety net, and supports the findings of Bertels *et al.* (2013) where prescribers reported concerns over repeating errors because they were not informed of them.

Prescribers recognised the differences between previous and current feedback practices from being one of directive, to facilitative feedback (Archer 2010) that was more memorable and they were likely to learn from, where there was a clear focus on learning from error, a solution focused approach consistent within the feedback literature (Kluger and DeNisi 1996, Hysong 2009).

This contrasts with the findings of Sullivan *et al.* (2013) where prescribers posed the question "Why do we need this summary information every 2 weeks when pharmacists already call us for each error?" following e-mailed feedback. Bangert-Drowns *et al.* (1991) reported that "feedback can promote learning if it is received mindfully". If directed feedback is merely corrective, evokes an automatic prescriber response and does not facilitate reflection, then it may be received mindlessly and supports design of the feedback intervention used throughout this thesis.

Feedback was considered memorable as it was not routine. If feedback was delivered for every single PE, its effectiveness may be limited with feedback becoming cognitively or motivationally inhibiting (Bangert-Drowns *et al.* 1991), underscoring the importance of a threshold for feedback on prescribing performance, for example a significant error or prescribing event, as used in this thesis.

Inaccuracies in self-assessment (Colthart *et al.* 2008) have been reported, with external involvement required for more accurate evaluation of prescribing performance (Davis *et al.* 2006). In this chapter, ward-pharmacists were considered credible facilitators of PE feedback where they have the advantage of established rapport and observing prescribing practice, key tenets of effective feedback (Archer 2010, Ivers *et al.* 2012, Bok *et al.* 2013).

Advancing on this, prescribers reported a raised awareness of the role of pharmacists, and increased communication and teamwork to inform prescribing decisions. Prescribers also reported greater information and feedback-seeking behaviour, outcomes of feedback described elsewhere (Velo and Minuz 2009, Bertels *et al.* 2013), whilst good teamwork alone is considered to improve quality of care and patient safety (Firth-Cozens and Moss 1998, Baker *et al.* 2006).

Therefore, the anxieties and apprehensions reported by pharmacists in chapter 4 would appear unfounded. Additionally, the intervention appears to

have positive influences on inter-professional relationships with pharmacists' views of the process explored in chapter 8.

One prescriber shared their feedback with others, whilst the potential for shared learning was also voiced. This potential has been reported elsewhere (Franklin *et al.* 2007, Gordon and Bose-Haider 2012, Booth *et al.* 2012), although empirical evidence (Ivers *et al.* 2012) suggests individualised feedback is more effective. Therefore, any shared learning should ideally supplement, and not replace personalised feedback, as argued previously (Shaw *et al.* 2003).

The impact of feedback on prescribing suggested that prescribers were more motivated and engaged to prescribe correctly. Whilst this motivation may have been to simply improve, it was also clear that the potential for feedback or embarrassment from making a PE, were driving influences too, sentiments reported elsewhere (Ferguson *et al.* 2017).

Feedback was perceived as informal and appeared to mitigate potential anxieties around the process. This endorses the need for a no-blame culture or 'safe learning climate' as reported by Bok *et al.* (2013) where a non-punitive process is less likely to be resisted by the recipient (Kluger and DeNisi 1996), making the process more useful and actionable as argued by Hysong (2009). The clinical workplace can be an unpredictable and difficult environment for both facilitator and recipient, to deliver and receive feedback (Bok *et al.* 2012). An informal approach may have therefore been adopted out of necessity, where pharmacists could not arrange a set time to deliver feedback because of clinical commitments.

The "healthcare sterile cockpit" model (Hohenhaus and Powell 2008) iterates that non-essential tasks are prohibited during clinical tasks. Therefore, a flexible approach to feedback is critical to ensure that PE feedback does not interrupt clinical tasks. Additionally, feedback should be delivered away from the clinical area for an environment that is free from distraction, to facilitate effective feedback (Kroll *et al.* 2008). In this chapter, the prescribers

interviewed reported that errors would often be corrected, with constructive feedback following at a later convenient time.

Feedback has potential to enhance knowledge and technical performance (Archer 2010) but it also appears to influence other processes. The outcomes reported in this chapter suggest that feedback is not a simple intervention, but resonates with a complex intervention (Craig *et al.* 2008). Here, feedback could be considered a complex intervention as it includes:

- A number of interacting components (pharmacist, error, cause of error, prescriber, feedback, social context, negotiated outcomes, local context).
- A number and difficulty of required behaviours for both feedback recipient and facilitator (delivery and receipt of feedback, negotiation of solutions and behavioural change).
- A variety of prescriber grades and specialty areas requiring the intervention (Different learning needs, hierarchy, local culture).
- A degree of flexibility / variation in delivery of the feedback (Facilitator/ recipient personality, feedback approach, location, social interaction, provision of education).
- Number and variability of outcomes (Each error, feedback session and so negotiated outcomes and influence on prescribing behaviour will be unique).

Prescribing is a complex skill with multiple constituent parts whilst PE causation is equally complex. Considering this, feedback is unlikely to have a linear cause and effect relationship but rather, non-linear responses with unexpected outcomes (Craig *et al.* 2008), it is an open system (Cohen *et al.* 2011). As a light source can hit a prism and refract, or a dropped stone creates a ripple effect across a still lake, feedback has the potential to create a cascade amplification of outcomes that influence the prescriber and prescribing process. Any outcome could therefore depend on several variables including the credibility of facilitator, any variation in feedback or

additional training provided, the openness to receipt of feedback, interpretation of an error, or identifying the cause of or solutions to error.

Despite provision of facilitator training in the process of constructive feedback and identification of error causation, feedback is a social and complex interaction and cannot be automated. These heterogeneous variables would be difficult to control and whilst there may a cascade amplification of outcomes, this equally creates a cascade amplification of uncertainties. Therefore, whilst feedback may be catalysing changes in prescribing, it is uncertain what aspect of the feedback process or what specific outcome is influencing prescribing the most.

Individualised feedback was valued to limit potential embarrassment, but also allows open dialogue to question, clarify and consolidate learning from feedback in a safe learning environment: caveats of effective feedback endorsed elsewhere (Bok *et al.* 2012). Such dialogue has been reported to complete "a full circle of shared responsibility" (Sullivan *et al.* 2013).

The provision of written, in addition to verbal feedback, was welcomed and encouraged reflective practice, with prescribers using the written element for their training portfolios. This augmented approach is consistent with empirical recommendations for effective feedback (Ivers *et al.* 2012) and supports the use of the feedback proforma.

Additionally, the written feedback provided goals for prescribers to respond to and improve upon. Control theory argues that individuals try to match their behaviour to goals and standards (Carver and Scheier 1981). Goals may be learning or performance orientated (Archer 2010, Bok *et al.* 2013) and considering this, prescribers will want to learn and develop professionally or they will want to avoid negative experiences. The proforma was used by some prescribers to benchmark their performance to peers, and could have created a competitiveness that further motivated prescribers to improve. However, the evidence regarding benchmarking through peer

comparisons is conflicting (Ivers *et al.* 2012, Kiefe *et al.* 2001, Scheneider *et al.* 2008).

Prescribers suggested local inductions would be useful to raise awareness of common errors in each clinical area. A recent systematic review (Saedder *et al.* 2014) of serious medication incidents, revealed that seven drug classes account for 47% of all serious errors and ten drug classes for 73% of all fatal medication errors. Increased awareness of these drugs and likely errors could be useful and their impact explored alongside PE feedback for example. This need could reflect the additional educational sessions that were reportedly provided by pharmacists as an outcome of feedback discussions.

Timely feedback is important to make it actionable (Hysong *et al.* 2006). Barriers to timely feedback could include shift patterns, annual leave, or difficulty in identifying prescribers. Electronic prescribing will facilitate prescriber identification whilst e-mailed feedback could be an alternative mode of communication although this has been reported as least effective feedback by prescribers elsewhere (Ferguson *et al.* 2017).

Time and work pressures are obvious barriers to receipt of feedback. However, interviewees in this chapter reported that the feedback sessions were non-intrusive, typically lasting for 5 minutes for individual errors, and 15 minutes for the initial overall feedback. This is an important outcome for on-going sustainability of the project. The potential for feedback as a low-cost intervention has been expressed previously (Trooskin 2002) with Booth *et al.* (2012) iterating the need for cost-effective, low-technology solutions to reduce PEs in the current economic climate. Prescribers were effusive that feedback was a worthy investment of their time and was a low-cost, high-impact intervention.

Whilst prescribers advocated the intervention was feasible for themselves, they did question the potential impact on pharmacist time. This is an important consideration and will be explored further in chapter 8.

Lack of feedback may contribute to prescribers' unawareness of PEs (Dornan *et al.* 2009) and could be considered a system failure that contributes to PEs (Franklin *et al.* 2011). In these interviews, prescribers outlined the need for feedback to continue as part of routine practice. Where feedback raises awareness of prescribing performance, it alters prescriber perceptions and they can calibrate their behaviours to achieve the desired prescribing standards, behaviour consistent with perceptual control theory (Ferguson *et al.* 2017).

Training grade doctors prescribe more than consultants (Dornan *et al.* 2009, Seden *et al.* 2013) and may benefit most from feedback. Improved, individualised workplace feedback has been suggested previously to support prescribers in the formative years of post-graduate training (Ryan *et al.* 2014). However, feedback should not be limited to a particular prescriber grade, but to all prescribers to support continuing professional development. It has been suggested (Sullivan *et al.* 2013) that feedback is "a vector to communicate and highlight vulnerabilities in medication safety that may change over time". Feedback is a possible vector to raise awareness of these issues, and prevent similar PEs from occurring. The results in this chapter present feedback as a complex intervention and therefore as a vector, the direction and size of effect is likely to be dependent on many interacting variables.

6.6. Strengths and Limitations

This is the first known qualitative study exploring the in-depth views of prescribers to receiving formalised feedback on PEs. The results reported in this study support outcomes of chapter 5 that feedback can improve prescribing.

However, the variability in delivery of PE feedback and the reported outcomes (enhanced teamwork, role awareness, information seeking behaviour, feedback seeking behaviour for example) suggest that feedback

is a complex intervention. Whilst identification of potential reasons for improved prescribing is a strength of this chapter, there is uncertainty as to which variable can influence prescribing the most.

It is argued that qualitative results cannot be generalised (Basit 2010). However, a range of prescriber grades were recruited and reflected the skill mix on the intervention wards, whilst data saturation (see chapter 3) was achieved confirming adequacy of participant numbers. As a case study, the results in this chapter demonstrate that prescribers are open to and willing to receive feedback and engage with pharmacists more on an inter-professional level.

The sample size was also small and it is possible that these views may not be shared on other wards or indeed in different hospitals where prescribing practices or pharmacy services for example differ. However, in STHK, prescribing policies, guidelines, prescriber skill mix and ward pharmacy services are relatively consistent and one might expect similar views and opinion throughout STHK.

Whilst the results provide a glimpse into potential behavioural changes of prescribers, the sample size was small and the topic guide designed as a process evaluation. Further research specifically exploring the impact of feedback on prescriber behaviour will be reported in chapter 9.

Participants reported discussing the process with colleagues on other wards and this may have contaminated the control group's prescribing practice. This risk could not be avoided and any diffusion of effect could have influenced the results in chapter 5, although the PE rate for control group did not decrease, it increased.

It is possible that prescriber comments did not reflect their true opinions as they were seeking to impress or reject the researcher. However, the use of semi-structured interviews allowed clarification and probing of responses as described in chapter 3. Equally, it is unknown if the positive opinions

reported throughout this chapter would persist or change with any longer-term intervention.

Whilst prescriber views have been reported in this chapter, the intervention requires pharmacists to deliver feedback. The impact on pharmacists is unknown and further research is necessary to determine their views of the process.

Finally, qualitative data analysis is a subjective process and all inferences may not have been identified by the author. However, data saturation (no further emergent themes) was achieved whilst the research supervisors (SDW and SVOB), both non-pharmacists and experienced qualitative researchers, also independently reviewed interview transcripts, codes and themes. Additionally, the results are part of a mixed methodological approach described in chapter 3 to support and corroborate results in other chapters.

6.7. Implications of these interview findings

PE feedback is welcomed with concerns reported by pharmacists in chapter 4 unfounded. The research aim has been addressed and the individualisation of pharmacist-led PE feedback, delivered constructively and timely, is valued. These outcomes underpin the rational design of the feedback intervention as described in chapter 2.

These findings have several practical implications.

- Prescribers valued the intervention, outlining that feedback should continue: This alone is a transferrable finding within STHK.
- A non-punitive approach to feedback that was timely and delivered verbally and in writing by a ward-based pharmacist, were all considered important design elements.
- These interventional model processes could be transferred to other areas of STHK and similar organisations.

- These findings can be used to reassure pharmacists of the perceived value of PE feedback, mitigating potential anxieties reported in chapter 4.

- The model of pharmacist-led feedback should be extended to other ward areas in STHK and evaluated further.

- Individualised feedback is preferred although there is an appetite for shared learning.

- Process outcomes such as enhanced role awareness, teamwork, communication and information- and feedback-seeking behaviour could be evaluated individually to determine their impact on prescribing.

- Further process evaluation is needed to explore the impact on pharmacists (chapter 8) and prescriber behaviour (chapter 9).

- There is appetite for additional education, tailored to each ward area to inform context specific prescribing and the feasibility of this, and its impact, could be explored.

6.8. Chapter Summary

A key aim of this qualitative study was to explore the experiences of prescribers towards receiving PE feedback. This chapter has presented relevant participant details, data collection and analysis techniques, and presentation and discussion of results.

Formalisation of pharmacist-led feedback on PEs is valued and well received by all prescriber grades with on-going feedback welcomed to support professional development. These results support the earlier positive findings on PE rates reported in chapter 5. The idea of feedback as a complex intervention is emerging with multiple variables and outcomes.

The next chapter will explore the impact of feedback on PE rates in a larger cohort study.

Chapter 7. Exploring the impact on prescribing errors

7.1. Introduction

This chapter will describe the impact of feedback on PEs using a larger controlled before and after study across sixteen hospitals wards.

This will address the primary research aim to:

> Investigate the impact of pharmacist-led feedback on prescribing error rates.

The results will also be used to test the research hypotheses outlined in chapter 3 and revisited below. As described in chapter 2, few studies have explored this subject in hospital settings or for generic prescribing. Data collection will be described and sample size and participant characteristics presented. This will be followed by presentation of the results and discussion of the findings.

7.1.1. Population and sample size

Sixteen wards were audited, eight with doctors receiving feedback (intervention wards) and eight wards with normal, existing practice (control wards) as described in chapter 3. A total of 78 prescribers were included, with 37 in the intervention group and 41 in the control group. Prescriber and ward details are presented in tables 14 and 15 below. Prescribers were not randomly allocated as described in chapter 3. Prescribers were included where they had prescribing data at baseline and post-intervention for comparison. Additionally, for the intervention arm, prescribers were included if they had received feedback at least once in between data collection periods.

7.1.2. Data collection

Pre-intervention data was collected over five consecutive days in September 2015. Hospital pharmacists collected prescribing data prospectively recording; ward area, prescriber name, number of items prescribed and, where identified, the number, type and severity of prescribing error. Data was recorded on the proforma in appendix 16. PE feedback was delivered to the intervention group as described in chapter 3 for overall prescribing and any ongoing PE that was significant or above. This process continued for a period of 3 months before re-auditing prescribing over five consecutive days in December 2015.

To limit inter-observer variability, the author independently reviewed each audit form and re-classified error severity and type where the PE was classified incorrectly. Sixty errors were reclassified according to severity for pre-intervention data whilst 15 errors were reclassified for post-intervention data. These were divided almost equally between over-grading (31 pre and 9 post) and under-grading (29 pre and 6 post) of errors. Any error that was reclassified was independently reviewed by another pharmacist with any differences in classification discussed and resolved for a consensus.

One doctor, prescriber number 36, was removed from data analysis following review of prescribing data as they had not prescribed the same type of prescription (inpatient or discharge) between pre-test and post-test making any true inferences on the impact of feedback difficult.

7.1.3. Data analysis

All data from pre-test and post-test audit periods was input into SPSS v.22 for data analysis with the prescriber and prescription the unit of analysis. As described in chapter 3, PE rate was calculated by dividing total errors by total number of items at the prescription and prescriber level. Results were calculated according to the mean PE rate and standard deviation with 95% confidence intervals. Univariate analyses were performed with chi-squared

tests to compare error frequencies at the prescription level. Independent t-tests were used to determine the impact on PE rates at the prescriber level.

Table 14: Number of each type of prescriber in intervention and control groups

Prescriber grade [a]	Number	
	Intervention	Control
FY1	14	12
FY2	7	12
CT/ST	14	13
Consultant	2	3
NMP	0	1
Total	37	41

[a] See chapter 1 for an overview of prescriber grades

Table 15: Prescriber and ward characteristics for intervention (feedback) and control (normal practice) groups

Prescriber	Grade [a]	Gender	Intervention or control group	Ward	Ward type [b]	Patient turnover (per week)
1	FY1	Female	Intervention	1	Medical CoE	40-50
2	FY1	Female	Intervention	1	Medical CoE	
3	FY1	Female	Intervention	1	Medical CoE	
4	CT1	Male	Intervention	1	Medical CoE	
5	Consultant	Male	Intervention	1	Medical CoE	
6	FY1	Male	Intervention	2	Medical	30-40
7	FY1	Female	Intervention	2	Medical	
8	FY2	Male	Intervention	2	Medical	

Prescriber	Grade [a]	Gender	Intervention or control group	Ward	Ward type [b]	Patient turnover (per week)
9	ST6	Male	Intervention	2	Medical	
10	FY2	Female	Intervention	3	Medical acute	60-80
11	CT1	Female	Intervention	3	Medical acute	
12	ST4	Female	Intervention	3	Medical acute	
13	FY1	Female	Intervention	4	Medical	30-40
14	FY1	Male	Intervention	4	Medical	
15	FY1	Female	Intervention	4	Medical	
16	CT2	Male	Intervention	4	Medical	
17	FY1	Male	Intervention	5	Medical	40-50
18	FY1	Male	Intervention	5	Medical	
19	FY2	Female	Intervention	5	Medical	
20	CT1	Female	Intervention	5	Medical	
21	ST4	Male	Intervention	5	Medical	
22	Consultant	Male	Intervention	5	Medical	
23	FY1	Female	Intervention	6	Medical	30-40
24	FY2	Male	Intervention	6	Medical	
25	CT2	Female	Intervention	6	Medical	
26	FY2	Male	Intervention	6	Medical	
27	CT2	Female	Intervention	6	Medical	
28	FY1	Female	Intervention	7	Medical	40-50
29	CT1	Female	Intervention	7	Medical	
30	CT2	Male	Intervention	7	Medical	
31	ST4	Female	Intervention	7	Medical	
32	ST4	Male	Intervention	7	Medical	
33	FY1	Female	Intervention	8	Acute medical / COE	40-50
34	FY1	Male	Intervention	8	Acute medical / COE	
35	FY2	Female	Intervention	8	Acute medical /	

Prescriber	Grade [a]	Gender	Intervention or control group	Ward	Ward type [b]	Patient turnover (per week)
					COE	
36	FY2	Male	Intervention	8	Acute medical / COE	
37	CT1	Female	Intervention	8	Acute medical / COE	
38	FY1	Male	Control	9	Medical	60-80
39	FY2	Female	Control	9	Medical	
40	CMT2	Female	Control	9	Medical	
41	CT2	Male	Control	9	Medical	
42	CT2	Male	Control	9	Medical	
43	FY2	Female	Control	10	Medical acute	120-140
44	FY2	Female	Control	10	Medical acute	
45	CT1	Female	Control	10	Medical acute	
46	CT1	Male	Control	10	Medical acute	
47	CT1	Female	Control	10	Medical acute	
48	Consultant	Male	Control	10	Medical acute	
49	FY1	Female	Control	11	Medical	60-80
50	FY1	Male	Control	11	Medical	
51	FY1	Male	Control	11	Medical	
52	FY2	Female	Control	11	Medical	
53	FY1	Male	Control	12	Surgical	30-40
54	FY1	Male	Control	12	Surgical	
55	FY1	Female	Control	12	Surgical	
56	FY2	Female	Control	12	Surgical	
57	FY1	Female	Control	13	Surgical	30-40
58	FY1	Female	Control	13	Surgical	
59	FY1	Male	Control	13	Surgical	

Prescriber	Grade [a]	Gender	Intervention or control group	Ward	Ward type [b]	Patient turnover (per week)
60	FY2	Male	Control	13	Surgical	
61	Consultant	Male	Control	13	Surgical	
62	NMP	Male	Control	13	Surgical	
63	FY2	Male	Control	14	Medical COE	10-20
64	FY2	Male	Control	14	Medical COE	
65	FY2	Female	Control	14	Medical COE	
66	CT1	Female	Control	14	Medical COE	
67	FY1	Female	Control	15	Medical COE	10-20
68	FY1	Female	Control	15	Medical COE	
69	FY2	Female	Control	15	Medical COE	
70	FY2	Female	Control	16	Medical	20-30
71	FY2	Male	Control	16	Medical	
72	ST2	Male	Control	16	Medical	
73	ST1	Male	Control	16	Medical	
74	ST2	Female	Control	16	Medical	
75	ST1	Male	Control	16	Medical	
76	ST1	Female	Control	16	Medical	
77	ST6	Male	Control	16	Medical	
78	Consultant	Male	Control	16	Medical	

[b] COE = Care of Elderly

7.2. Results

7.2.1. Impact of feedback on overall prescription errors

A summary of overall prescribing data for control and intervention groups for both pre-test and post-test is summarised in table 16 and figures 21 and 22 below.

Table 16: Overview of prescribing error data for overall prescribing in intervention and control groups

Group	Pre-items	Pre errors	Pre-error rate %	Post-items	Post errors	Post-error rate (%)	Difference in error rate Pre – post %	Chi-square and p-value
Intervention	3067	756	24.7	2985	168	5.6	-19.1	$\chi 2(1) =$ 313.8, p = <0.005, φ=0.212
Control	2124	382	18.0	2137	464	21.7	3.7	$\chi 2(1) =$ 6.2, p = 0.013, φ=-0.035
Total	5191	1138	22.0	5122	632	12.3	-9.7	

Pre-test

A total of 950 prescriptions were audited, 475 of which were error free (50%), with 5191 items prescribed and 1138 PEs identified. An overall PE rate of 21.9%.

There were 519 prescriptions in the intervention group, with 243 error free (46.8%). There were 3067 prescribed items with 756 PEs, an overall PE rate of 24.7%.

There were 431 prescriptions in the control group, with 232 error free (53.8%). There were 2124 prescribed items with 382 PEs, an overall PE rate of 18.0%.

Post-test

A total of 913 prescriptions were audited, with 541 error free (59.3%). There were 5122 prescribed items and 632 PEs identified. An overall PE rate of 12.3%.

There were 450 prescriptions in the intervention group, with 318 error free (70.7%). There were 2985 prescribed items with 168 PEs, an overall PE rate of 5.6%.

There were 463 prescriptions in the control group, with 223 error free (48.2%). There were 2137 prescribed items and 464 PEs, an overall PE rate of 21.7%.

Figure 21: Bar chart illustrating prescribed items and errors for the intervention group before and after the intervention period
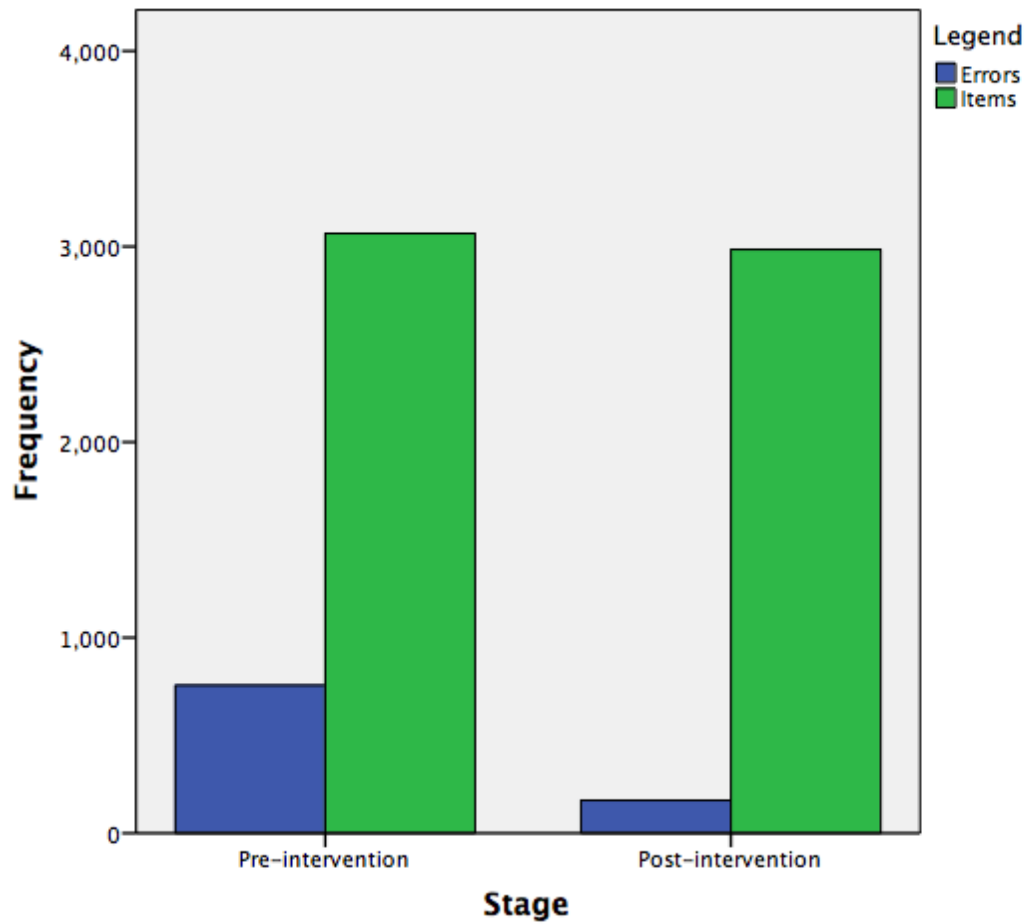
Figure 22: Bar chart illustrating prescribed items and errors for the control group before and after the intervention period
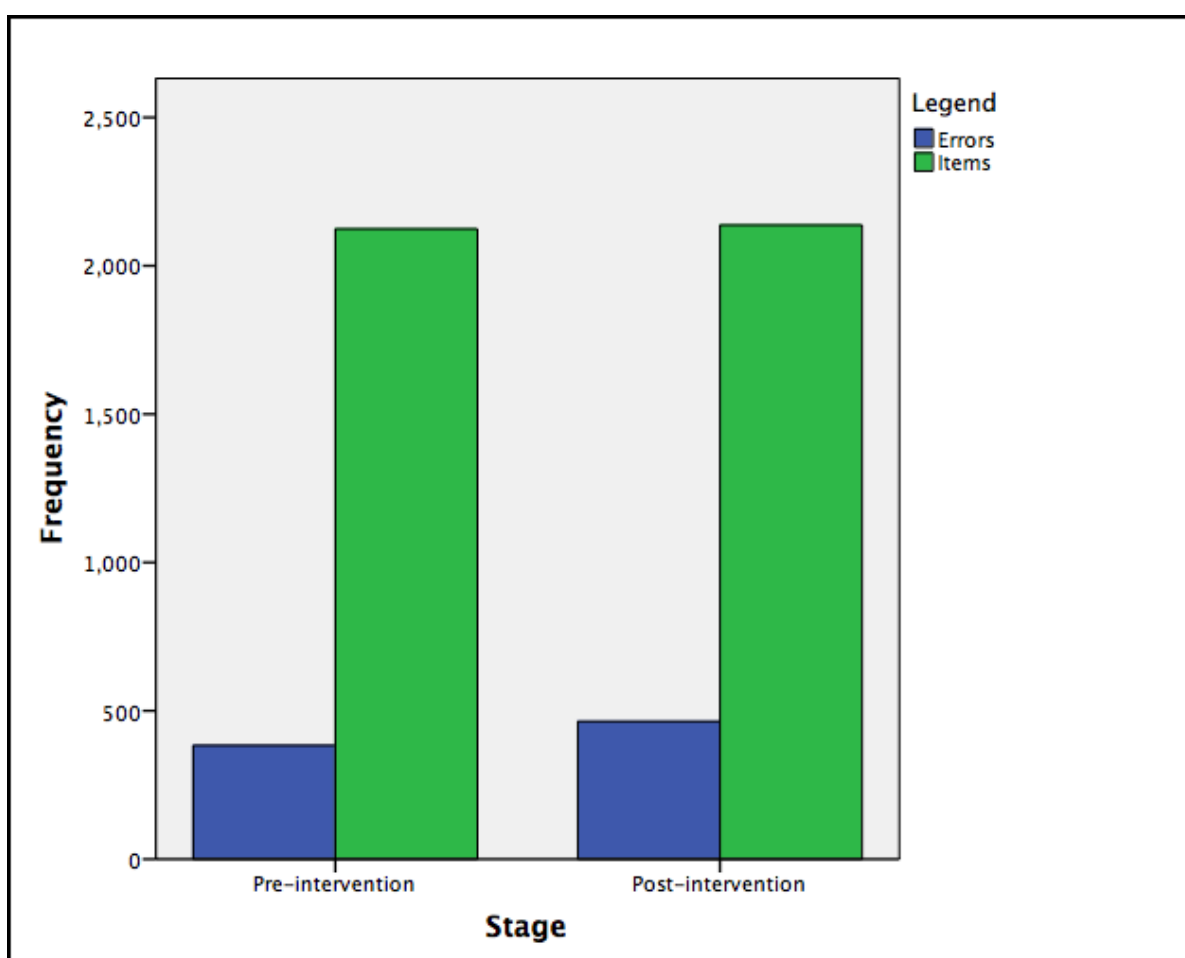
7.2.2 Analysis of overall prescription error frequency

A chi-square test for association was used to determine if there were any statistically significant differences between and within groups for error frequency. All expected cell frequencies were greater than five meeting the assumption of the chi-squared test as described in chapter 3.

Pre-intervention, there was a statistically significant association between groups (intervention or control) and frequency of PEs, $\chi^2(1) = 20.8$, *p* = <0.005, $\varphi=0.057$ with error frequency dependent on the group.

Post-intervention, there was a statistically significant association between group and frequency of prescribing errors, $\chi^2(1) = 228.2$, p = <0.005, φ=-0.199, with error frequency dependent on the group.

PE frequencies were statistically significantly different between pre- and post-testing for both intervention ($\chi^2(1) = 313.8$, p = <0.005) and control groups ($\chi^2(1) = 6.2$, $p = 0.014$) with error frequency different for each stage of data collection for each group (See table 16).

Whilst these results suggest that there is a difference between the two groups, the primary research question is concerned with determining if there is a difference in the mean change in PE rates. Independent t-tests were used to determine this as outlined below.

7.2.3. Impact of feedback on overall prescribing error rates

A summary of overall prescribing data per prescriber for both control and intervention groups is summarised in table 17 below.

Change scores were calculated by determining the difference between post-intervention PE rates and pre-intervention PE rates. This allowed comparison of the mean change in PE rates.

An independent t-test, as described in chapter 3, can be used to test the null hypothesis:

H$_0$: There is no difference in the mean change in prescribing error rates between the intervention and control groups following delivery of feedback to the intervention group.

7.2.3.1 Sample size and descriptive statistics

Thirty-six prescribers were included in the intervention group. There was a mean PE rate of 25.0% (SD 16.8, 95% CI 19.3 to 30.7) at baseline and a mean PE rate of 6.7% (SD 9.0, 95% CI 3.7 to 9.8) post-intervention.

There was a mean reduction in PE rate in the intervention group of 18.3% (SD +/-14.7, 95% CI -23.2 to -13.3).

Forty-one prescribers were included in the control group. There was a mean PE rate of 19.7% (SD 14.5, 95% CI 15.2 to 24.3) at baseline and a mean PE rate of 25.1% (SD 17.0, 95% CI 19.8 to 30.6) post-intervention.

There was a mean increase in PE rate in the control group of 5.4% (SD +/-15.6, 95% CI 0.6 to 10.4).

Table 17: Overall prescribing data per prescriber for control and intervention groups

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre - post
1	80	12	15	137	5	3.6	-11.4
2	84	11	13.1	58	4	6.9	-6.2
3	155	65	41.9	107	8	7.5	-34.4
4	164	62	37.8	161	7	4.4	-33.4
5	2	0	0	5	0	0	0
6	85	21	24.7	42	2	4.8	-19.9
7	110	34	30.9	187	16	8.6	-22.3
8	72	24	33.3	50	5	10.0	-23.3
9	28	11	39.3	47	3	6.4	-32.9
10	103	24	23.3	80	5	6.3	-17.0
11	181	83	45.9	63	13	20.6	-25.3
12	64	29	45.3	41	8	19.5	-25.8
13	201	30	15.0	124	3	2.4	-12.6
14	149	30	20.1	216	9	4.2	-15.9

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre - post
15	114	13	11.4	210	4	1.9	-9.5
16	165	28	17.0	372	22	5.9	-11.1
17	108	30	27.8	108	9	8.3	-19.5
18	76	22	29.0	90	6	6.7	-22.3
19	224	28	12.5	14	0	0	-12.5
20	95	25	26.3	275	11	4.0	-22.3
21	22	15	68.2	1	0	0	-68.2
22	12	0	0	4	0	0	0
23	25	6	24	101	8	7.9	-16.1
24	208	30	14.4	57	2	3.5	-10.9
25	23	11	47.8	2	1	50	2.2
26	23	12	52.2	16	0	0	-52.2
27	8	0	0	5	0	0	0
28	129	29	22.5	101	4	4.0	-18.5
29	53	11	20.8	24	1	4.2	-16.6
30	61	11	18.0	37	2	5.4	-12.6
31	19	0	0	68	1	1.5	1.5
32	11	6	54.6	12	2	16.7	-37.9
33	47	9	19.2	120	4	3.3	-15.9
34	86	14	16.3	28	1	3.6	-12.7
35	17	0	0	2	0	0	0
36	*prescriber removed from analysis as there was no matched prescribing data						
37	63	20	31.8	20	2	10.0	-21.8
38	15	0	0	34	7	20.6	20.6
39	40	7	17.5	56	13	23.2	5.7
40	39	8	20.5	61	22	36.1	15.6
41	93	42	45.2	66	22	33.3	-11.9
42	118	45	38.1	25	10	40.0	1.9
43	30	8	26.7	66	21	31.8	5.1
44	9	4	44.4	46	6	13.0	-31.4
45	50	19	38.0	52	25	48.1	10.1
46	27	4	14.8	17	5	29.4	14.6
47	43	11	25.6	14	2	14.3	-11.3
48	10	7	70	4	3	75.0	5
49	51	3	5.9	116	11	9.5	3.6

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre - post
50	95	13	13.7	133	23	17.3	3.6
51	57	10	17.5	63	12	19.1	1.6
52	80	16	20.0	73	14	19.2	-0.8
53	15	5	33.3	35	13	37.1	3.8
54	40	5	12.5	46	8	17.4	4.9
55	65	15	23.1	27	13	48.2	25.1
56	120	13	10.8	56	8	14.3	3.5
57	22	2	9.1	18	5	27.8	18.7
58	27	6	22.2	62	16	25.8	3.6
59	64	6	9.4	95	19	20.0	10.6
60	34	10	29.4	25	5	20.0	-9.4
61	19	4	21.1	13	2	15.4	-5.7
62	99	15	15.2	109	9	8.3	-6.9
63	59	15	25.4	112	46	41.1	15.7
64	10	4	40	49	16	32.7	-7.3
65	82	6	7.3	124	8	6.5	-0.8
66	113	14	12.4	33	7	21.2	8.8
67	90	9	10	22	8	36.4	26.4
68	54	5	9.3	91	19	20.9	11.6
69	21	8	38.1	159	45	28.3	-9.8
70	14	1	7.1	40	3	7.5	0.4
71	32	6	18.8	4	3	75.0	56.2
72	64	5	7.8	17	3	17.7	9.9
73	68	8	11.8	57	4	7.0	-4.8
74	66	4	6.1	29	2	6.9	0.8
75	64	3	4.7	25	2	8.0	3.3
76	60	5	8.3	39	0	0	-8.3
77	63	11	17.5	20	2	10.0	-7.5
78	2	0	0	4	2	50.0	50
Total	5191	1138	21.9%	5122	632	12.3%	

7.2.3.2. Assumption testing for overall prescribing error rates

As outlined in chapter 3, various assumptions have to be met to determine if the data is suitable for independent t-tests including normality of distribution, absence of outliers and homogeneity of variances. These will now be considered.

Normality of distribution

Shapiro-Wilk tests suggest non-normality of distribution with a p-value <0.05 for the intervention group (0.03) and the control group (0.02). However, inspection of the histogram (Figure 23) suggests an approximated normality for the control group and a mild negative skew for the intervention group. Additionally, inspection of the normality plots (Figures 24 and 25) suggested an approximated normality with a few residuals departing on both sides of the normal line influencing non-normality. T-tests are robust to deviations in normality as discussed in chapter 3, particularly with sample sizes over 30, whilst non-normality does not significantly affect type 1 error (false positive). Transforming data for a negative skew did not improve the distribution of the histograms (Figure 26). Hence, a normal distribution was assumed and the t-test performed.

Figure 23: **Histogram of distribution of change scores for overall prescribing in control and intervention groups**
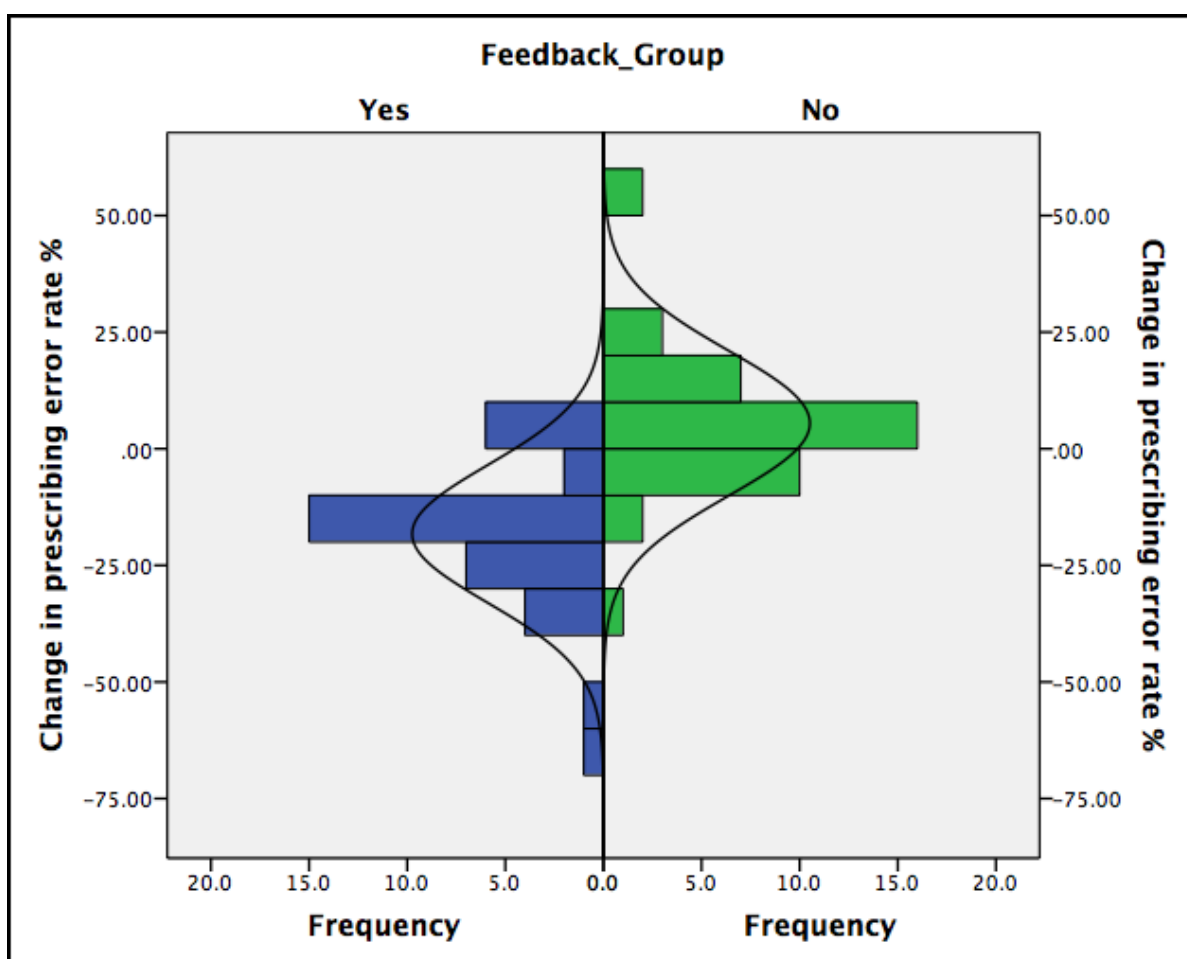
Figure 24: Probability plot for change in overall prescribing error rates for the intervention group

Normal Q-Q Plot of change in prescribing error rate
Intervention group
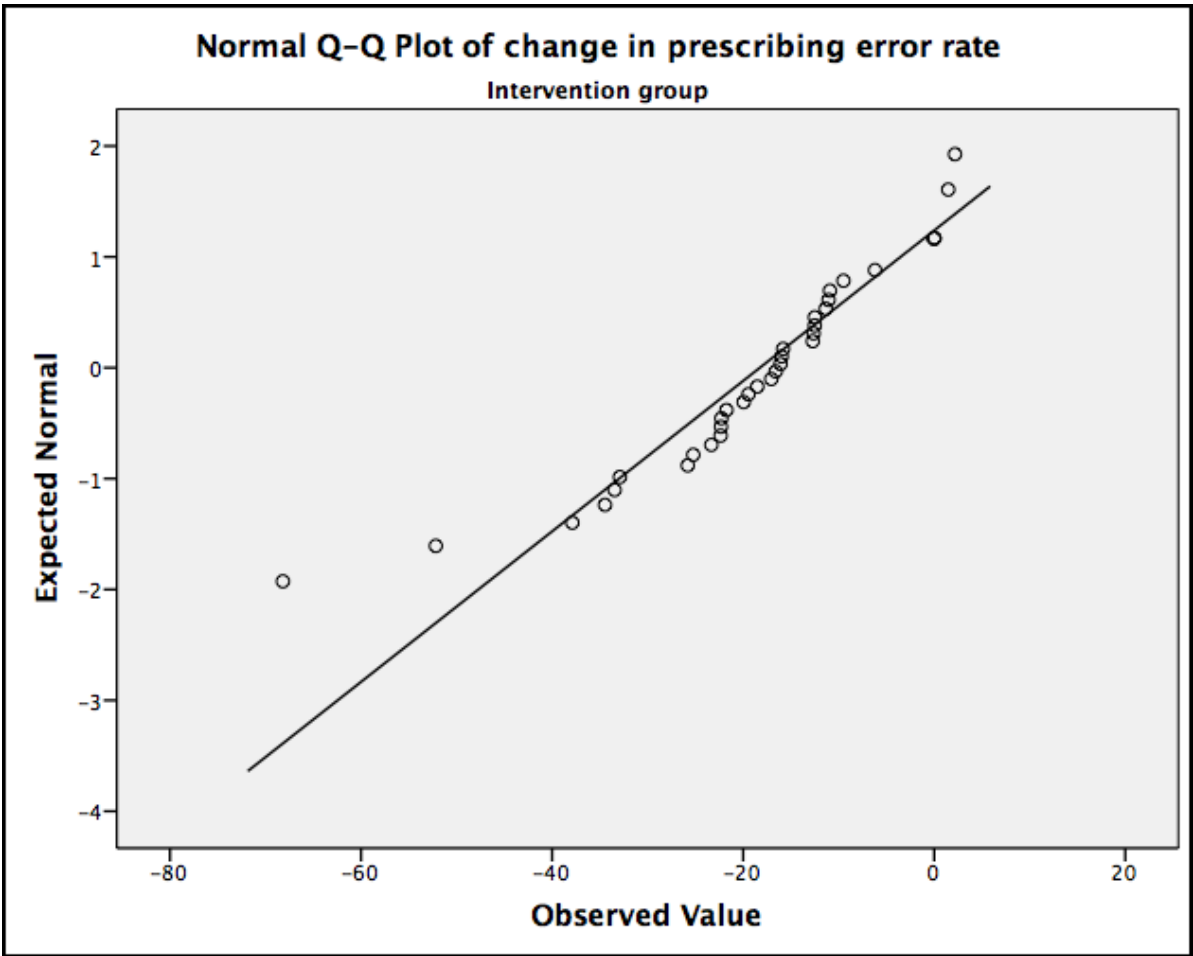
Figure 25: Probability plot for change in overall prescribing error rates for the control group

Normal Q–Q Plot for change in prescribing error rate
Control group
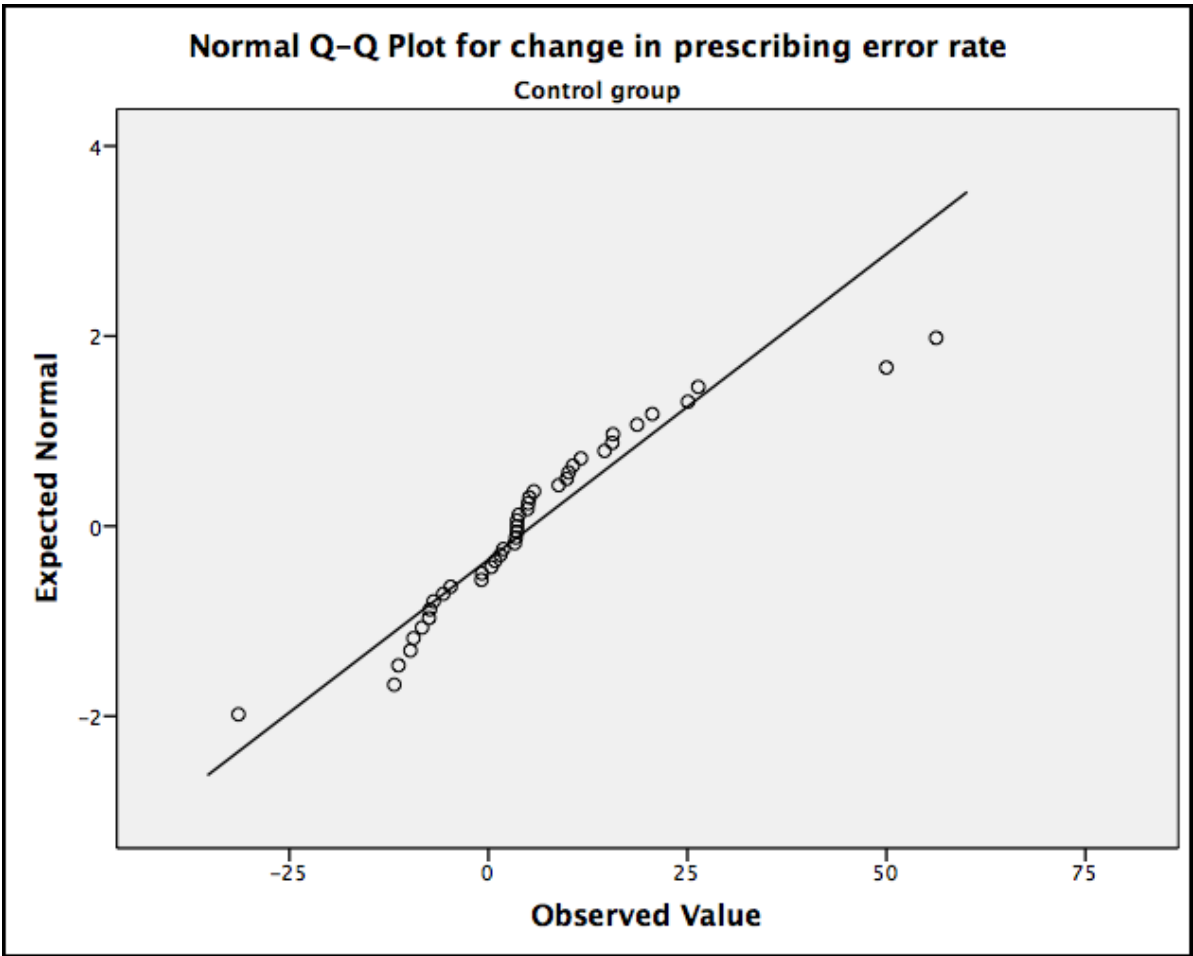
Figure 26: Histogram of distribution of transformed change scores for overall prescribing in control and intervention groups
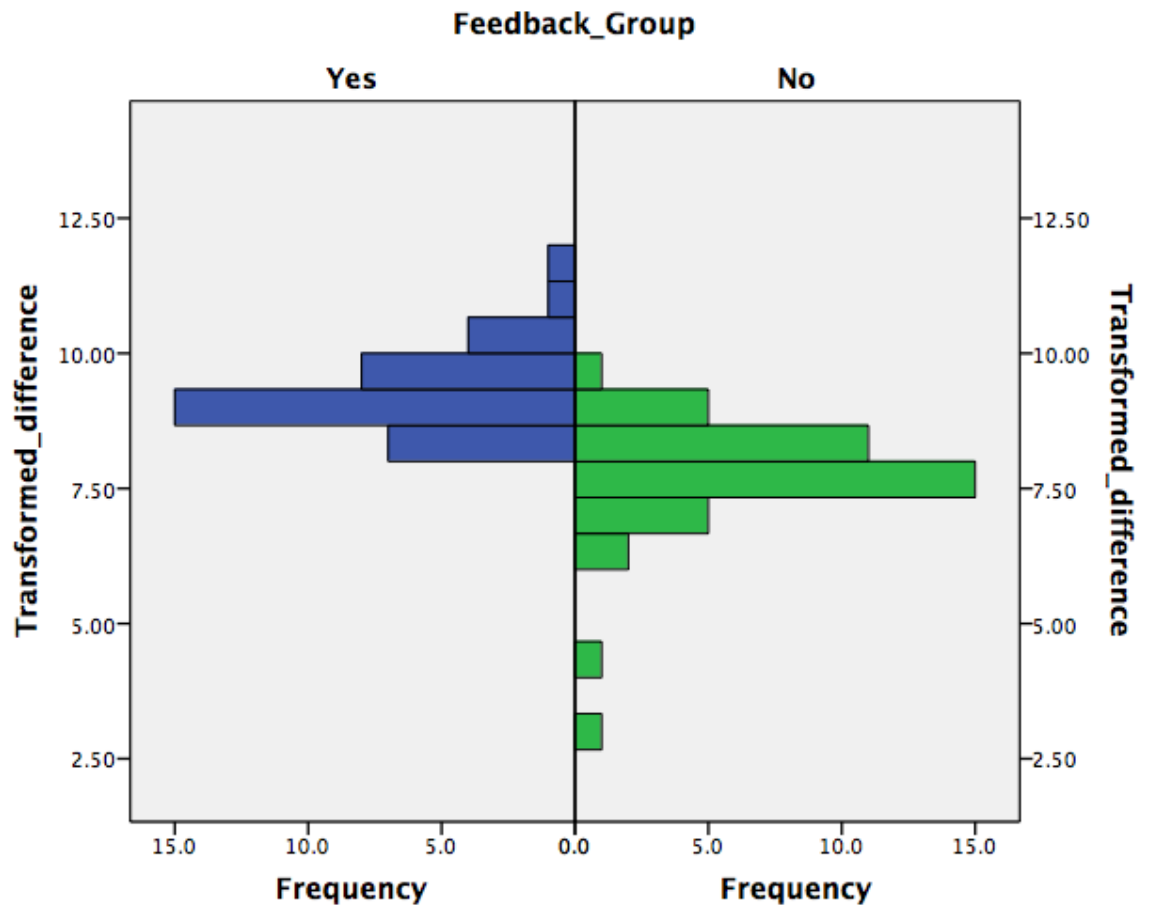
Outliers

Five outliers were identified from inspection of the box plots (Figure 27). Whilst the t-test is robust to outliers, a sensitivity test was performed to compare significance with and without outliers with significance unaffected as reported below.

Figure 27: Boxplot for change in prescribing error rates for overall prescribing
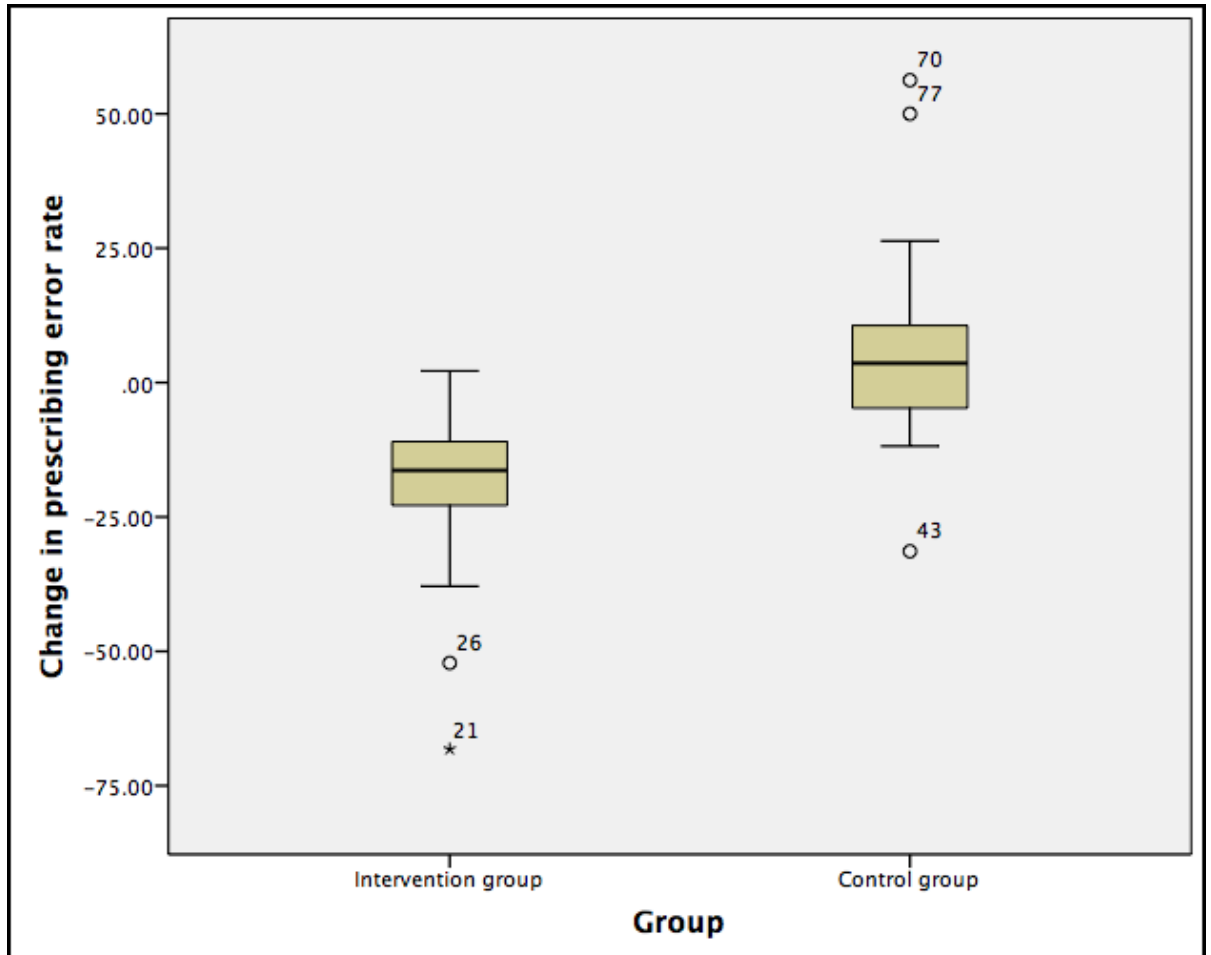
Homogeneity of variance

The final assumption for independent t-tests is homogeneity of variances as described in chapter 3. This was demonstrated by Levene's tests (p>0.05 at 0.948) and this assumption met.

7.2.3.3. Results for overall change in prescribing error rates

PE rates were statistically significantly lower in the intervention group compared to the control group. Mean difference of 23.7% (SD 3.5, 95% CI, -30.6 to -16.8), t(75) = -6.849, p<0.05, effect size (d) = 1.57 (large effect size).

Removal of outliers for overall prescribing

The t-test was repeated to determine the difference on the significance of the results without the outliers (prescribers 21, 26, 42, 69 and 76).

Shapiro-Wilk scores suggested normality for the intervention group (0.593) and non-normality for the control group (0.004) although inspection of the histogram (figure 28) would suggest an approximated normal distribution for the control group. There was homogeneity of variances as demonstrated by Levene's score p>0.05 (0.218). There was a statistically significant change in PE rates between the two groups with the intervention group (mean change -15.8%, SD 10.66) demonstrating a greater mean change in PE rate compared to the control group (+6.0%, SD 16.0). Mean difference as determined by the independent t-test was -21.8% (SD 3.2, 95% CI = -28.2 to -15.3) t(70) = -6.707. Results were still significant justifying inclusion of outliers in the initial analysis.

Figure 28: Histogram of distribution of change scores for control and intervention groups following removal of outliers
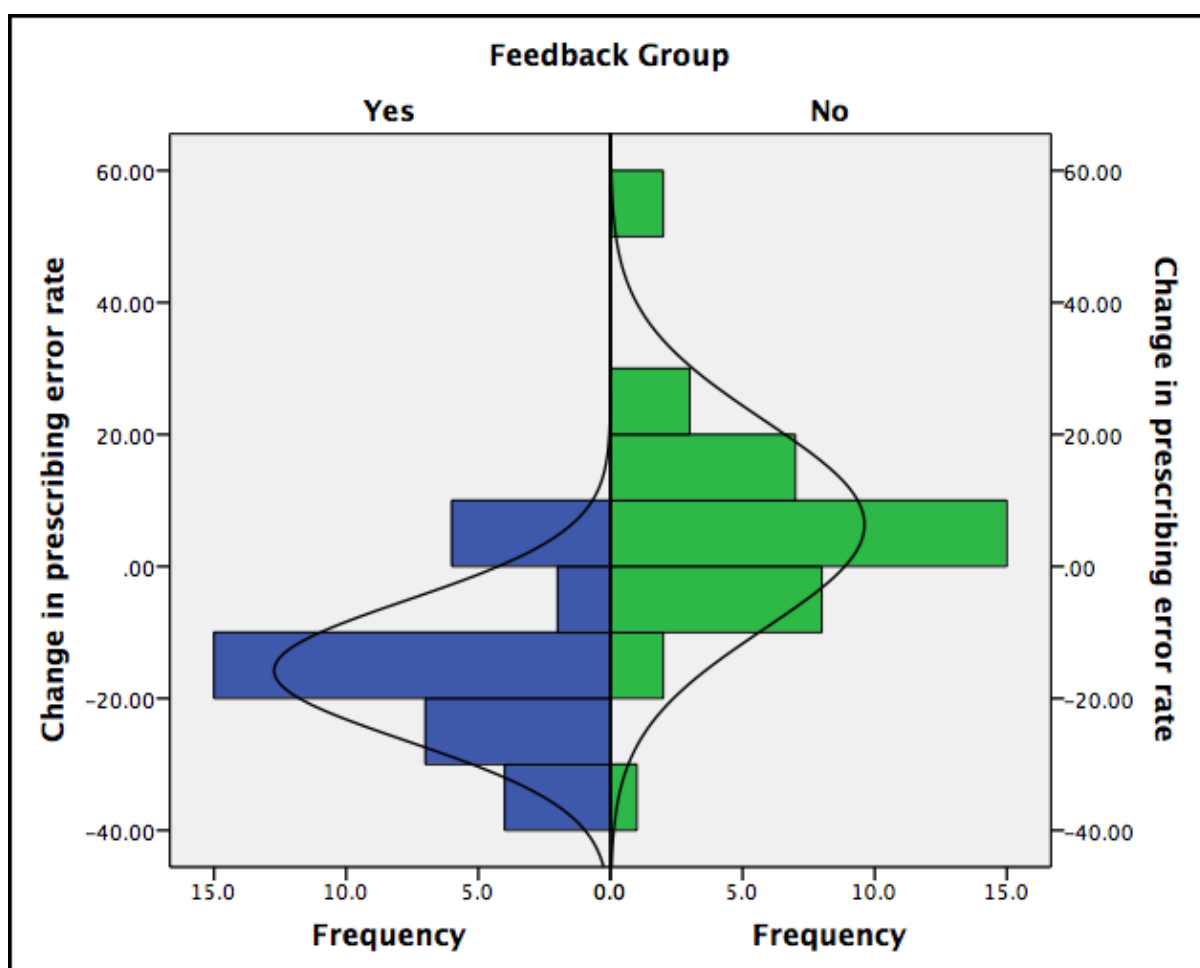
7.2.4. Impact of feedback on overall error free prescription rate

7.2.4.1. Sample size and descriptive statistics for EFP rate

Prescribing data for error free prescriptions (EFPs) is presented in table 18 below.

There was a mean EFP rate of 48.4% (SD 27.7, 95% CI 39.1 to 57.8) at baseline and 72.1% (SD 27.7, 95% CI 39.1 to 57.8) post-intervention for the intervention group.

There was a mean improvement in EFP rate of 23.7% (95% CI, 15.6 to 31.8, SD 24.0) in the intervention group (n=36).

There was a mean EFP rate of 53.7% (SD 21.4, 95% CI 46.9 to 60.4) in the control group at baseline and 47.9% (SD 22.5, 95% CI 40.8 to 55.0) post-intervention.

There was a mean reduction in the EFP rate of 5.8% (95% CI, -14.4 to 2.9, SD 27.4) in the control group (n=41).

Table 18: Prescribing data for overall error free prescriptions per prescriber

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Pre-EFP	Post-EFP (%)	Difference in EFP % pre - post
1	18	10	55.6	21	17	81.0	25.4
2	17	9	52.9	8	5	62.5	9.6
3	26	9	34.6	15	10	66.7	32.1
4	22	7	31.8	21	14	66.7	34.9
5	2	2	100.0	4	4	100.0	0
6	16	9	56.3	6	4	66.7	10.4
7	19	6	31.6	30	23	76.7	45.1
8	19	7	36.8	10	5	50.0	13.2
9	8	4	50.0	7	5	71.4	21.4
10	21	12	57.1	11	6	54.6	-2.5
11	41	11	26.8	14	8	57.1	30.3
12	10	5	50.0	11	6	54.6	4.6
13	23	10	43.5	19	16	84.2	40.7
14	17	6	35.3	34	26	76.5	41.2
15	16	10	62.5	31	27	87.1	24.6
16	21	10	47.6	42	22	52.4	4.8
17	23	13	56.5	14	6	42.9	-13.6
18	10	4	40.0	14	9	64.3	24.3
19	36	23	63.9	2	2	100	36.1
20	18	11	61.1	36	28	77.8	16.7
21	5	3	60.0	1	1	100	40.0
22	8	8	100.0	2	2	100	0
23	5	0	0	15	9	60	60.0
24	22	14	63.6	11	9	81.8	18.2

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Pre-EFP	Post-EFP (%)	Difference in EFP % pre - post
25	4	0	0	1	0	0	0
26	5	0	0	3	3	100	100
27	1	1	100.0	1	1	100	0
28	16	4	25.0	9	6	66.7	41.7
29	11	4	36.4	4	3	75.0	38.6
30	8	3	37.5	8	6	75.0	37.5
31	9	9	100.0	12	11	91.7	-8.3
32	2	0	0	8	6	75.0	75.0
33	7	3	42.9	18	14	77.8	34.9
34	16	9	56.3	3	2	66.7	10.4
35	3	3	100.0	1	1	100	0
36	*prescriber removed from analysis as there was no matched prescribing data						
37	14	4	28.6	3	1	33.3	4.7
38	7	7	100.0	8	4	50.0	-50.0
39	14	10	71.4	21	11	52.4	-19.0
40	12	8	66.7	17	4	23.5	-43.2
41	13	4	30.8	14	8	57.1	26.3
42	34	18	52.9	8	3	37.5	-15.4
43	7	3	42.9	16	3	18.8	-24.1
44	6	3	50.0	10	6	60.0	10.0
45	18	9	50.0	14	0	0	-50.0
46	8	6	75.0	11	6	54.6	-20.4
47	19	9	47.4	10	8	80.0	32.6
48	6	3	50.0	3	0	0	-50.0
49	7	4	57.1	16	11	68.8	11.7
50	18	10	55.6	23	13	56.5	0.9
51	12	4	33.3	13	5	38.5	5.2
52	9	2	22.2	16	8	50.0	27.8
53	10	5	50.0	15	7	46.7	-3.3
54	8	4	50.0	14	8	57.1	7.1
55	14	4	28.6	6	0	0	-28.6
56	24	16	66.7	12	6	50.0	-16.7
57	8	7	87.5	3	1	33.3	-54.2
58	8	5	62.5	20	9	45.0	-17.5
59	9	5	55.6	19	10	52.6	3.0
60	4	0	0	6	4	66.7	66.7

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Pre-EFP	Post-EFP (%)	Difference in EFP % pre - post
61	4	1	25.0	5	3	60.0	35.0
62	15	6	40.0	24	17	70.8	30.8
63	10	4	40.0	15	4	26.7	-13.3
64	2	1	50.0	7	2	28.6	-21.4
65	15	9	60.0	15	12	80.0	20.0
66	16	8	50.0	7	3	42.9	-7.1
67	12	4	33.3	5	2	40.0	6.7
68	8	4	50.0	12	3	25.0	-25.0
69	3	1	33.3	21	5	23.8	-9.5
70	6	5	83.3	8	5	62.5	-20.8
71	4	1	25.0	4	1	25.0	0
72	9	5	55.6	6	4	66.7	11.1
73	14	10	71.4	8	4	50.0	-21.4
74	8	6	75.0	6	4	66.7	-8.3
75	10	8	80.0	8	6	75.0	-5
76	9	7	77.8	6	6	100.0	22.2
77	9	4	44.4	7	5	71.4	27.0
78	2	2	100.0	4	2	50.0	-50

7.2.4.2. Assumption testing for overall error free prescription rate change

Normality testing for error free prescriptions

The Shapiro-Wilk test indicated non-normality for the intervention group (p<0.05 at 0.019) and normality for the control group (p>0.05 at 0.396). Inspection of the histogram (figure 29) and normality plots (figures 30 and 31) suggest distributions that could be approximated as normal with a few outliers below the normality line influencing normality. Removal of these outliers produced statistically significant results with normality of distribution as described below.

Figure 29: Histogram of distribution of change scores for error free prescription percentage for overall prescribing
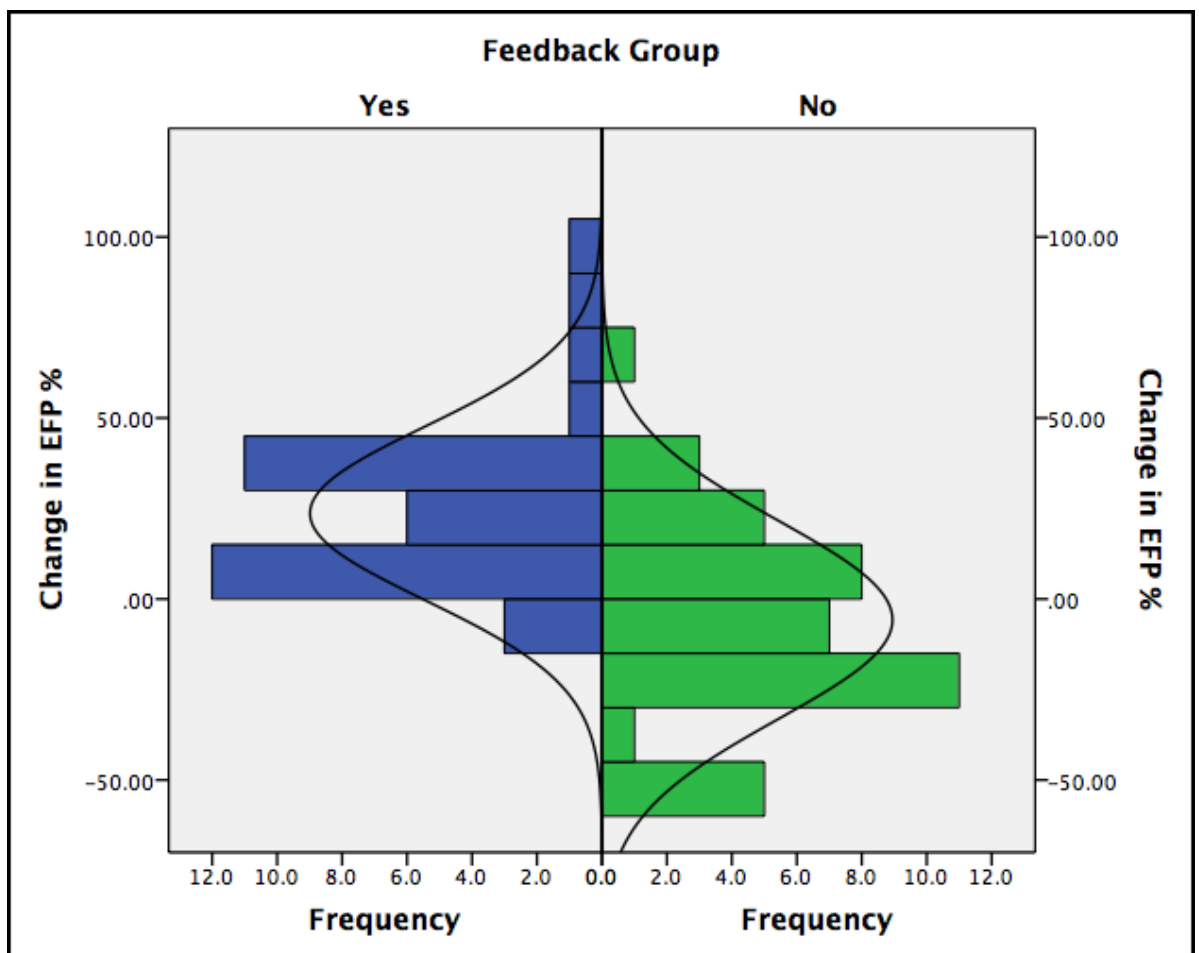
Figure 30: Probability plot for change in overall EFP rate in the intervention group

Normal Q–Q Plot of change in EFP %
Intervention group
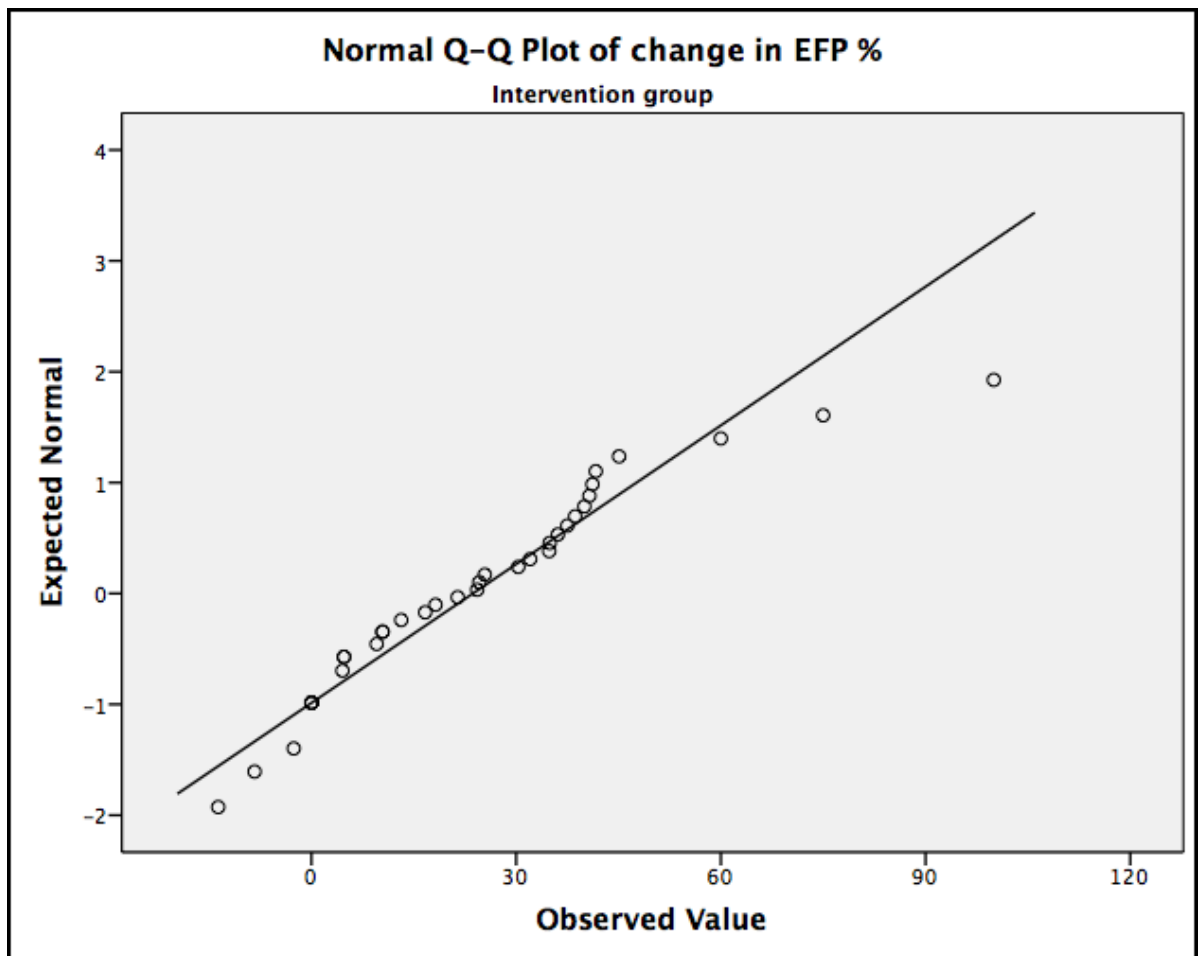
Figure 31: Probability plot for change in overall EFP rate in the control group

Normal Q–Q Plot of change in EFP %
Control group
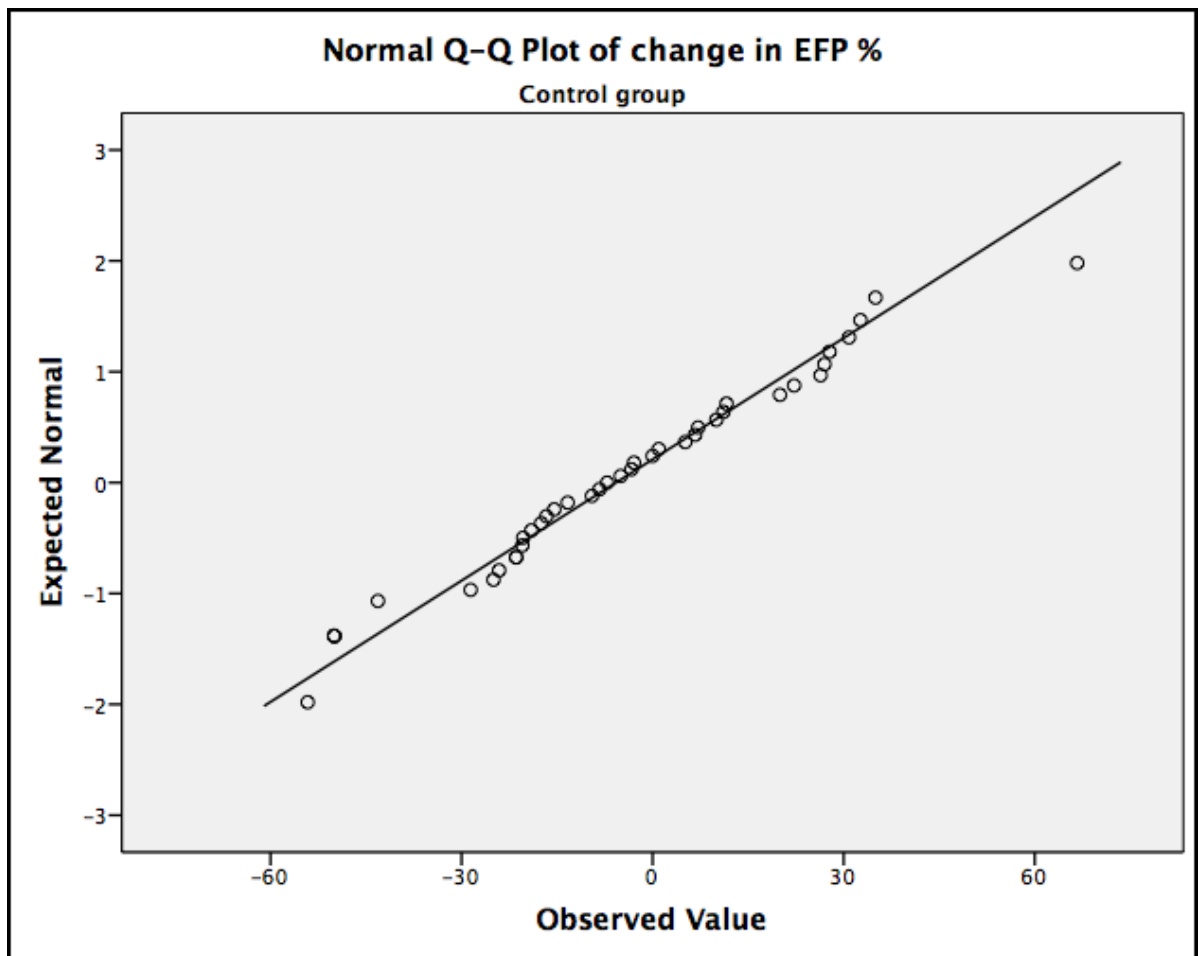
Outliers

Two outliers were identified from inspection of the box plots (Figure 32). These were considered true outliers following manual inspection of the data and unlikely to affect the outcome of the test. This was confirmed by comparing results of the t-test with and without the outlier with test significance unchanged.

Figure 32: Box plot of error free prescription % for overall prescribing
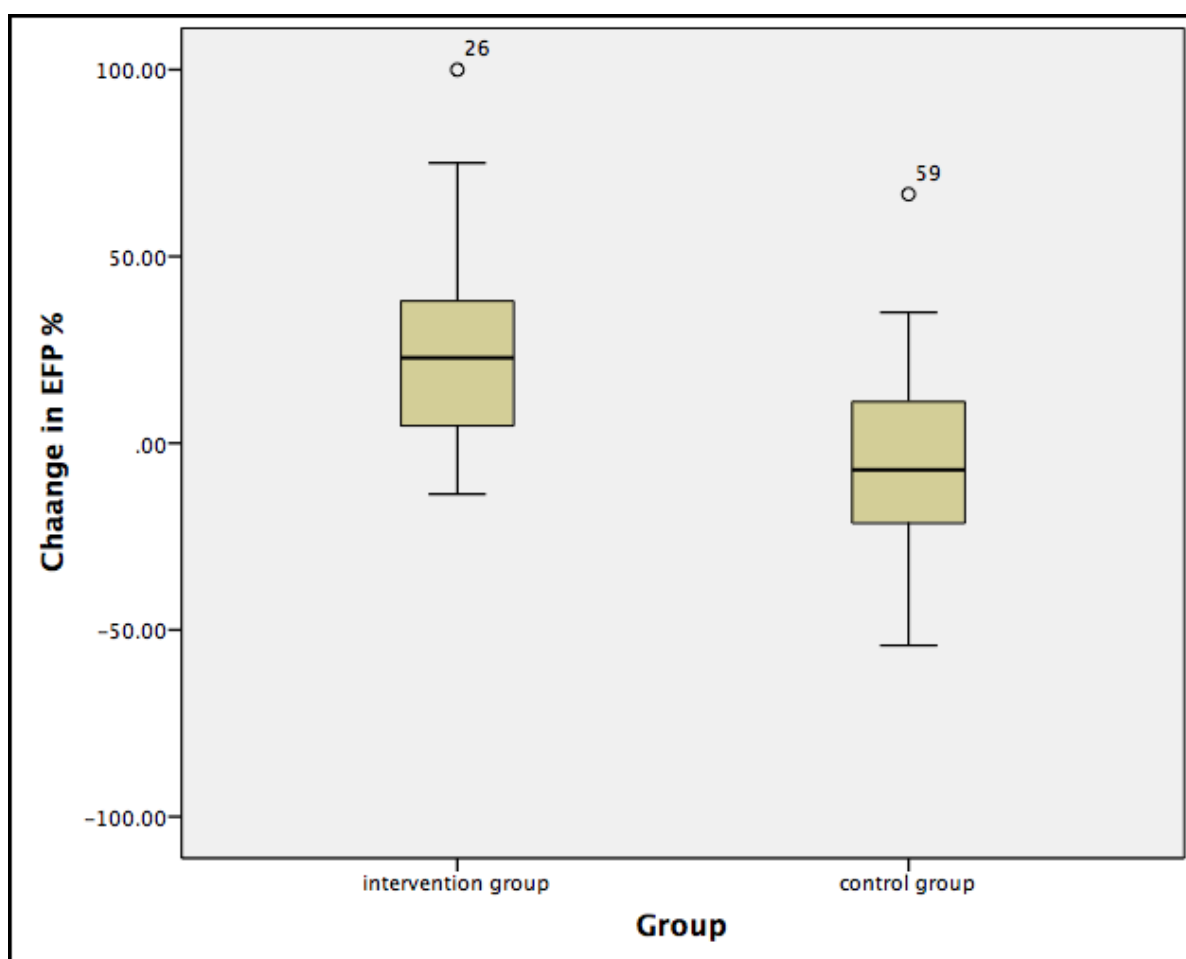
Homogeneity of variance

There was homogeneity of variance as determined by Levene's test p>0.05 (0.4)

7.2.4.3. Results for change in overall error free prescriptions

The intervention group demonstrated a mean improvement in EFPs (mean change 23.7%, SD 24.0) compared to the control group (mean change -5.8%, SD 27.4), a statistically significant difference of 29.5% (SD 5.9, 95% CI, 17.7 to 41.2), t(75) = 4.978, p = <0.005. Effect size (d) = 1.14 (large effect size).

Sensitivity testing

Results remained significant (mean difference 27.3%, t=4.80, p<0.05) when performed without the above outliers (prescribers 26 and 59) with assumptions of normality (Shapiro-Wilk p>0.05 for both groups and see figure 33 below) and homogeneity of variances (Levene's test >0.05, p=0.115) met.

Figure 33: Histogram of distribution of change scores for error free prescription percentage for overall prescribing without outliers
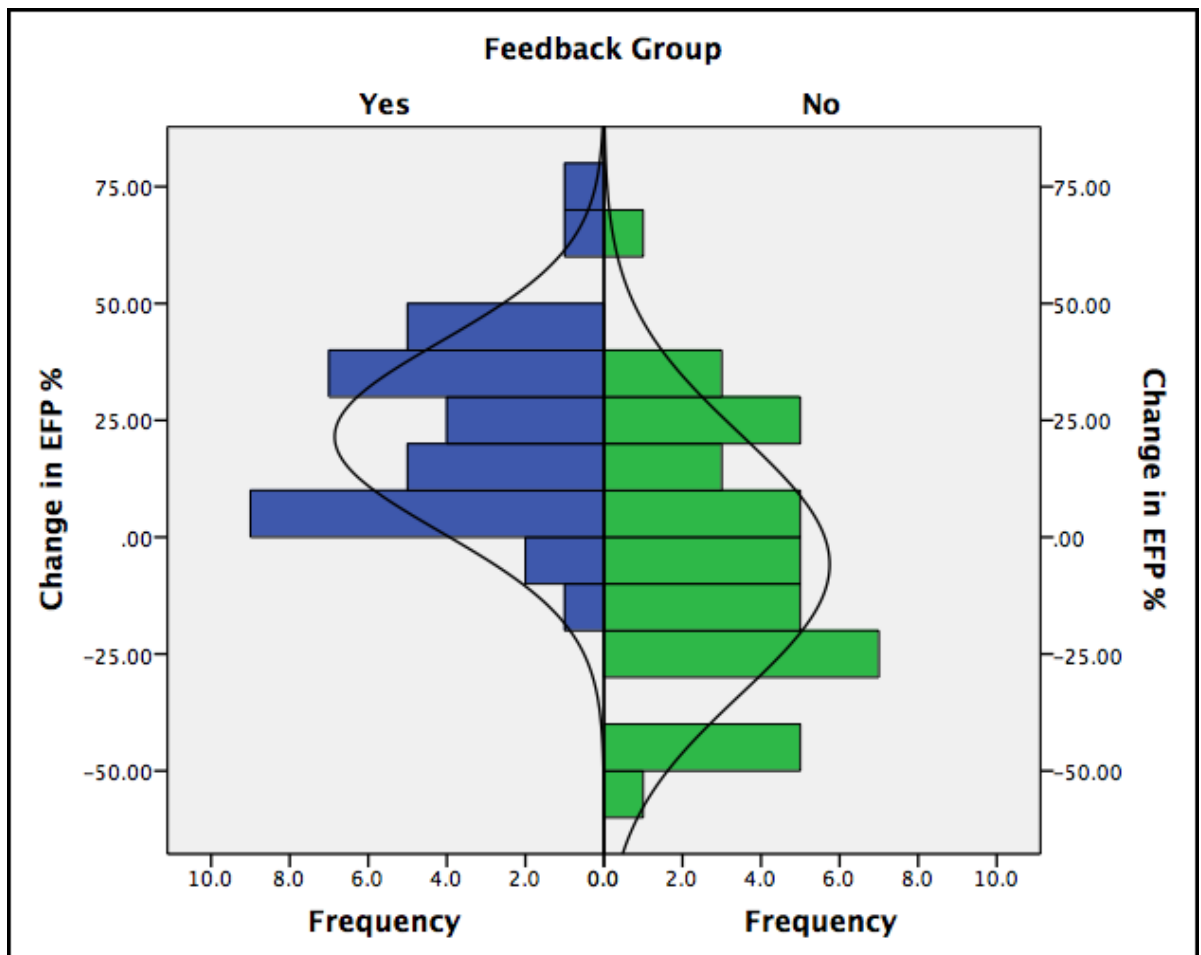
7.2.5.1. Association between change in prescribing error rate and number of feedback sessions

The number of individual feedback sessions (excluding the initial overall feedback session) for PEs classified as significant or greater are displayed in table 19 below.

To determine if there is an association between number of feedback sessions and change in PE rate, Pearson's correlation coefficient test was used.

The null hypothesis for this test is as follows:

H_0: $\rho = 0$; the population correlation coefficient is equal to zero.

And the alternative hypothesis is:

H_A: $\rho \neq 0$; the population correlation coefficient is not equal to zero.

Table 19: Difference in overall prescribing and number of feedback sessions each prescriber received

Prescriber	Pre-error rate%	Post-error rate (%)	Absolute difference in error rate Post-pre (%)	Number of individual feedback sessions	Number of prescribing errors feedback delivered on
1	15	3.6	-11.4	6	8
2	13.1	6.9	-6.2	9	12
3	41.9	7.5	-34.4	7	9
4	37.8	4.4	-33.4	4	6
5	0	0	0	0	0
6	24.7	4.8	-19.9	4	7
7	30.9	8.6	-22.3	3	5
8	33.3	10.0	-23.3	6	9
9	39.3	6.4	-32.9	5	12
10	23.3	6.3	-17.0	7	10
11	45.9	20.6	-25.3	1	3
12	45.3	19.5	-25.8	1	2
13	15.0	2.4	-12.6	5	12
14	20.1	4.2	-15.9	4	6
15	11.4	1.9	-9.5	3	3
16	17.0	5.9	-11.1	4	7
17	27.8	8.3	-19.5	1	1
18	29.0	6.7	-22.3	2	6
19	12.5	0	-12.5	3	7
20	26.3	4.0	-22.3	4	5
21	68.2	0	-68.2	0	0
22	0	0	0	0	0
23	24	7.9	-16.1	4	4
24	14.4	3.5	-10.9	4	4
25	47.8	50	2.2	1	2
26	52.2	0	-52.2	1	1
27	0	0	0	1	3
28	22.5	4.0	-18.5	6	9
29	20.8	4.2	-16.6	3	6
30	18.0	5.4	-12.6	2	4

Prescriber	Pre-error rate%	Post-error rate (%)	Absolute difference in error rate Post-pre (%)	Number of individual feedback sessions	Number of prescribing errors feedback delivered on
31	0	1.5	1.5	1	1
32	54.6	16.7	-37.9	1	1
33	19.2	3.3	-15.9	3	5
34	16.3	3.6	-12.7	2	3
35	0	0	0	0	0
36	*prescriber removed from analysis as there was no matched prescribing data				
37	31.8	10.0	-21.8	3	4
38	0	20.6	20.6	0	0
39	17.5	23.2	5.7	0	0
40	20.5	36.1	15.6	0	0
41	45.2	33.3	-11.9	0	0
42	38.1	40.0	1.9	0	0
43	26.7	31.8	5.1	0	0
44	44.4	13.0	-31.4	0	0
45	38.0	48.1	10.1	0	0
46	14.8	29.4	14.6	0	0
47	25.6	14.3	-11.3	0	0
48	70	75.0	5	0	0
49	5.9	9.5	3.6	0	0
50	13.7	17.3	3.6	0	0
51	17.5	19.1	1.6	0	0
52	20.0	19.2	-0.8	0	0
53	33.3	37.1	3.8	0	0
54	12.50	17.4	4.9	0	0
55	23.1	48.2	25.1	0	0
56	10.8	14.3	3.5	0	0
57	9.1	27.8	18.7	0	0
58	22.2	25.8	3.6	0	0
59	9.4	20.0	10.6	0	0
60	29.4	20.0	-9.4	0	0
61	21.1	15.4	-5.7	0	0
62	15.2	8.3	-6.9	0	0
63	25.4	41.1	15.7	0	0
64	40	32.7	-7.3	0	0

Prescriber	Pre-error rate%	Post-error rate (%)	Absolute difference in error rate Post-pre (%)	Number of individual feedback sessions	Number of prescribing errors feedback delivered on
65	7.3	6.5	-0.8	0	0
66	12.4	21.2	8.8	0	0
67	10	36.4	26.4	0	0
68	9.3	20.9	11.6	0	0
69	38.1	28.3	-9.8	0	0
70	7.1	7.5	0.4	0	0
71	18.8	75.0	56.2	0	0
72	7.8	17.7	9.9	0	0
73	11.8	7.0	-4.8	0	0
74	6.1	6.9	0.8	0	0
75	4.7	8.0	3.3	0	0
76	8.3	0	-8.3	0	0
77	17.5	10.0	-7.5	0	0
78	0	50.0	50	0	0

Figure 34: Scatterplot of absolute change in error rate and number of prescribing errors the prescriber received feedback on for the intervention group
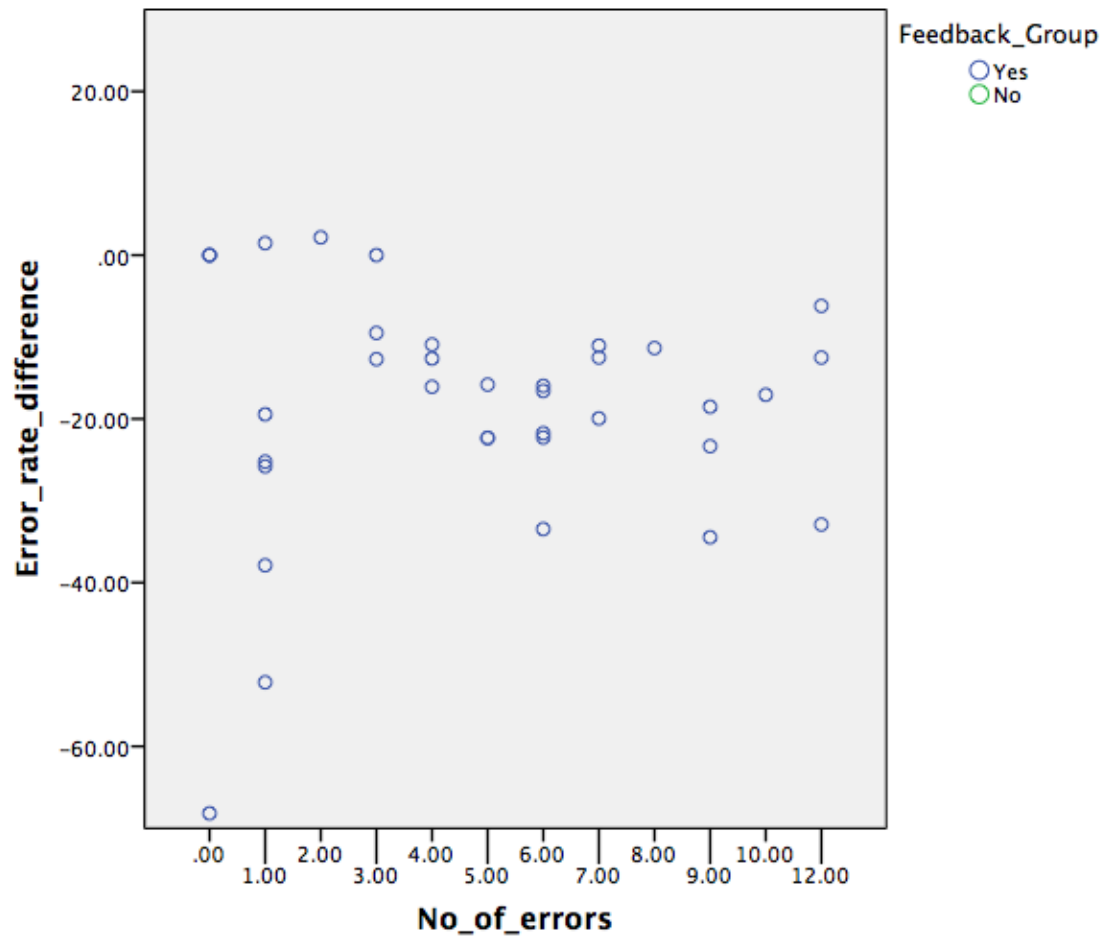
Figure 35: Scatterplot of transformed absolute error rate difference data and number of errors the prescriber received feedback on
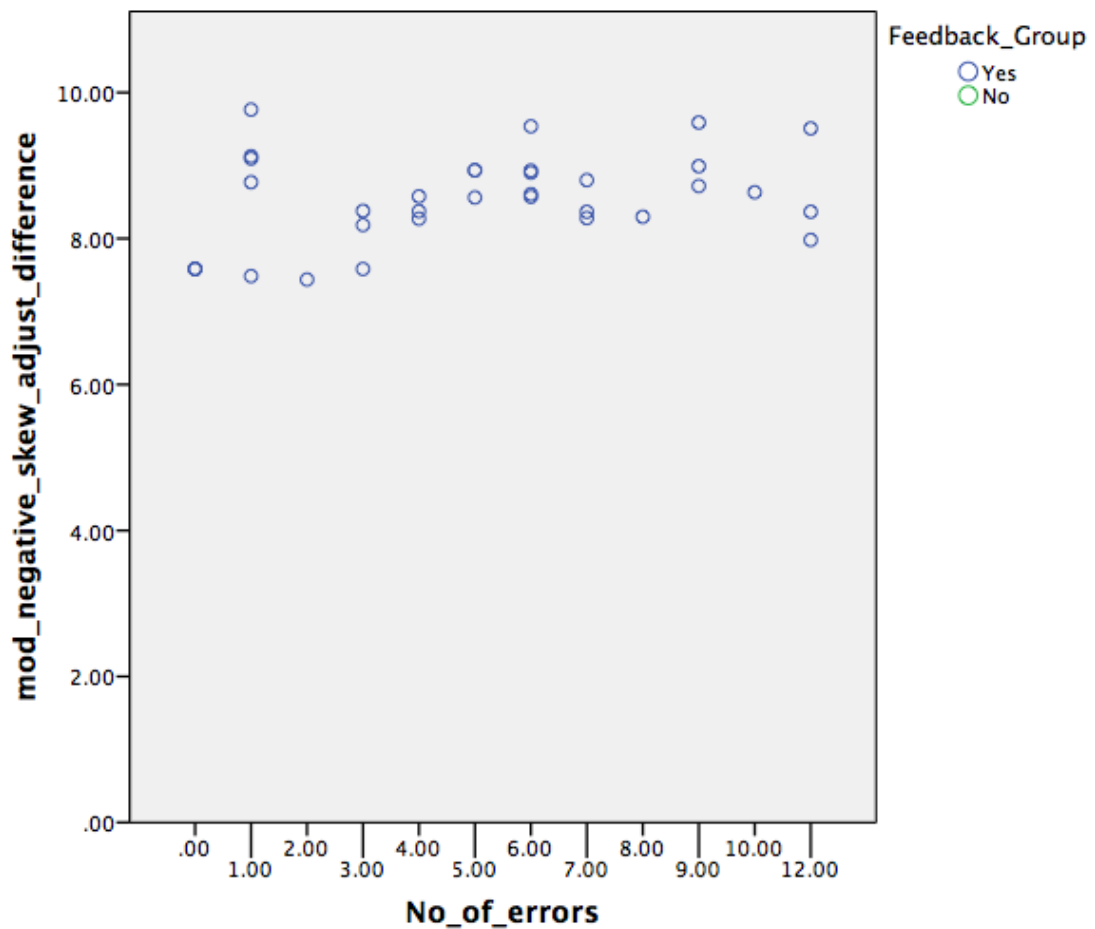
Assumptions of Pearson's test include linearity of response and no significant outliers.

The relationship between number of errors the prescriber received feedback on and change in PE rate was considered non-linear (Figure 34) but is monotonic from visual inspection of figure 35. Therefore, Spearman's rank test was performed as an alternative as described in chapter 3.

An increase in number of errors that prescribers received feedback on was associated with a non-significant improvement in change in PE rates, rs(32) = -0.127, p >0.05 (0.46). Removal of outliers (prescribers 21 and 26) did not affect the outcome of the test.

7.2.5.2 Association between error free prescription rate and number of feedback sessions

Pearson's correlation could not be used as its assumptions of linearity was violated. Therefore, a bivariate analysis using Spearman's rank test was used and demonstrated a non-significant increase in absolute mean EFP rate (r(36)=0.038, p=0.825) and relative mean EFP rate (rs(36)=0.19, p=0.267) for the intervention group.

7.2.6. Impact of feedback on inpatient prescription errors

The impact of feedback on inpatient prescription errors will be discussed here.

7.2.6.1. Sample size and descriptive statistics

A summary of inpatient prescribing data for control and intervention groups at baseline and post-test is summarised in table 20 below.

Pre-test

A total of 620 inpatient prescriptions were audited at baseline, 330 of which were error free (53.2%), with 2891 items prescribed and 655 prescribing errors identified. An overall prescribing error rate of 22.7%.

There were 315 inpatient prescriptions in the intervention group, with 168 error free (53.3%). There were 1358 prescribed items with 370 prescribing errors, an overall prescribing error rate of 27.3%.

There were 305 inpatient prescriptions in the control group, with 162 error free (53.1%). There were 1533 prescribed items with 285 prescribing errors, an overall prescribing error rate of 18.6%.

Post-test

A total of 563 inpatient prescriptions were audited at baseline, with 349 error free (62.0%). There were 2500 prescribed items and 329 prescribing errors identified. An overall prescribing error rate of 13.2%.

There were 265 inpatient prescriptions in the intervention group, with 192 error free (72.5%). There were 1191 prescribed items with 85 prescribing errors, an overall prescribing error rate of 7.1%.

There were 298 inpatient prescriptions in the control group, with 157 error free (52.7%). There were 1309 prescribed items and 244 prescribing errors, an overall prescribing error rate of 18.6%.

Table 20: Overview of prescribing error data for inpatient prescribing in intervention and control groups

Group	Pre-items	Pre-errors	Pre-error rate %	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre-post (%)	Chi-square and p-value
Intervention	1358	370	27.3	1191	85	7.1	-20.2%	χ2(1) = 124.3, p = <0.005, φ=0.203
Control	1533	285	18.6	1309	244	18.6	+0.05%	χ2(1) = 0.01, p = 0.978 (ns), φ=0
Total	2891	655	22.7	2500	329	13.2	-9.5%	

7.2.6.2. Analysis of inpatient prescription error frequency

Using chi-squared test, there was a statistically significant change in error frequency in the intervention group (p<0.005) and a non-significant increase in error frequency in the control group (p=0.978). Between group analysis suggested a statistically significant difference pre-test ($\chi 2(1)$ = 19.4, p = <0.005, φ =0.074) and post-test ($\chi 2(1)$ = 55.8 p = <0.005, φ =-0.14).

7.2.6.3. Impact of feedback on inpatient prescribing error rates

7.2.6.4. Sample size and descriptive statistics for inpatient PE rate

A summary of inpatient prescribing data per prescriber is summarized in table 21 below. Prescribers 27 and 36 were excluded from the analysis as they did not have any post-test inpatient prescriptions for comparison.

There were 35 prescribers in the intervention group and 41 prescribers in the control group.

There was a mean PE rate of 29.4% (SD 21.0, 95% CI 22.2 to 36.6) at baseline and 8.8% (SD 10.3, 95% CI 5.3 to 12.4) post-intervention for the intervention group.

There was a mean reduction in inpatient PE rates of -20.6% (SD 20.3, 95%CI -27.5 to -13.6) in the intervention group.

There was a mean PE rate of 21.4% (SD 19.3, 95% CI 15.3 to 27.5) at baseline and 27.4% (SD 25.0, 95% CI 19.5 to 35.3) post-intervention for the control group.

There was a mean increase in inpatient PE rates of 6.0% (SD 27.8, 95% CI -2.7 to 14.8) in the control group.

Table 21: Inpatient prescribing data per prescriber

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre - post
1	34	6	17.7	52	3	5.8	-11.9
2	36	5	13.9	16	2	12.5	-1.4
3	31	8	25.8	62	7	11.3	-14.5
4	41	16	39.0	17	1	5.9	-33.1
5	2	0	0	5	0	0	0
6	40	11	27.5	4	1	25.0	-2.5
7	70	24	34.3	45	1	2.2	-32.1
8	27	9	33.3	42	5	11.9	-21.4
9	14	3	21.4	30	3	10.0	-11.4
10	68	17	25.0	13	3	23.1	-1.9
11	105	55	52.4	20	5	25.0	-27.4
12	64	29	45.3	41	8	19.5	-25.8
13	60	11	18.3	56	2	3.6	-14.7
14	5	4	80.0	116	7	6.0	-74.0
15	45	4	8.9	125	3	2.4	-6.5
16	7	1	14.3	108	8	7.4	-6.9
17	55	12	21.8	55	6	10.9	-10.9
18	25	11	44.0	39	2	5.1	-38.9
19	99	10	10.1	1	0	0	-10.1
20	76	22	29.0	89	4	4.5	-24.5
21	22	15	68.2	1	0	0	-68.2
22	12	0	0	4	0	0	0
23	4	3	75.0	31	4	12.9	-62.1
24	153	27	17.7	12	0	0	-17.7
25	23	11	47.8	2	1	50.0	2.2
26	17	10	58.8	2	0	0	-58.8
27	*Prescriber excluded from analysis as no matched prescribing data						

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre - post
28	19	6	31.6	42	1	2.4	-29.2
29	9	3	33.3	11	1	9.1	-24.2
30	24	4	16.7	16	2	12.5	-4.2
31	19	0	0	68	1	1.5	1.5
32	11	6	54.6	12	2	16.7	-37.9
33	10	2	20.0	28	1	3.6	-16.4
34	56	6	10.7	12	0	0	-10.7
35	17	0	0	2	0	0	0
36	*Prescriber excluded from analysis as no matched prescribing data						
37	58	19	32.8	12	1	8.3	-24.5
38	15	0	0	34	7	20.6	20.6
39	16	5	31.3	31	7	22.6	-8.7
40	36	8	22.2	42	17	40.5	18.3
41	90	42	46.7	53	19	35.9	-10.8
42	62	25	40.3	20	8	40.0	-0.3
43	5	1	20.0	46	13	28.3	8.3
44	3	3	100	21	3	14.3	-85.7
45	33	16	48.5	40	17	42.5	-6.0
46	20	4	20.0	6	3	50.0	30.0
47	25	10	40.0	8	1	12.5	-27.5
48	10	7	70.0	4	3	75.0	5.0
49	41	1	2.4	77	5	6.5	4.1
50	54	9	16.7	73	6	8.2	-8.5
51	49	9	18.4	53	9	17.0	-1.4
52	56	13	23.2	65	12	18.5	-4.7
53	6	2	33.3	5	3	60.0	26.7
54	32	3	9.4	27	2	7.4	-2.0

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre - post
55	30	6	20.0	2	2	100.0	80.0
56	110	12	10.9	25	5	20.0	9.1
57	14	2	14.3	4	0	0	-14.3
58	14	4	28.6	45	13	28.9	0.3
59	51	4	7.8	45	9	20.0	12.2
60	34	10	29.4	25	5	20.0	-9.4
61	11	2	18.2	9	1	11.1	-7.07
62	33	6	18.2	56	4	7.1	-11.1
63	37	11	29.7	34	9	26.5	-3.2
64	1	0	0	46	15	32.6	32.6
65	71	4	5.6	69	3	4.4	-1.2
66	67	11	16.4	3	3	100.0	83.6
67	29	6	20.7	5	2	40.0	19.3
68	40	5	12.5	41	5	12.2	-0.3
69	5	1	20.0	60	12	20.0	0
70	14	1	7.2	40	3	7.5	0.3
71	32	6	18.8	4	3	75.0	56.2
72	64	5	7.8	17	3	17.7	9.9
73	68	8	11.8	57	4	7.0	-4.8
74	66	4	6.1	29	2	6.9	0.8
75	64	3	4.7	25	2	8.0	3.3
76	60	5	8.3	39	0	0	-8.3
77	63	11	17.5	20	2	10.0	-7.5
78	2	0	0	4	2	50.0	50.0
Total	2891	655		2500	329		

7.2.6.5. Assumption testing for inpatient prescribing error rates

Assumption testing for the t-test is outlined below.

Normality of distribution

Shapiro-Wilk tests were <0.05 for both control and intervention groups indicating non-normality. Inspection of the histogram suggested the data was skewed (Figure 36) whilst the normality plots (figures 37 and 38) suggested a distribution that could be approximated as normal with several outliers above and below the normality lines.

Figure 36: Histogram illustrating distribution of inpatient prescribing error rate change for intervention and control groups
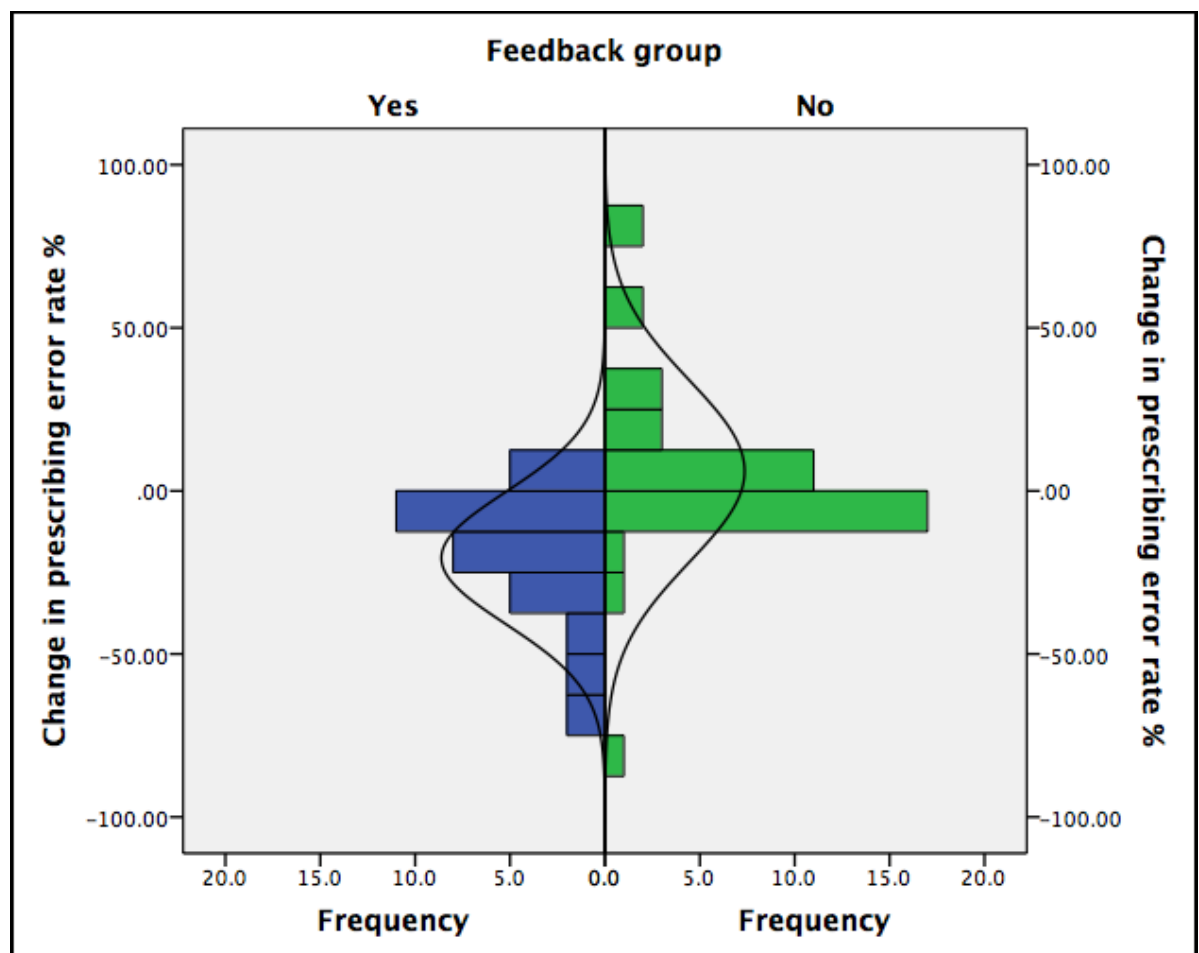
Figure 37: Probability plot for change in inpatient prescribing error rates for the intervention group
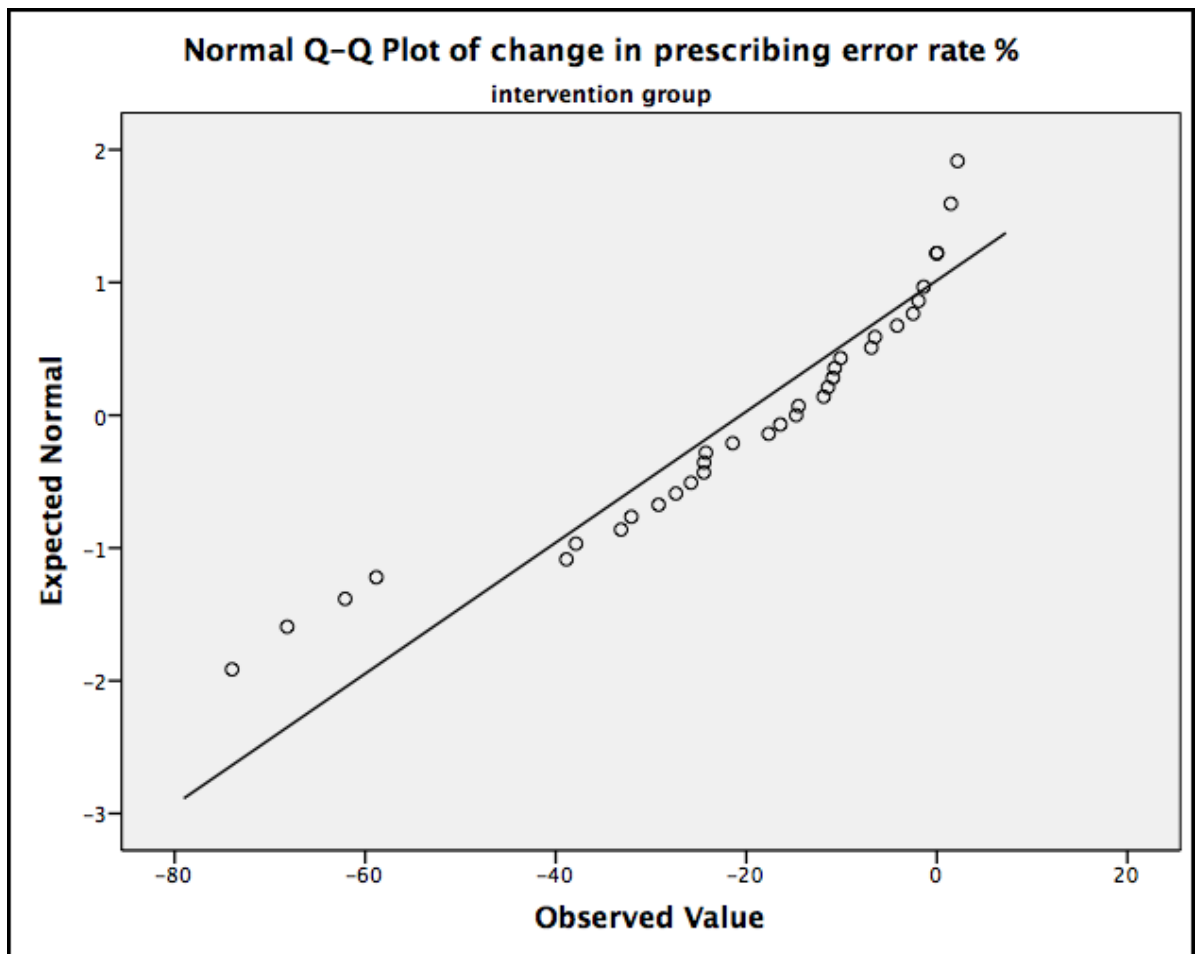
Figure 38: Probability plot for change in inpatient prescribing error rates for the control group
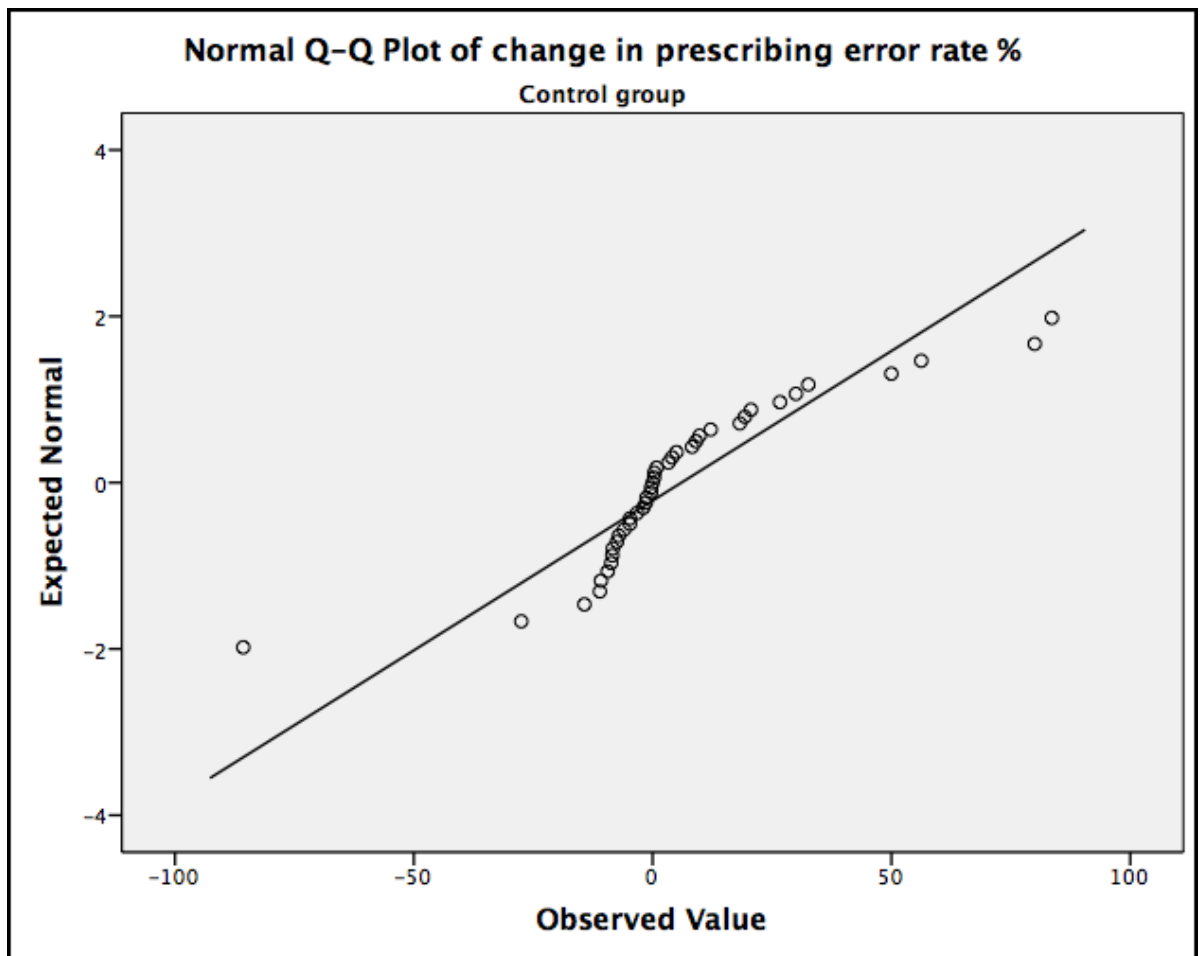
Although the t-test is robust to deviations from normality as described in chapter 3, transformation of the data was attempted before proceeding. Using a reflect and logarithmic transformation did not improve distribution of data (see figures 39-41 below)

Figure 39: Transformed data illustrating mean change in inpatient prescribing error rates for intervention and feedback groups
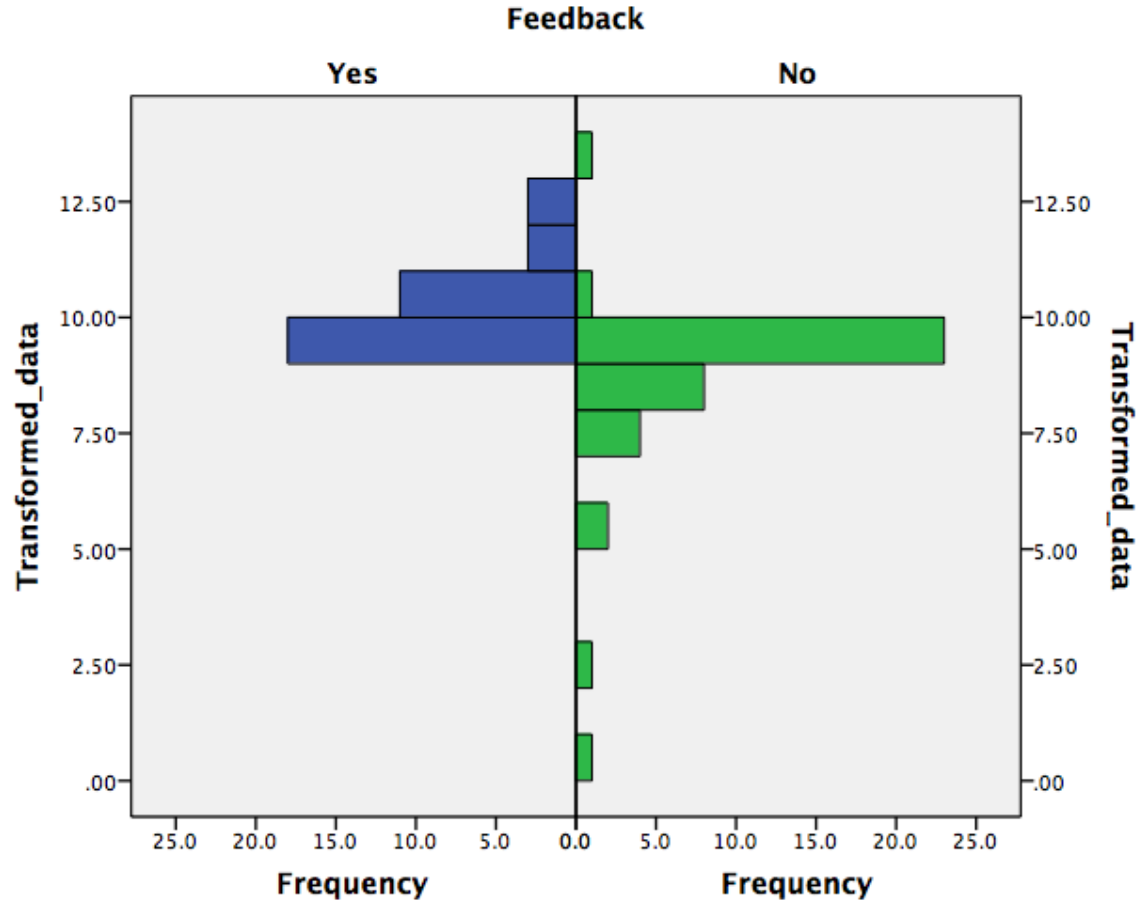
Figure 40: Probability plot for transformed change in inpatient prescribing error rates for the intervention group

Normal Q–Q Plot of Transformed_data
for Feedback= Yes
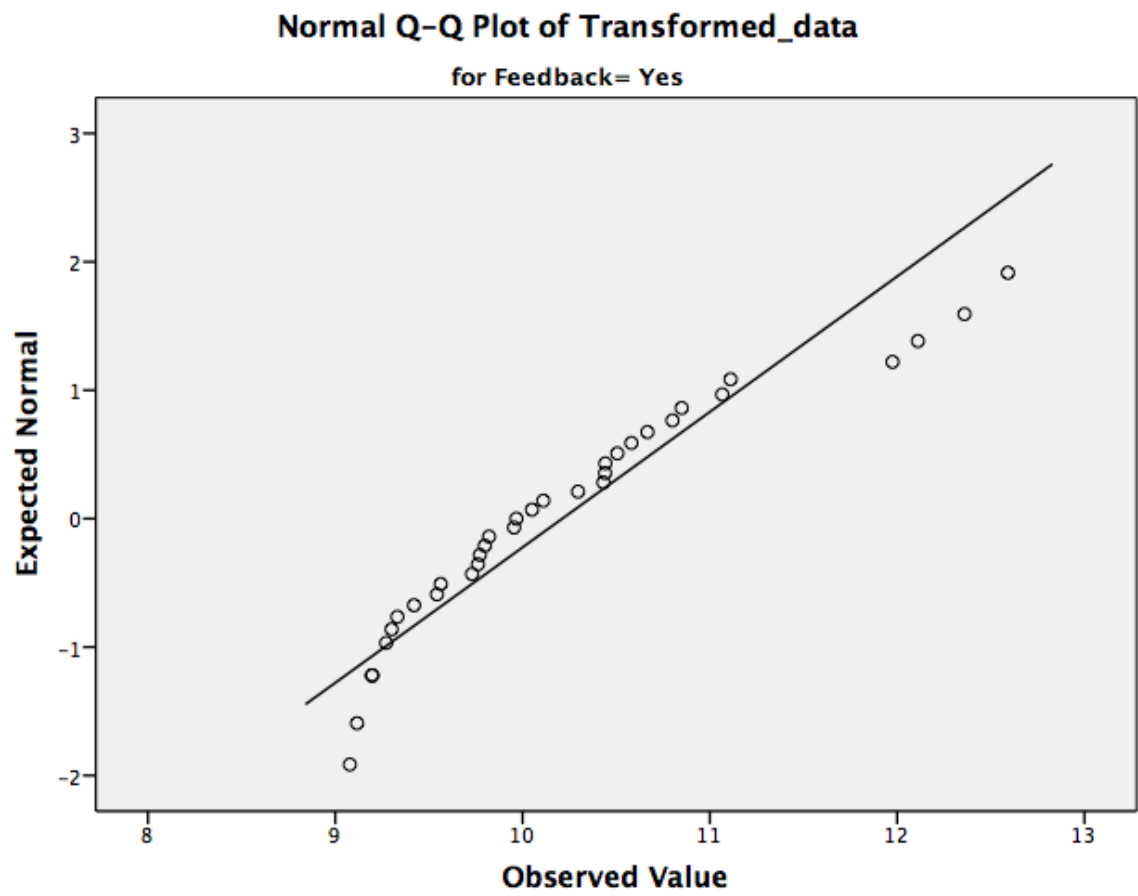
Figure 41: Probability plot for transformed change in inpatient prescribing error rates for the control group
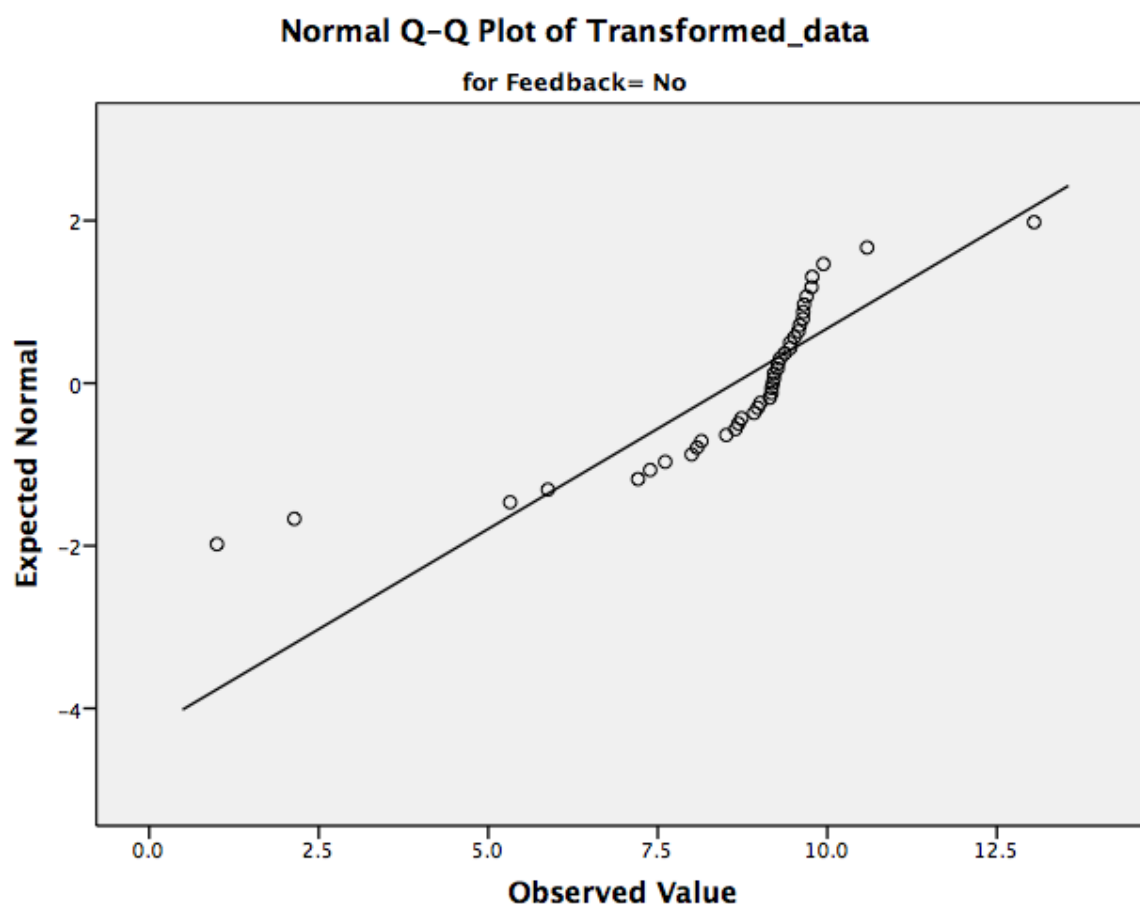
Considering this, the t-test was performed on the original data set, as although a Mann-Whitney U test could be performed, the t-test is robust to deviations from normality when sample sizes are greater than thirty.

Outliers

Seven outliers were identified from inspection of the box plots below (Figure 42). Manual inspection of the data suggested these were true outliers. Removal of the outliers produced a normal distribution for the control group but not for the intervention group (Shapiro-Wilk 0.055 and 0.008 respectively) although the normality plot was improved with a few data points above the normality line affecting the distribution. The t-test was performed with and

without the outliers with no change in significance of results as reported below.

Figure 42: Boxplot of mean change scores for inpatient prescribing in intervention and control groups
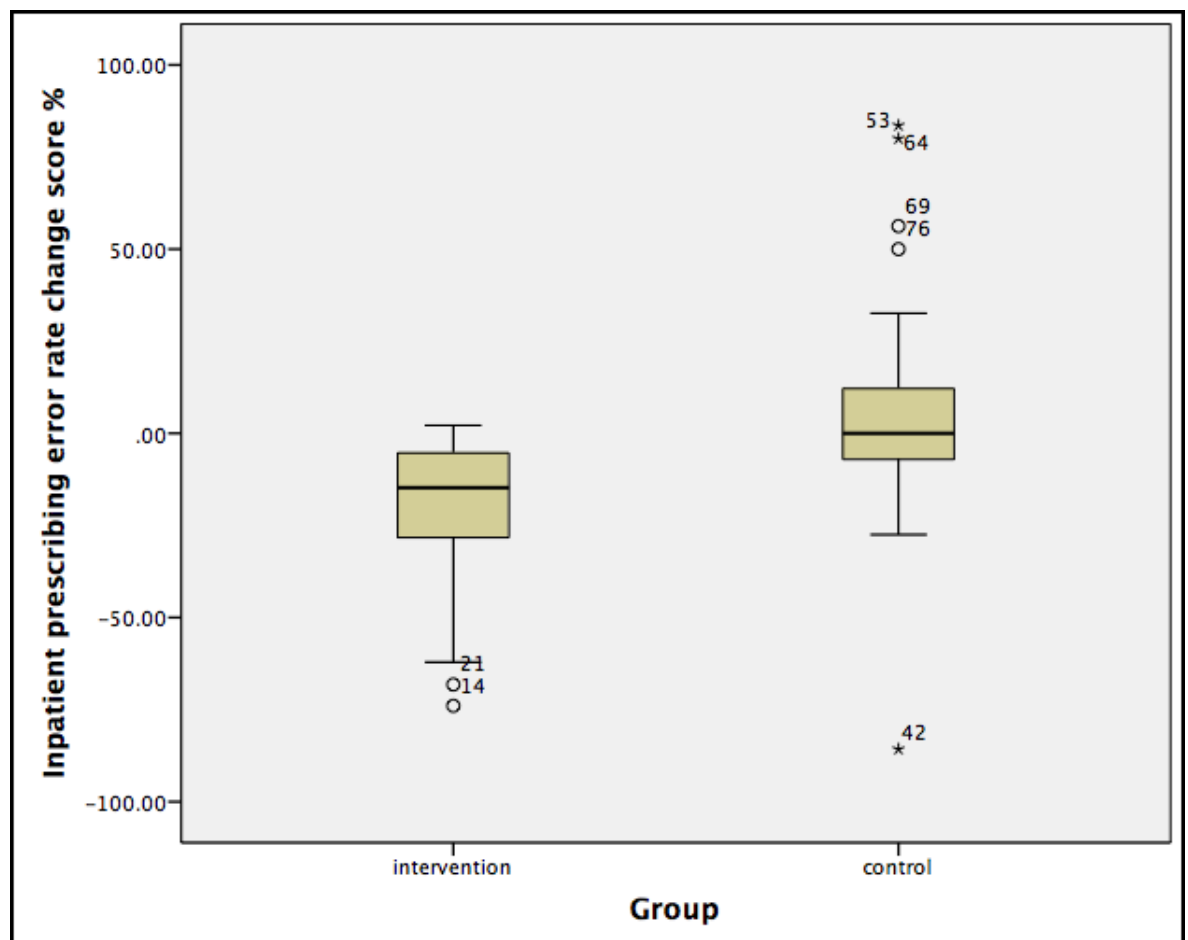
Homogeneity of variances

There was homogeneity of variances for mean difference in inpatient PE rates for the intervention and control groups, as assessed by Levene's test for equality of variances (p>0.05 at 0.533).

7.2.6.6. Results for change in inpatient prescribing error rates

Mean differences in inpatient PE rates were 26.6% (95% CI, -37.9% to -15.3, SD = +/- 5.7) statistically, significantly lower in the intervention group compared to the control group t(74)=-4.70, p<0.005 (0.000012). Effect size (d) = 1.09 (large effect size).

Removal of outliers had no significant outcome on the statistical test (-19.3% mean difference, SD 3.5, 95% CI -26.3 to -12.2) t(73)=-5.462, p<0.005, justifying their inclusion.

7.2.7. Impact of feedback on inpatient error free prescriptions

7.2.7.1. Sample size and descriptive statistics for inpatient EFPs

Prescribing data for EFPs per prescriber are presented in table 22 below.

There was an EFP rate of 52.5% (SD 28.6, 95% CI 42.7 to 62.3) at baseline and 72.9% (SD 22.6, 95% CI 65.1 to 80.7) post-intervention in the intervention group.

There was a 20.4% (95% CI, 10.6 to 30.1, SD 28.5) mean improvement in EFPs in the intervention group (n=35)

There was an EFP rate of 53% (SD 25.2, 95% CI 45.1 to 61.0) at baseline and 50.1% (SD 27.7, 95% CI 41.4 to 58.9) post-intervention in the control group

There was a reduction in EFP rate of 2.9% (95% CI, -14.5 to 8.8, SD 36.9,) in the control group (n=41).

Table 22: Prescribing data for inpatient error free prescriptions for intervention and control groups

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Post-EFP	Post-EFP (%)	Difference in EFP % pre - post
1	10	5	50.0	10	7	70.0	20.0
2	8	5	62.5	3	2	66.7	4.2
3	8	5	62.5	11	7	63.6	1.1
4	6	3	50.0	5	4	80.0	30.0
5	2	2	100	4	4	100.0	0
6	9	5	56.0	3	2	67.0	11.0
7	16	6	37.5	4	3	75.0	37.5
8	11	6	54.6	9	4	44.4	-10.2
9	5	4	0.8	5	3	60.0	-20.0
10	14	8	57.1	5	2	40.0	-17.1
11	31	8	25.8	11	6	54.6	28.8
12	10	5	50.0	11	6	54.6	4.6
13	11	6	54.6	11	9	81.8	27.2
14	4	1	25.0	24	18	75.0	50.0
15	8	6	75.0	22	19	86.4	11.4
16	4	3	75.0	21	14	66.7	-8.3
17	16	10	62.5	9	4	44.4	-18.1
18	5	1	20	9	7	77.8	57.8
19	26	17	65.4	1	1	100.0	34.6
20	15	9	60.0	21	17	81.0	21.0
21	5	3	60.0	1	1	100.0	40.0
22	8	8	100.0	2	2	100.0	0
23	3	0	0	8	5	62.5	62.5
24	18	11	61.1	6	6	100.0	38.9
25	4	0	0	1	0	0	0
26	4	0	0	1	1	100.0	100.0
27	*Prescriber excluded from analysis as no matched prescribing data						
28	5	1	20.0	6	5	83.3	63.3
29	5	3	60.0	2	1	50.0	-10.0
30	4	2	50.0	5	3	60.0	10.0
31	9	9	100.0	12	11	91.7	-8.3
32	2	0	0	8	6	75.0	75.0
33	3	2	66.7	10	9	90.0	23.3
34	11	8	72.7	1	1	100.0	27.3

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Post-EFP	Post-EFP (%)	Difference in EFP % pre - post
35	3	3	100.0	1	1	100.0	0
36	*Prescriber excluded from analysis as no matched prescribing data						
37	12	3	25.0	2	1	50.0	25.0
38	7	7	100.0	8	4	50.0	-50.0
39	3	1	33.3	11	6	54.6	21.3
40	9	5	55.6	11	3	27.3	-28.3
41	12	3	25.0	12	7	58.3	33.3
42	18	9	50.0	5	2	40.0	-10.0
43	3	2	66.7	10	3	30.0	-36.7
44	2	0	0	3	2	66.7	66.7
45	8	2	25.0	8	0	0	-25.0
46	5	3	60.0	4	1	25.0	-35.0
47	12	3	25.0	7	6	85.7	60.7
48	6	3	50.0	3	0	0	-50.0
49	5	4	80.0	8	6	75.0	-5.0
50	12	6	50.0	14	11	78.6	28.6
51	10	3	30.0	10	5	50.0	20.0
52	6	1	16.7	13	7	53.9	37.2
53	5	3	60.0	4	1	25.0	-35.0
54	5	2	40.0	8	6	75.0	35.0
55	10	4	40.0	2	0	0	-40.0
56	22	15	68.2	4	0	0	-68.2
57	4	3	75.0	1	1	100.0	25.0
58	4	3	75.0	16	6	37.5	-37.5
59	6	4	66.7	11	5	45.5	-21.2
60	4	0	0	6	4	66.7	66.7
61	2	1	50.0	4	3	75.0	25.0
62	5	2	40.0	15	12	80	40.0
63	8	4	50.0	7	2	28.6	-21.4
64	1	1	100.0	6	2	33.3	-66.7
65	13	9	69.2	8	7	87.5	18.3
66	12	6	50.0	2	0	0	-50.0
67	6	1	16.7	3	2	66.7	50.0
68	7	3	42.9	7	3	42.9	0
69	2	1	50.0	10	3	30.0	-20.0
70	6	5	83.3	8	5	62.5	-20.8

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Post-EFP	Post-EFP (%)	Difference in EFP % pre - post
71	4	1	25.0	4	1	25.0	0
72	9	5	55.56	6	4	66.7	11.1
73	14	10	71.4	8	4	50.0	21.4
74	8	6	75.0	6	4	66.7	-8.3
75	10	8	80.0	8	6	75.0	-5.0
76	9	7	77.8	6	6	100.0	22.2
77	9	4	44.4	7	5	71.4	27.0
78	2	2	100.0	4	2	50.0	20.0
Total	**620**	**330**			**563**	**349**	

7.2.7.2. Impact of feedback on inpatient error free prescription rates

7.2.7.3. Assumption testing for inpatient error free prescription rates

Normality of distribution

There was normality of distribution as assessed by inspection of the histograms (Figure 43) and normality plots (figures 44 and 45) and Shapiro-Wilk test with p values >0.05 for both intervention (0.086) and control (0.232) groups.

Figure 43: Histogram illustrating distribution of mean change in inpatient EFP % in both intervention and control groups
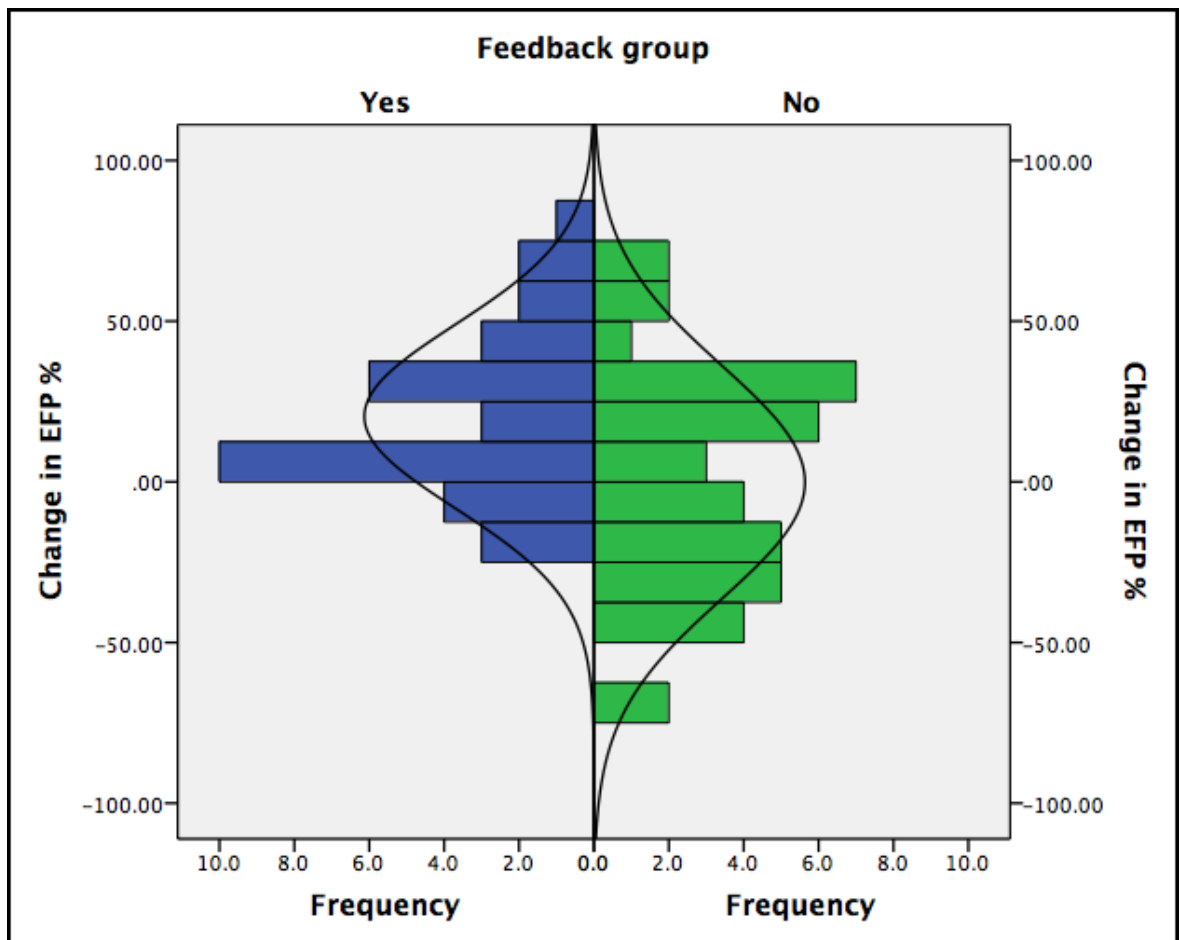
Figure 44: Probability plot for change in inpatient EFP % for the intervention group

Normal Q–Q Plot of change in EFP %
intervention group
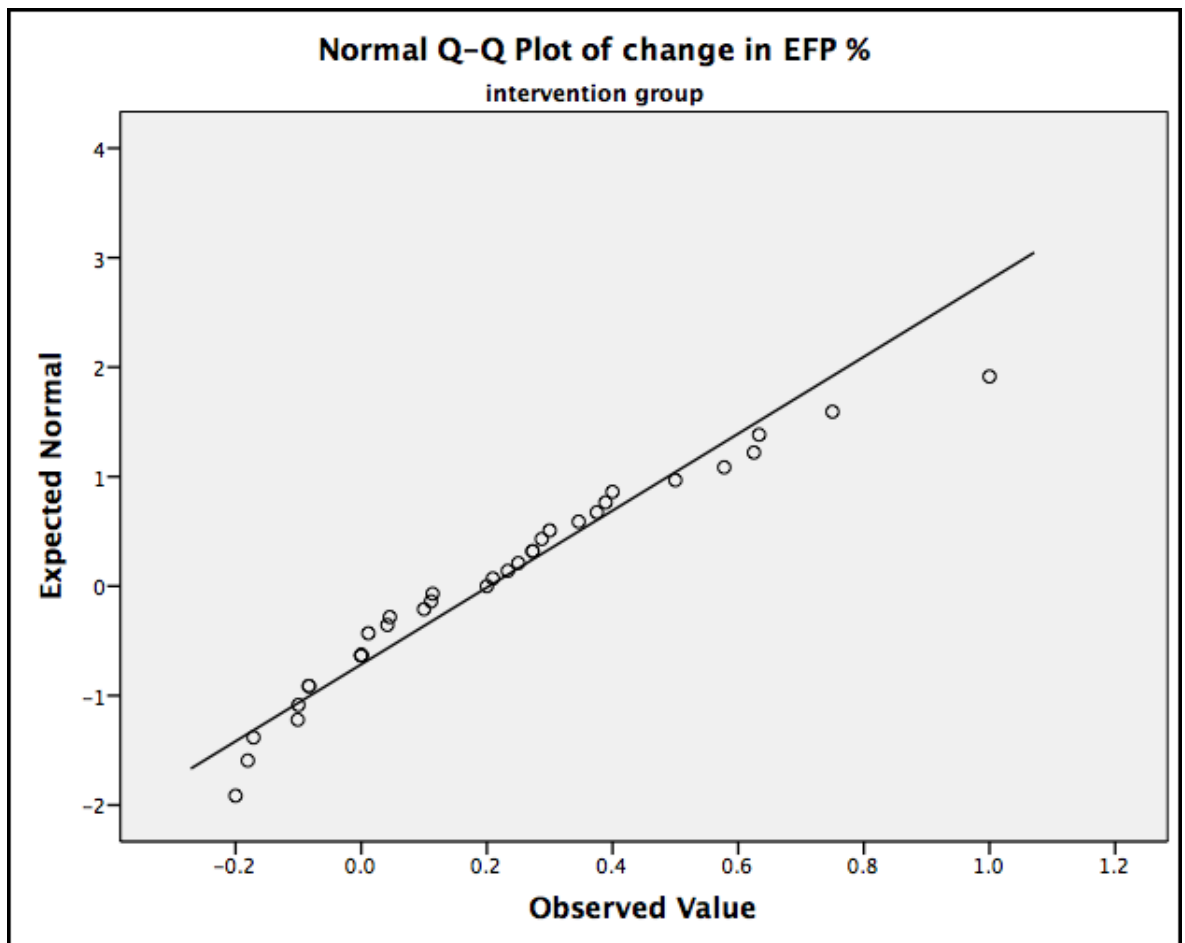
Figure 45: Probability plot for change in inpatient EFP % for the control group
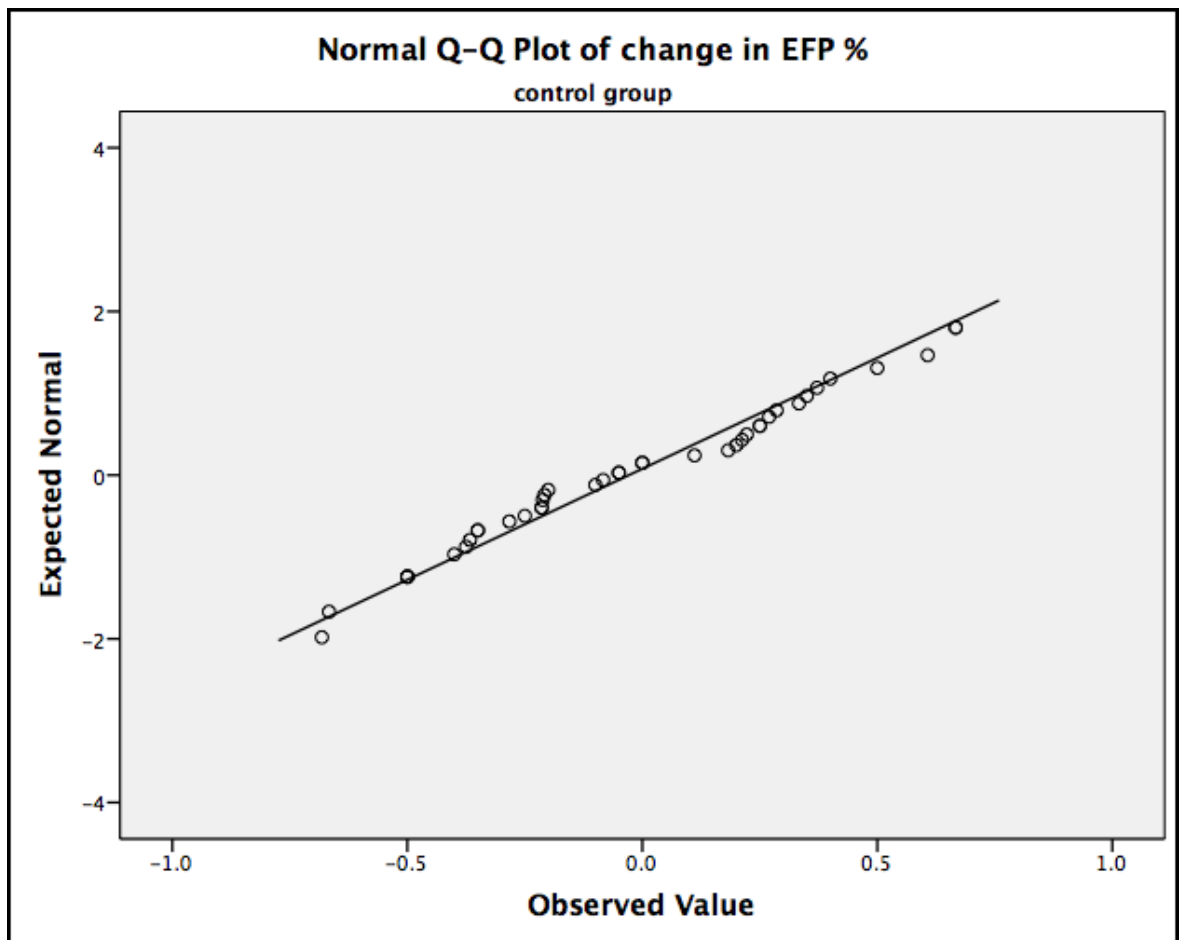
Outliers

One outlier (prescriber 26) was identified from inspection of the box plot below (see figure 46). Following inspection of the data manually, the test was performed with the outlier and repeated for sensitivity testing without the outlier with no difference in the statistical significance.

Figure 46: Box plot of change in inpatient EFP %
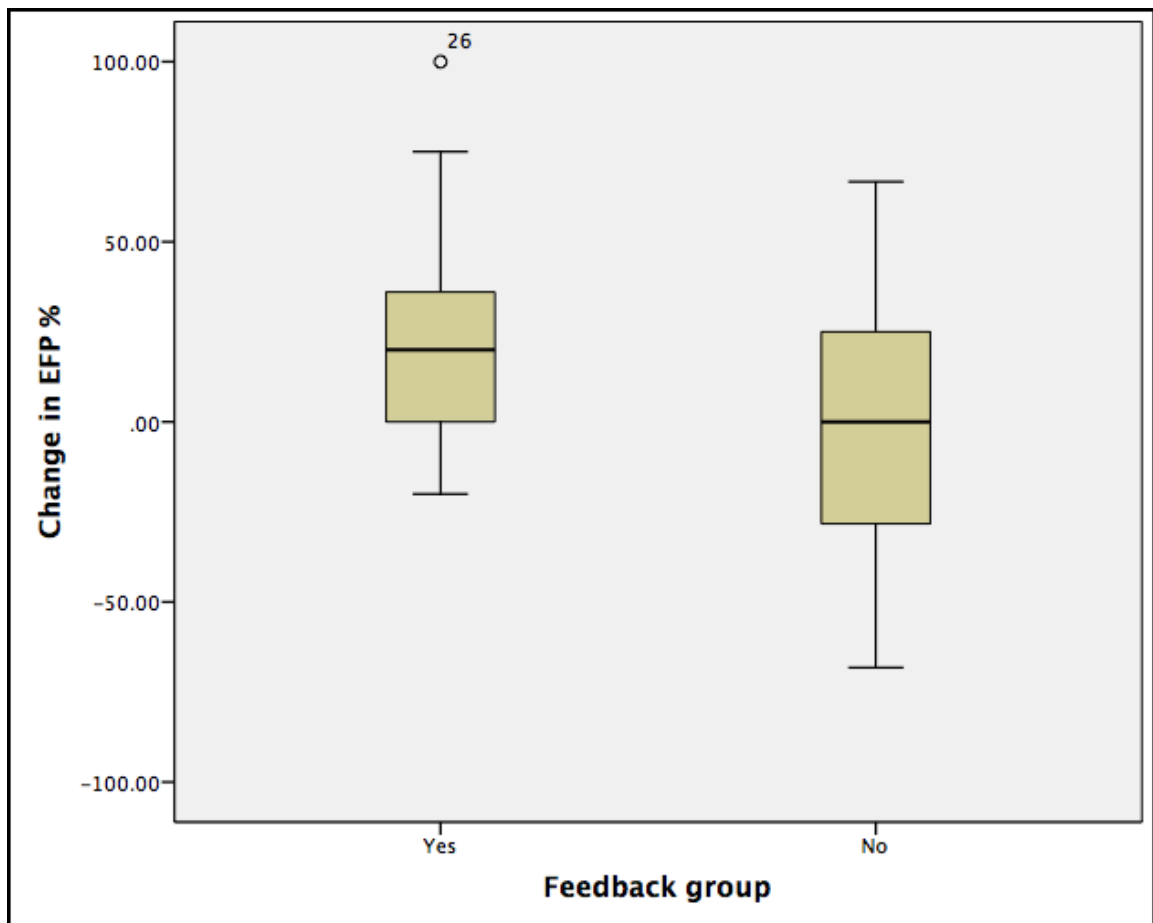
Homogeneity of variance

The assumption of homogeneity of variance was violated as determined by Levene's test (p<0.05 at 0.038). The independent t-test is robust to violations of this assumption and could be reported where the variations are not huge (p=0.038), hence the t-test could be reported or alternatively, Welch's t-test reported.

7.4.7.4. Results for change in inpatient error free prescription rates

The intervention group had a statistically significantly higher mean change in EFP prescription rate compared to the control group with a mean difference of 23.23% (SD 7.7, 95% CI 8.0 to 38.5), t(74) = 3.033, p<0.005 (0.003). Effect size (d) = 0.70 (medium effect size).

Comparing the alternative Welch's t-test for unequal variances, the results are still significant with a mean improvement of 23.2% (± 7.6 95% CI 8.3 to 38.2) in EFP rates compared to the control group, t(73.313)= 3.095, p < 0.05 (0.0033) reported.

Performing the t-test without the outlier (prescriber 26) produced a mean difference of -20.8% (SD ± 7.5, 95% CI 6.0 to 35.7) between groups that was still statistically significant: t (73) = 2.8, p < 0.05 (0.007) justifying inclusion of the outlier.

7.2.8. Impact of feedback on discharge prescribing

7.2.8.1. Sample size and descriptive statistics

A summary of discharge prescribing data for control and intervention groups at baseline and post-test is summarised in table 23.

Table 23: Overview of prescribing error data for discharge prescribing in intervention and control groups

Group	Pre-items	Pre-errors	Pre-error rate %	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre-post (%)	Chi-square and p-value
Intervention	1709	386	22.6	1794	83	4.6	-18.0	$\chi 2(1)$ =192, p = <0.005, φ=0.219
Control	591	97	16.4	828	220	26.6	+10.2	$\chi 2(1)$ =13.2, p = <0.005, φ= -0.087
Total	2300	483		2658	303			

Pre-test

A total of 330 discharge prescriptions were audited at baseline, 145 of which were error free (43.9%), with 2300 items prescribed and 483 PEs identified. An overall prescribing error rate of 21%.

There were 204 discharge prescriptions in the intervention group, with 75 error free (36.8%). There were 1709 prescribed items with 386 PEs, an overall prescribing error rate of 22.6%.

There were 126 discharge prescriptions in the control group, with 70 error free (55.6%). There were 591 prescribed items with 97 prescribing errors, an overall PE rate of 16.4%.

Post-test

A total of 350 discharge prescriptions were audited post-test, with 192 error free (54.9%). There were 2658 prescribed items and 303 prescribing errors identified. An overall PE rate of 11.4%.

There were 185 discharge prescriptions in the intervention group, with 126 error free (68.1%). There were 1794 prescribed items with 83 PEs, an overall PE rate of 4.6%.

There were 165 discharge prescriptions in the control group, with 66 error free (40%). There were 828 prescribed items and 220 PEs, an overall PE rate of 26.6%.

7.2.8.2. Analysis of discharge prescription error frequency

Using chi squared test, there was a statistically significant reduction in error frequency in the intervention group (p<0.005) and a significant increase in error frequency in the control group (p=<0.005). Between groups, there was

a statistically significant difference in error frequency at baseline χ2(1) =6.8, p = 0.009, φ =0.049 and post-intervention (χ2(1) =204.4, p = <0.005, φ =-0.263)

7.2.8.3. Impact of feedback on discharge prescriber error rates

7.2.8.4. Sample size and descriptive statistics for discharge PE rates

A summary of discharge prescribing data per prescriber is summarised in table 24 below.

The intervention group included 28 prescribers. Nine prescribers (5, 12, 21, 22, 25, 31, 32, 35 and 36) were excluded from the analysis as they did not have comparative discharge prescriptions at either baseline, post-intervention or both.

The mean discharge PE rate was 22.4% (SD 12.2, 95% CI 17.7 to 27.1) at baseline and 4.0% (SD 4.3, 95% CI 2.4 to 5.7) post-intervention for the intervention group. A mean reduction in PE rates of -18.4% (SD 12.5, 95% CI -23.2 to -13.6) in the intervention group.

The control group consisted of 29 prescribers. Twelve prescribers (38, 60, 69-78) were excluded from the analysis as they did not have comparative discharge prescriptions at either baseline, post-intervention or both.

The mean discharge PE rate was 16.1% (SD 12.6, 95% CI 11.3 to 20.9) at baseline and 27.3% (SD 13.0, 95% CI 22.4 to 32.3) post-intervention for the control group. A mean increase in PE rates of 11.2 % (SD 15, 95% CI 5.5 to 16.9) in the control group.

Table 24: Discharge prescribing data per prescriber

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre-post
1	46	6	13.0	85	2	2.4	-10.6
2	48	6	12.5	42	2	4.8	-7.7
3	124	57	46.0	45	1	2.2	-43.8
4	123	46	37.4	144	6	4.2	-33.2
5	*Prescriber excluded from analysis as no matched prescribing data						
6	45	10	22.2	38	1	2.6	-19.6
7	40	10	25.0	142	15	10.6	-14.4
8	45	15	33.3	8	0	0	-33.3
9	14	8	57.1	17	0	0	-57.1
10	35	7	20.0	67	2	3.0	-17.0
11	76	28	36.8	43	8	18.6	-18.2
12	*Prescriber excluded from analysis as no matched prescribing data						
13	141	19	13.5	68	1	1.5	-12.0
14	144	26	18.1	100	2	2	-16.1
15	69	9	13.0	85	1	1.2	-11.8
16	158	27	17.1	264	14	5.3	-11.8
17	53	18	34.0	53	3	5.7	-28.3
18	51	11	21.6	51	4	7.8	-13.8
19	125	18	14.4	13	0	0	-14.4
20	19	3	15.8	186	7	3.8	-12.0
21	*Prescriber excluded from analysis as no matched prescribing data						
22	*Prescriber excluded from analysis as no matched prescribing data						
23	21	3	14.3	70	4	5.7	-8.6
24	55	3	5.5	45	2	4.4	-1.1

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre-post
25	*Prescriber excluded from analysis as no matched prescribing data						
26	6	2	33.3	14	0	0	-33.3
27	8	0	0	5	0	0	0
28	110	23	20.9	59	3	5.1	-15.8
29	44	8	18.2	13	0	0	-18.2
30	37	7	18.9	21	0	0	-18.9
31	*Prescriber excluded from analysis as no matched prescribing data						
32	*Prescriber excluded from analysis as no matched prescribing data						
33	37	7	18.9	92	3	3.3	-15.6
34	30	8	26.7	16	1	6.3	-20.4
35	*Prescriber excluded from analysis as no matched prescribing data						
36	*Prescriber excluded from analysis as no matched prescribing data						
37	5	1	20.0	8	1	12.5	-7.5
38	*Prescriber excluded from analysis as no matched prescribing data						
39	24	2	8.3	25	6	24.0	15.7
40	3	0	0	19	5	26.3	26.3
41	3	0	0	13	3	23.1	23.1
42	56	20	35.7	5	2	40.0	4.3
43	25	7	28	20	8	40.0	12.0
44	6	1	16.7	25	3	12.0	-4.7
45	17	3	17.7	12	8	66.7	49.0
46	7	0	0	11	2	18.2	18.2
47	18	1	5.6	6	1	16.7	11.1

Prescriber	Pre-items	Pre-errors	Pre-error rate%	Post-items	Post-errors	Post-error rate (%)	Difference in error rate Pre-post
48	*Prescriber excluded from analysis as no matched prescribing data						
49	10	2	20.0	39	6	15.4	-4.6
50	41	4	9.8	60	17	28.3	18.5
51	8	1	12.5	10	3	30.0	17.5
52	24	3	12.5	8	2	25.0	12.5
53	9	3	33.3	30	10	33.3	0
54	8	2	25.0	19	6	31.6	6.6
55	35	9	25.7	25	11	44.0	18.3
56	10	1	10.0	31	3	9.7	-0.3
57	8	0	0	14	5	35.7	35.7
58	13	2	15.4	17	3	17.7	2.3
59	13	2	15.4	50	10	20.0	4.6
60	*Prescriber excluded from analysis as no matched prescribing data						
61	8	2	25.0	4	1	25.0	0
62	66	9	13.6	53	5	9.4	-4.2
63	22	4	18.2	78	37	47.4	29.2
64	9	4	44.4	3	1	33.3	-11.1
65	11	2	18.2	55	5	9.1	-9.1
66	46	3	6.5	30	4	13.3	6.8
67	61	3	4.9	17	6	35.3	30.4
68	14	0	0	50	14	28.0	28.0
69	16	7	43.8	99	33	33.3	-10.5
Total	2300	483		2658	303		

7.2.8.5. Assumption testing for discharge prescribing PE rates

Normality of distribution

The Shapiro-Wilk test indicated non-normality for the intervention group (p=0.03) and normality for the control group (p=0.443). Transformation of the data did not improve the histograms or Shapiro-Wilk test results. Inspection of the histogram (figure 47) and normality plots (Figures 48 and 49) would suggest that the intervention group could be approximated to a normal distribution with a mild negative skew caused by a few residuals above the normal line. Removal of outliers (see figure 50) normalized the distribution (Figures 51-53) with Shapiro-Wilk values of 0.506 and 0.426 in the intervention and control groups. Considering the robustness of the independent t-test to outliers, the t-test was performed with the outliers and repeated without them as a measure of sensitivity with no difference in the significance of the t-test reported.

Figure 47: Histogram illustrating distribution of control and intervention group mean change in discharge prescribing error rates
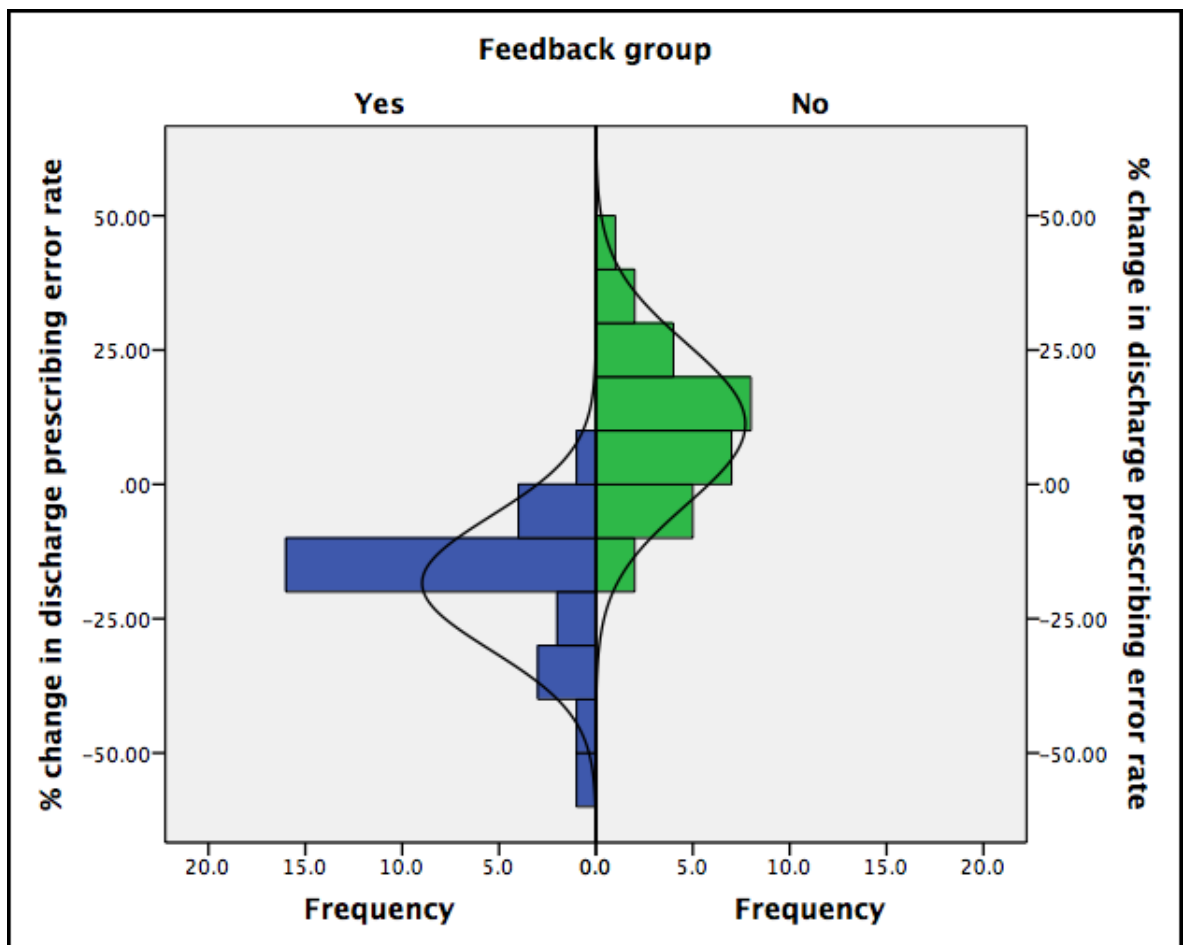
Figure 48: Probability plot for intervention group mean change in discharge prescribing error rate

Normal Q–Q Plot of % change in prescribing error rates
Intervention
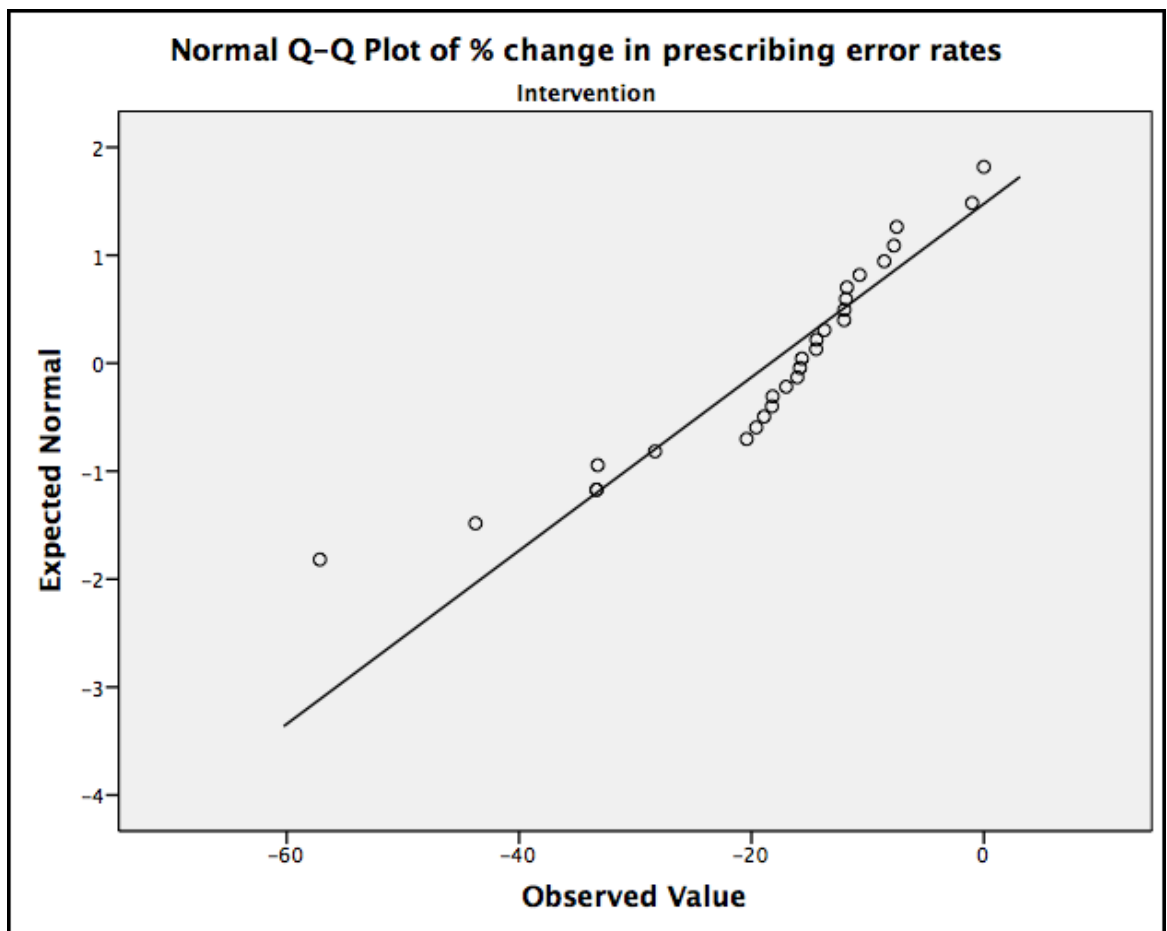
Figure 49: Probability plot for control group mean change in discharge prescribing error rate

Normal Q–Q Plot of % change in discharge prescribing error rates
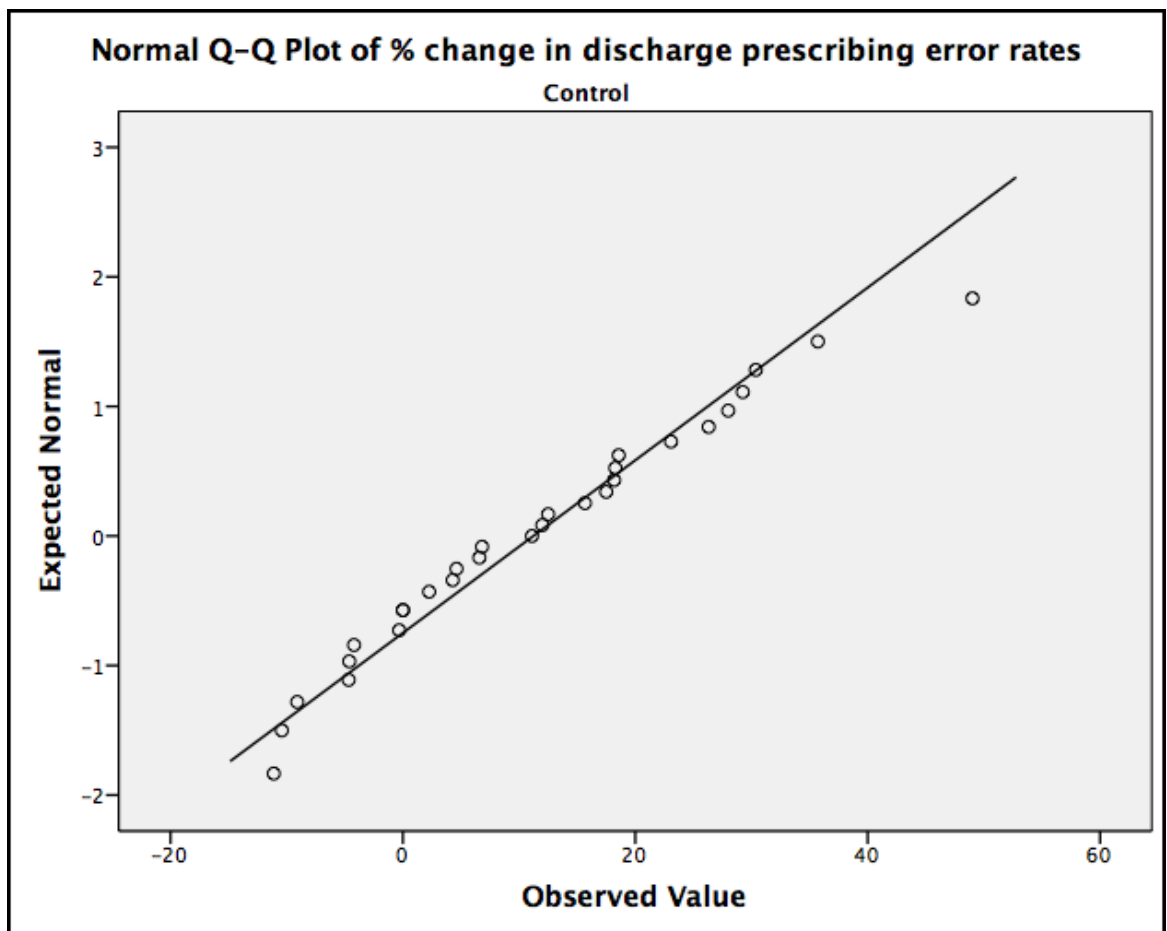
Figure 50: Boxplot of mean change in prescribing error rates for discharge prescribing in intervention and control groups
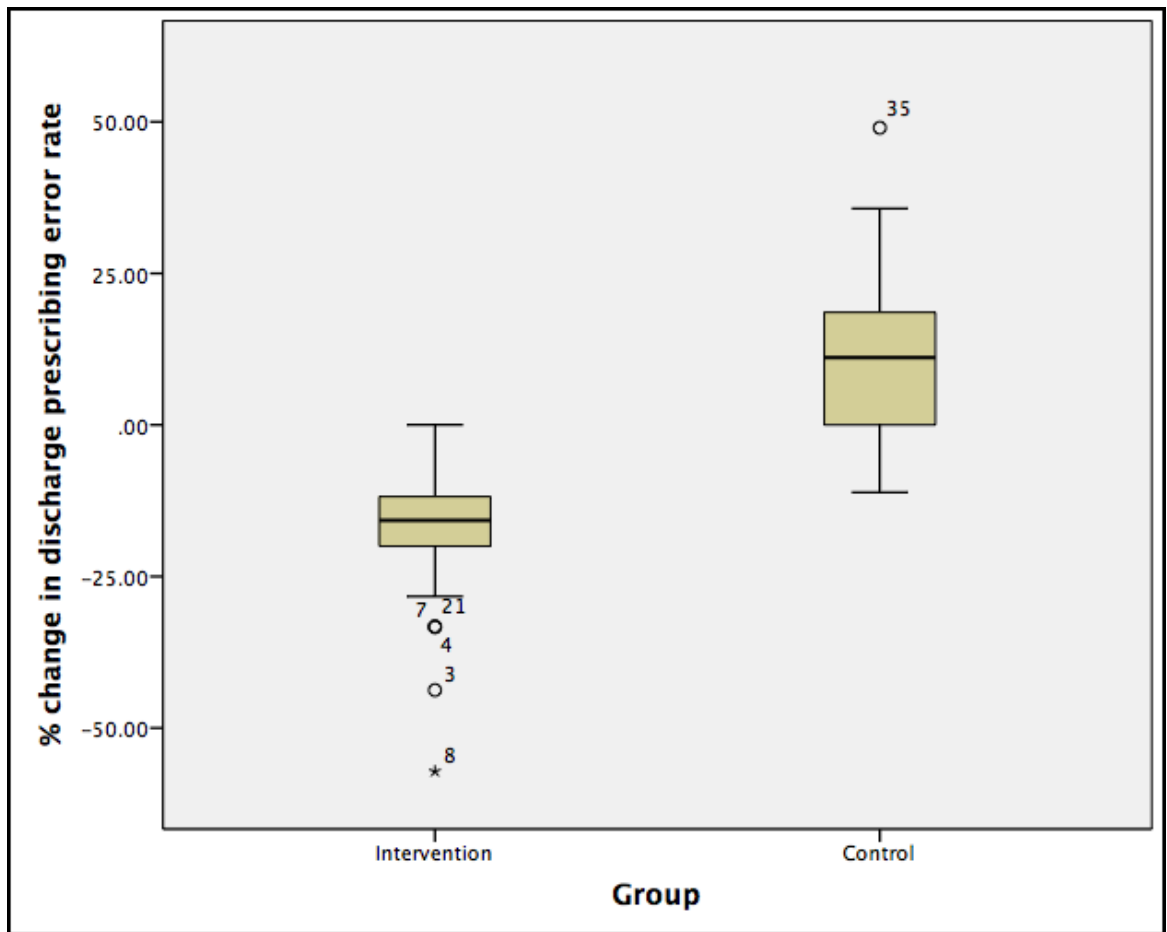
Six outliers were identified from visual inspection of the box plot (see figure 50) for discharge prescribing data. Five prescribers (prescribers 3, 4, 8, 9 and 26) were in the intervention group and one in the control group (prescriber 45). Removal of outliers produced normality of distribution as demonstrated by Shapiro-Wilk values (0.506 and 0.426 for intervention and control groups) and inspection of normality plots and histograms (figures 51-53).

Figure 51: Probability plot for mean change in discharge prescribing error rate without outliers for the intervention group

Normal Q–Q Plot of % change in discharge prescribing error rates
intervention group
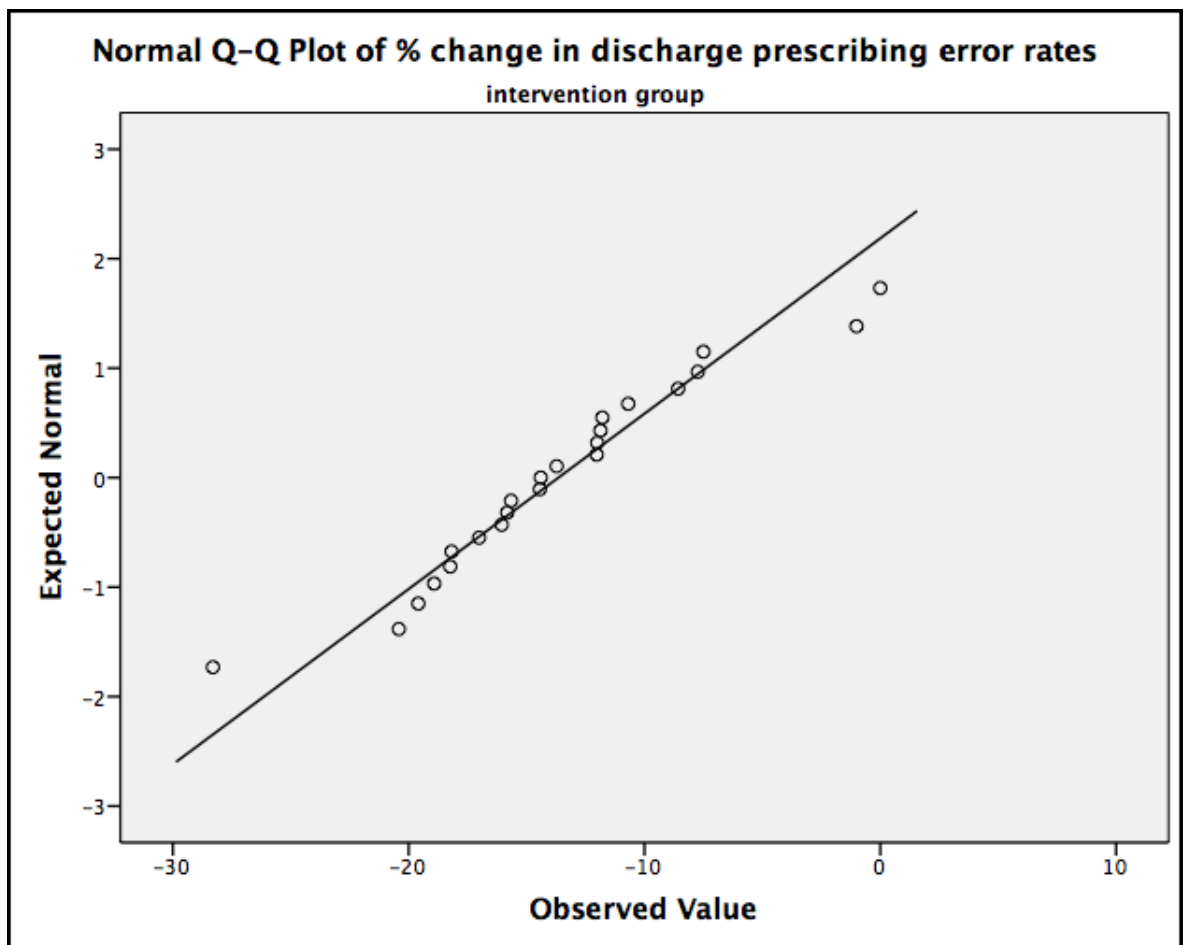
Figure 52: Probability plot for mean change in discharge prescribing error rate without outliers for the control group

Normal Q–Q Plot of % change in discharge prescribing error rates
control group
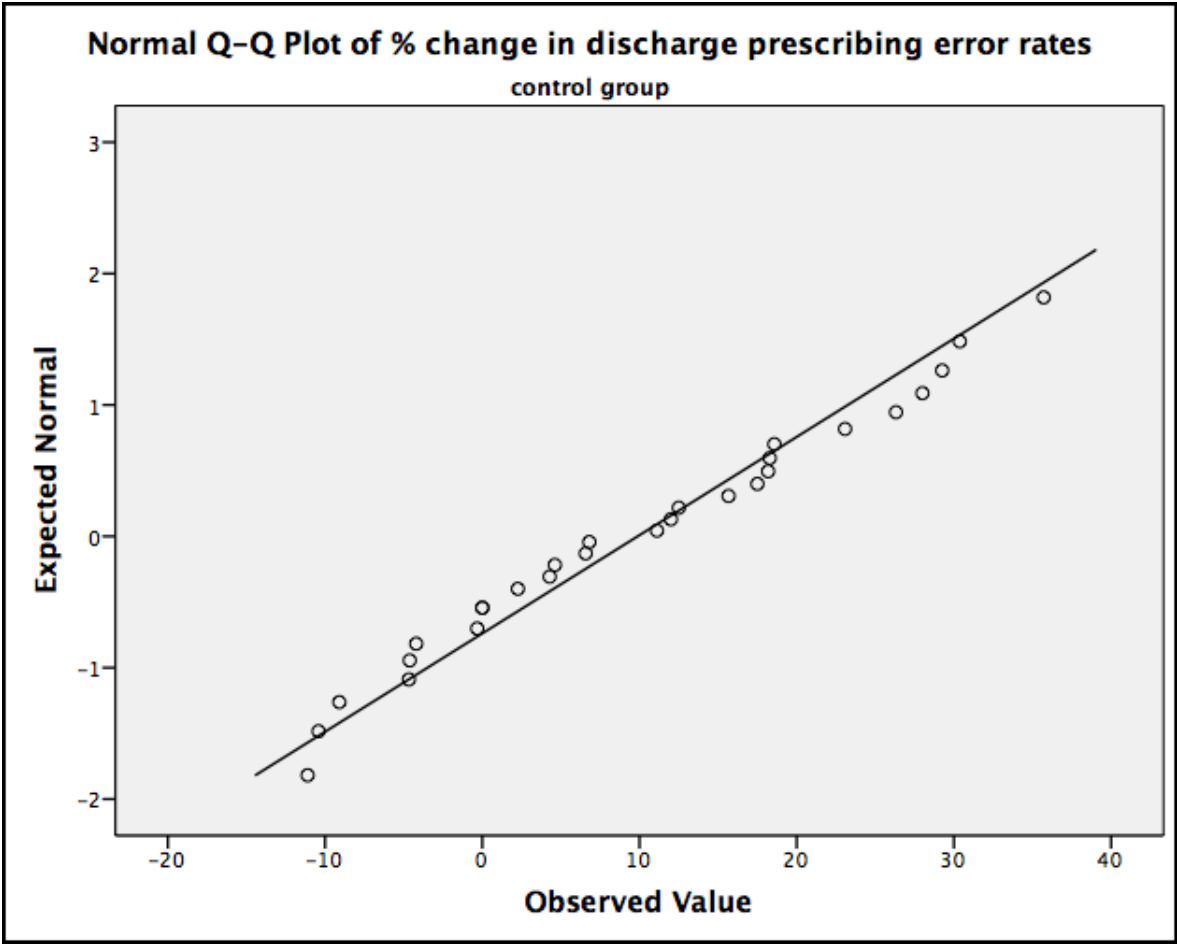
Figure 53: Histogram illustrating distribution of control and intervention group mean change in discharge prescribing error rates without outliers
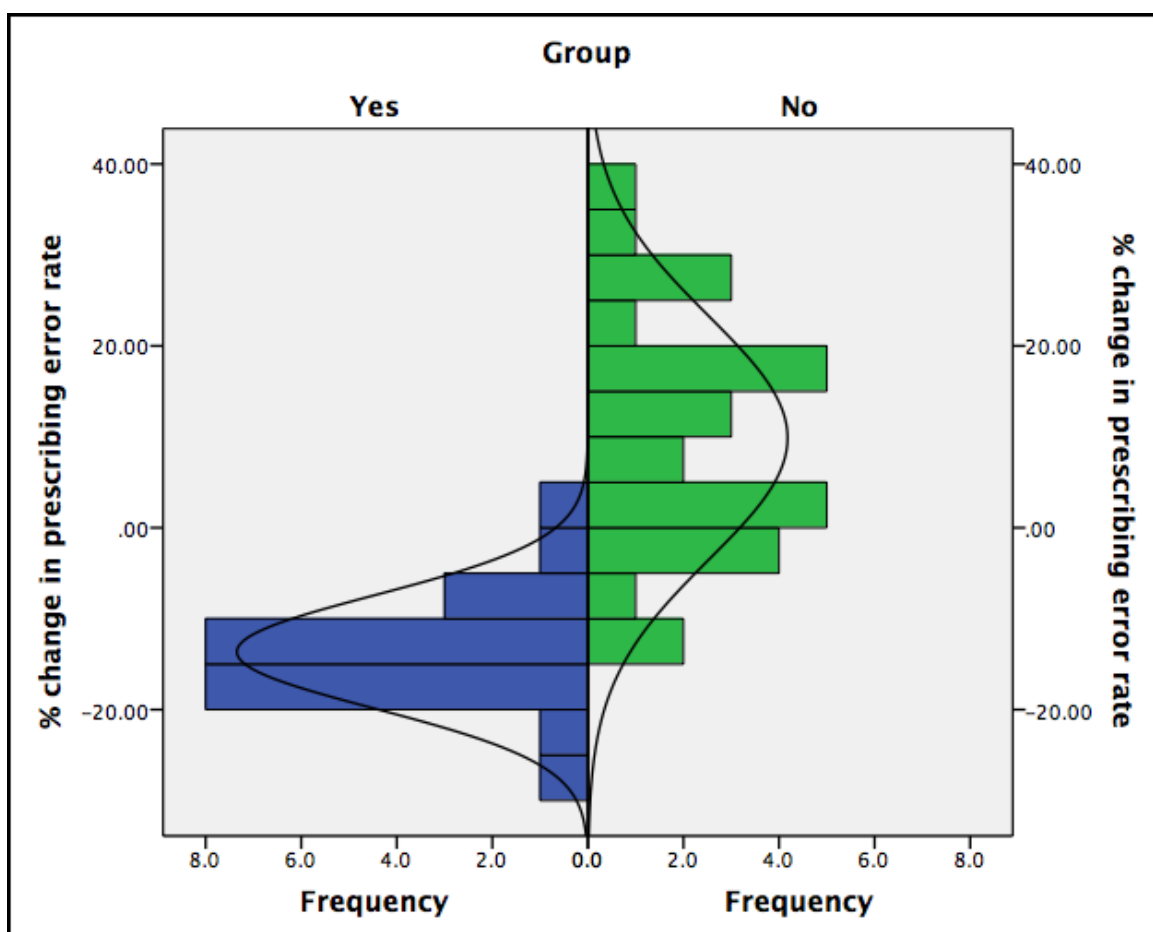
7.2.8.6. Results for change in discharge PE rates

Homogeneity of variances was demonstrated from the Levene's test for equality of variances (p= 0.131). There was a statistically significant difference in mean change of PE rates in the intervention compared to the control group, mean difference=-29.6% (SD 3.7, 95% CI -37.0 to -22.3), t(55) = -8.094, p <0.005. Effect size (d)=2.15 (large effect size).

Sensitivity test

The t-test was performed without the outliers. Mean PE rates decreased by 13.6% (SD 6.2, 95% CI -16.4 to -11.0) in the intervention group and

increased by 9.9% (SD 13.4, 95% CI 4.7 to 15.1) in the control group. There was a statistically significant difference in the mean change in PE rate of -23.5% (SD 3.0, 95% CI -29.6 to -17.4) t(49)=-7.765, p<0.005. However, as the equality of variance was violated (P<0.05) Welch's test should also be reported as a mean difference -23.3% (SD 2.8, 95% CI -29.3 to -17.8), t(39.801)=-8.28, p<0.005. As the result was still significant, inclusion of the above outliers can be justified.

7.2.9. Impact of feedback on error free discharge prescriptions

7.2.9.1 Sample size and descriptive statistics

Prescribing data for discharge EFPs per prescriber are presented in table 25 below. A total of 57 prescribers were included in the analysis, 28 in the intervention group and 29 in the control group

The mean discharge EFP rate was 37.2% (SD 25.0, 95% CI 27.5 to 46.9) at baseline and 70.6% (SD 25.5, 95% CI 60.7 to 80.5) post-intervention for the intervention group. A mean improvement in EFP rates of 33.4%, SD 37.7, 95% CI 18.7 to 48.0).

The mean discharge EFP rate was 49.1% (SD 35.5, 95% CI 35.5 to 62.6) at baseline and 34.3% (SD 28.4, 95% CI 23.5 to 45.1) post-intervention for the control group. A mean decrease in EFP rates of 14.8%, SD 43.2, 95% CI -31.3 to 1.6).

Table 25: Error free discharge prescriptions for prescriber

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Pre-EFP	Post-EFP (%)	Difference in EFP % pre-post
1	8	5	62.5	11	10	90.9	28.4
2	9	4	44.4	5	3	60.0	15.6
3	18	4	22.2	4	3	75.0	52.8
4	16	4	25.0	16	10	62.5	37.5
5	*Prescriber excluded from analysis as no matched prescribing data						
6	7	4	57.1	3	2	66.7	9.6
7	3	0	0	26	20	76.9	76.9
8	8	1	12.5	1	1	100.0	87.5
9	3	0	0	2	2	100.0	100
10	7	4	57.1	6	4	66.7	9.6
11	10	3	30.0	3	2	66.7	36.7
12	*Prescriber excluded from analysis as no matched prescribing data						
13	12	4	33.3	8	7	87.5	54.17
14	13	5	38.5	10	8	80.0	41.5
15	8	4	50.0	9	8	88.9	38.9
16	17	7	41.2	21	8	38.1	-3.1
17	7	3	42.9	5	2	40.0	-2.9
18	5	3	60.0	5	2	40.0	-20.0
19	10	6	60.0	1	1	100.0	40.0
20	3	2	66.7	15	11	73.3	6.6
21	*Prescriber excluded from analysis as no matched prescribing data						
22	*Prescriber excluded from analysis as no matched prescribing data						
23	2	0	0	7	4	57.1	57.1
24	4	3	75.0	5	3	60.0	-15.0
25							0
26	1	0	0	2	2	100.0	100.0
27	1	1	100.0	1	1	100.0	0
28	11	3	27.3	3	1	33.3	6.0
29	6	1	16.7	2	2	100.0	83.3
30	4	1	25.0	3	3	100.0	75.0
31	*Prescriber excluded from analysis as no matched prescribing data						
32	*Prescriber excluded from analysis as no matched prescribing data						
33	4	1	25.0	8	5	62.5	37.5
34	5	1	20.0	2	1	50.0	30.0
35	*Prescriber excluded from analysis as no matched prescribing data						

Prescriber	Pre-prescriptions	Pre-EFP	Pre-EFP %	Post-prescriptions	Pre-EFP	Post-EFP (%)	Difference in EFP % pre-post
36	*Prescriber excluded from analysis as no matched prescribing data						
37	2	1	50.0	1	0	0	-50.0
38	*Prescriber excluded from analysis as no matched prescribing data						
39	11	9	81.8	10	5	50.0	-31.8
40	3	3	100.0	6	1	16.7	-83.3
41	1	1	100.0	2	1	50.0	-50.0
42	16	9	56.3	3	1	33.3	-22.9
43	4	1	25.0	6	0	0	-25.0
44	4	3	75.0	7	4	57.1	-17.9
45	10	7	70.0	6	0	0	-70.0
46	3	3	100	7	5	71.4	-28.6
47	7	6	85.7	3	2	66.7	-19.0
48	*Prescriber excluded from analysis as no matched prescribing data						
49	2	0	0	8	5	62.5	62.5
50	6	4	66.7	9	2	22.2	-44.4
51	2	1	50.0	3	0	0	-50.0
52	3	1	33.3	3	1	33.3	0
53	5	2	40.0	11	6	54.6	14.6
54	3	2	66.7	6	2	33.3	-33.34
55	4	0	0	4	0	0	0
56	2	1	50.0	8	6	75.0	25.0
57	4	4	100.0	2	0	0	-100.0
58	4	2	50.0	4	3	75.0	25.0
59	3	1	33.3	8	5	62.5	29.2
60	*Prescriber excluded from analysis as no matched prescribing data						
61	2	0	0	1	0	0	0
62	10	4	40.0	9	5	55.6	15.6
63	2	0	0	8	2	25.0	25.0
64	1	0	0	1	0	0	0
65	2	0	0	7	5	71.4	71.4
66	4	2	50.0	5	3	60.0	10.0
67	6	3	50.0	2	0	0	-50.0
68	1	1	100	5	0	0	-100.0
69	1	0	0	11	2	18.2	18.2
Total	330	145	43.9%	350	192	54.9%	

7.2.9.2. Impact of feedback on error free discharge prescription rates

7.2.9.3. Assumption testing for error free discharge prescription rates

Normality of distribution

There was normality of distribution as demonstrated by inspection of the histogram (Figure 54) and normality plots (Figures 55 and 56) and the Shapiro-Wilk test having a p>0.05 (0.740 for intervention group and 0.661 for control groups).

Figure 54: Histogram illustrating distribution of control and intervention group change in error free prescriptions percentage
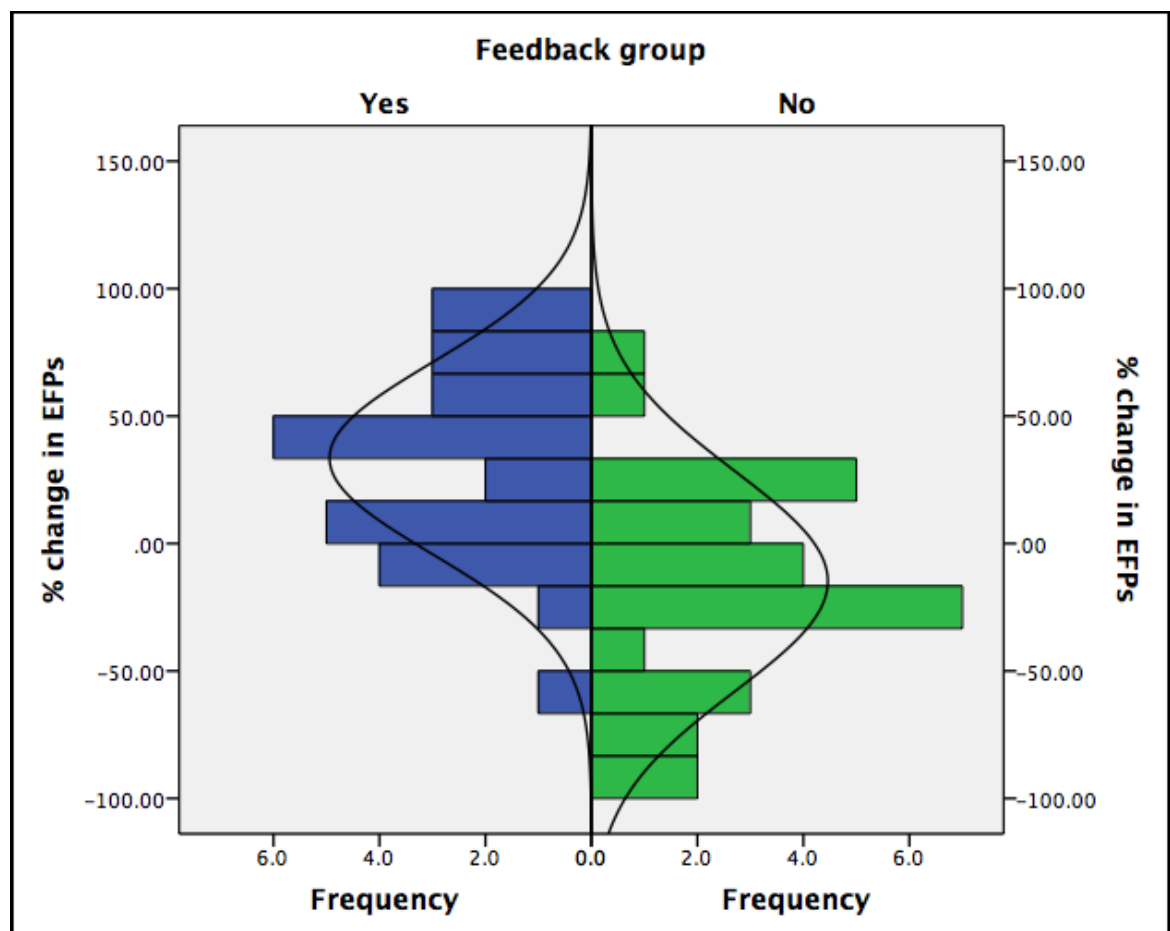
Figure 55: Probability plot for intervention group mean change in EFP rate

Normal Q-Q Plot of % change in EFPs at discharge
Intervention group
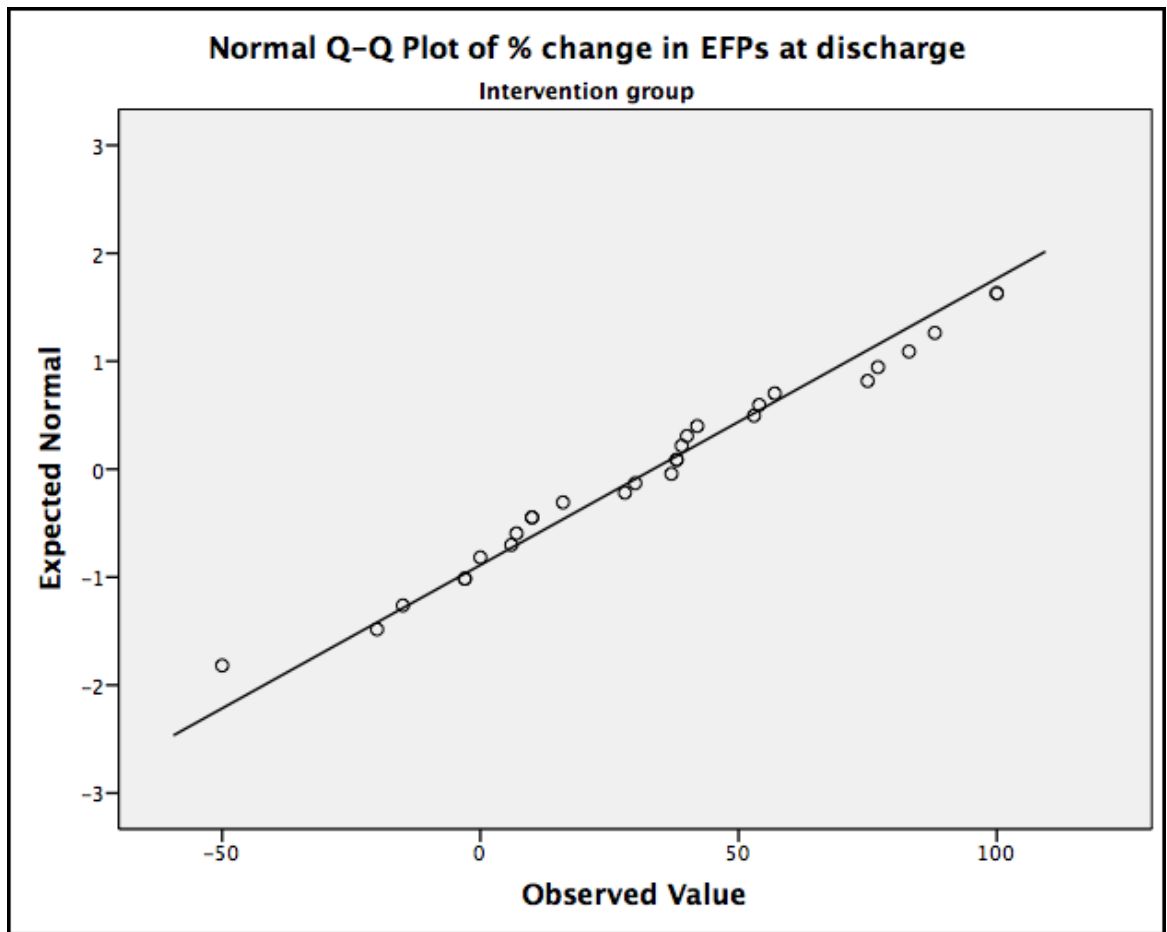
Figure 56: Probability plot for control group mean change in discharge EFP rate

Normal Q-Q Plot of % change in EFPs at discharge
control group
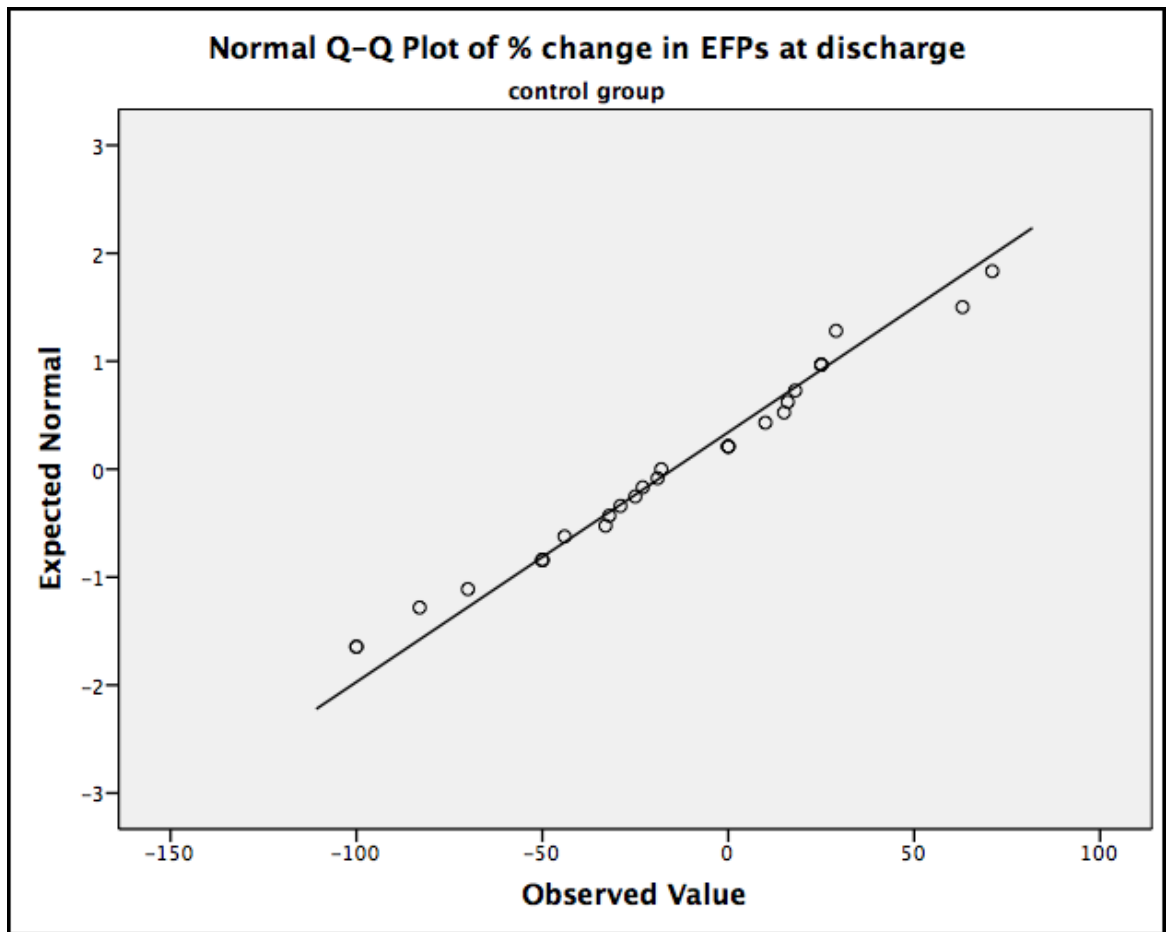
Outliers

No outliers were identified from inspection of the box plot below (figure 57).

Figure 57: Boxplot of mean change in error free prescription percentage per prescriber for discharge prescribing
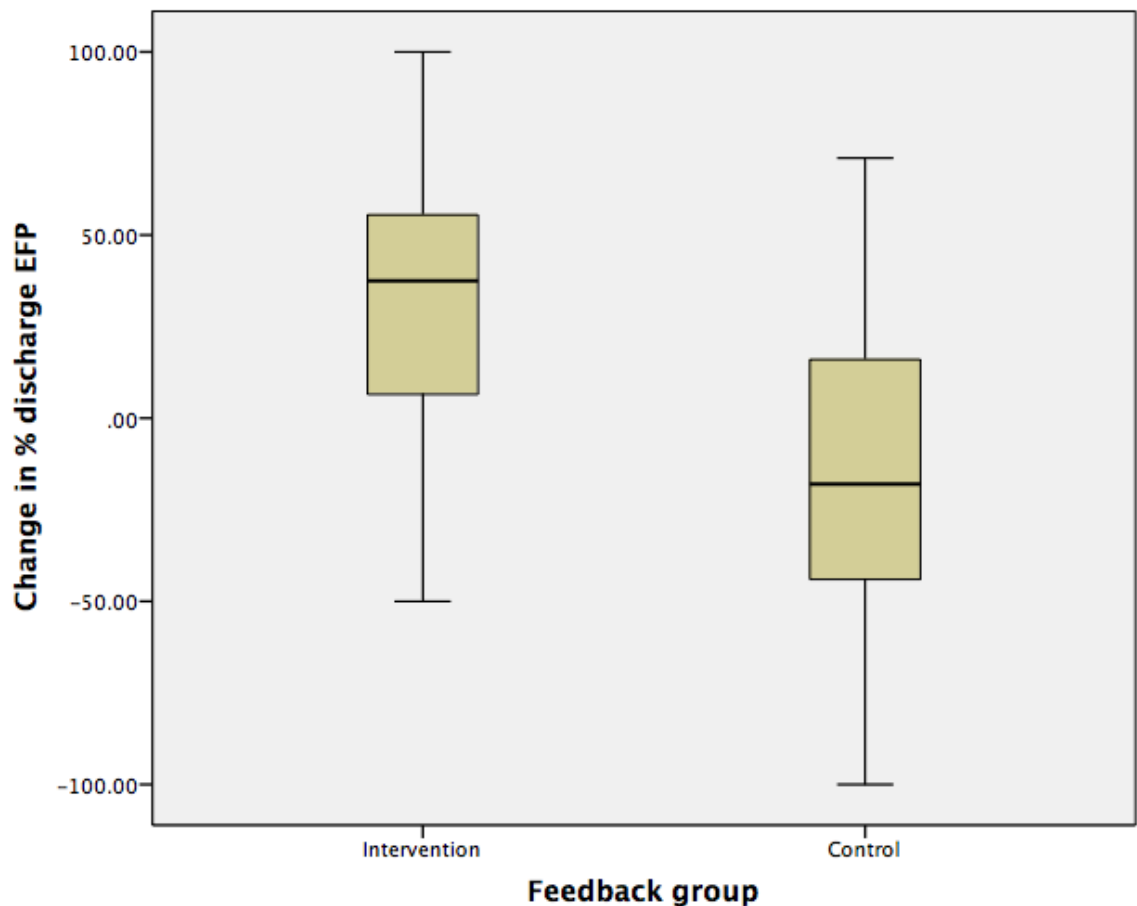
Homogeneity of variance

There was homogeneity of variance as demonstrated by Levene's test p>0.05 (0.441), therefore all assumptions were met for the t-test.

7.2.9.4. Results for change in error free discharge prescription rates

There was an improvement in the mean percentage of EFPs in the intervention group compared to the control group. This was statistically significant with a mean difference of 48.2% (SD+/-10.8, 95% CI, 26.6 to 69.7), t(55)=4.478, p<0.005 (0.000038). Effect size (d) = 1.19 (large effect size).

7.2.10. Impact on prescribing error severity

The frequency and percentage of PE severities is reported in table 25, and figures 58 and 59 below.

To explore the impact of the intervention on the distribution of PE severity, chi-squared tests of homogeneity were used. Chi-squared tests were also used to determine the significance of any change in frequency of PE severity within each group.

The null hypothesis is;

H_0: There is no difference in the distribution of error severity between groups

The chi-square of homogeneity for the intervention group was reported as $\chi^2(2) = 0.807$ p=0.668, $\varphi = 0.30$. Therefore, the null hypothesis is accepted, the distribution of error severity is the same between pre- and post-testing for the intervention group.

Figure 58: Distribution of prescribing error severity for the intervention group at baseline and post-intervention
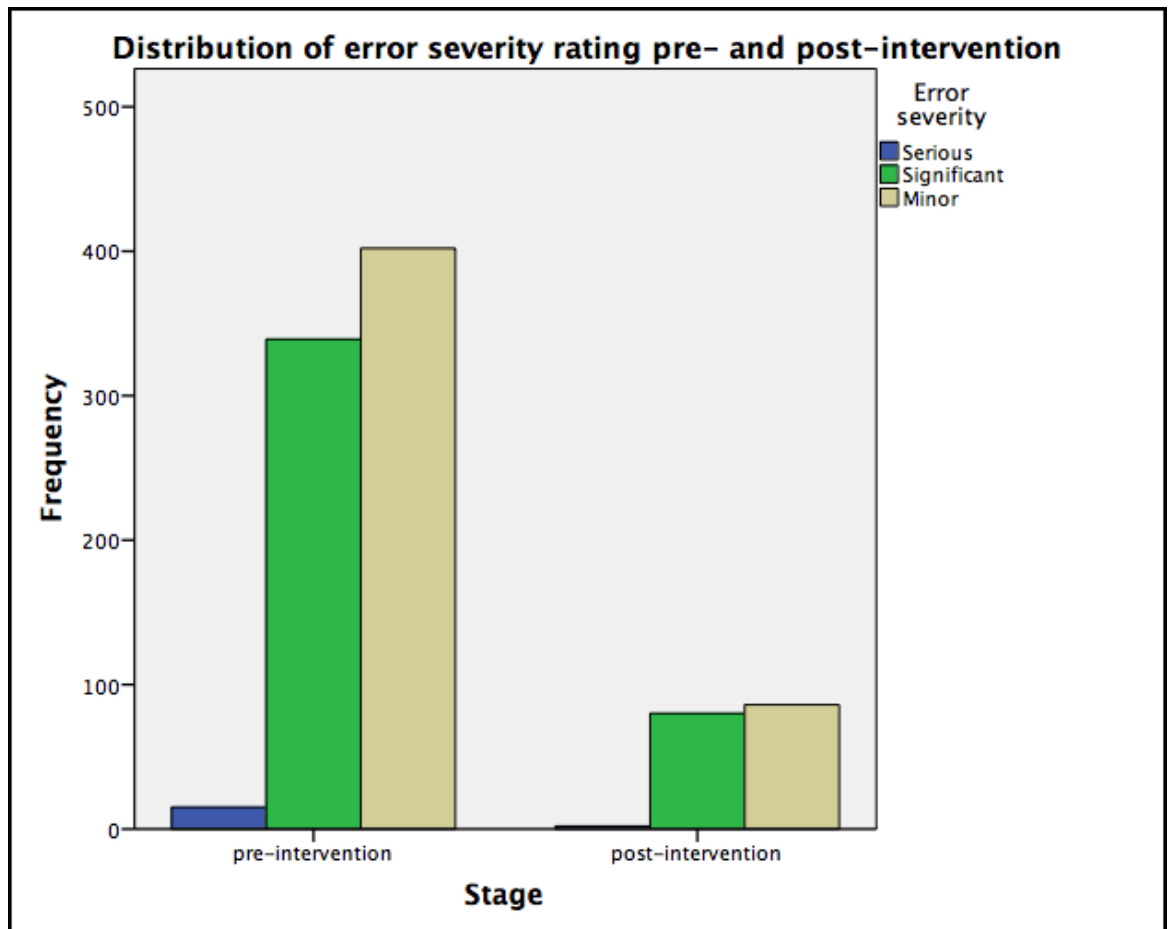
As observed in figure 59, the distribution of error severity changed between pre-and post-data collection for the control group with minor errors predominating in the pre-intervention period and significant errors predominating in the post-intervention data collection period.

The chi-square of homogeneity for the control group was reported as $\chi^2(3) = 38.313$, $p<0.005$, $\varphi=0.213$. Therefore, the null hypothesis is rejected and the alternate hypothesis that the distribution of PE severity is different between pre- and post-testing in the control group accepted. Within group analysis suggested a statistically significant increase in the proportion of significant PEs ($\chi^2(1)=11.9$, $p=0.001$, $\varphi=-0.098$) and a statistically significant reduction in the proportion of minor PEs ($\chi^2(1)=12.6$, $p<0.005$, $\varphi=0.1$).

Figure 59: Distribution of prescribing error severity for the control group at baseline and post-intervention
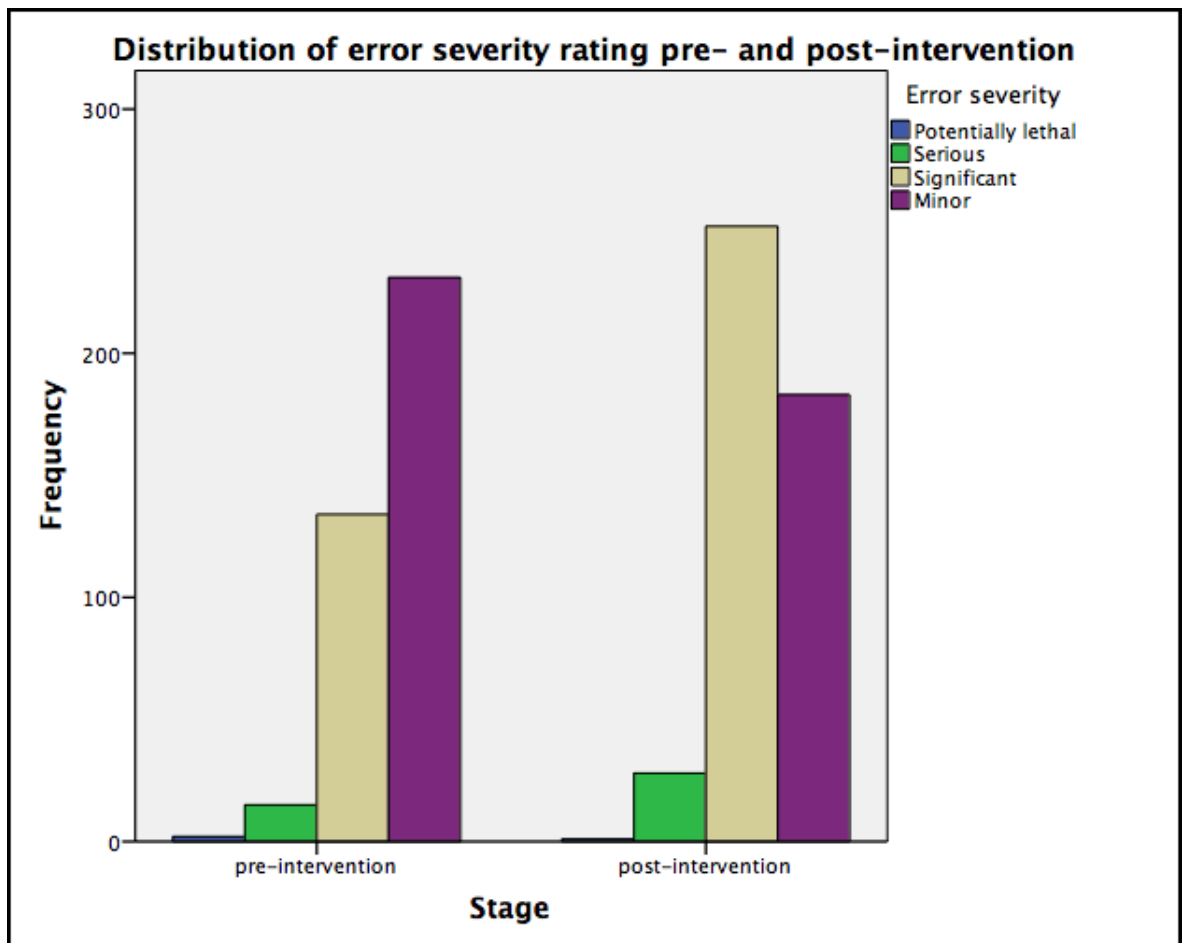
The frequency of each error severity is reported in table 26 below. Where reported, all expected cell frequencies were greater than five.

Here the null hypothesis is;

H₀: There is no difference in the frequency of error severity following the intervention period

All grades of PE were reduced in the intervention group. No potentially lethal errors were reported.

In the control group, there was a significant reduction in minor errors with a non-significant reduction in potentially lethal errors. There was a significant trend towards an increase in overall prescribing errors (3.7%) with statistically significant increases in significant errors and non-significant increases in serious errors reported.

Table 26: Prescribing error severity and frequency pre- and post-intervention

Severity	Intervention group				Control Group			
	Pre- rate (%) (Errors/items)	Post-rate (%) (Errors/items)	Difference (ARR)	χ^2 and p-value	Pre- rate (%) (Errors/items)	Post-rate (%) (Errors/items)	Difference (ARR)	p-value
Potentially lethal	0/3067= 0%	0/2985= 0%	n/a	N/A	2/2124= 0.1% (0.5% of errors)	1/2137= 0.047% (0.2% of errors)	-0.1% (-0.3% of errors)	*Fishers exact test p>0.05, =0.624
Serious	15/3067 = 0.5% (2% of errors)	2/2985= 0.07% (1.2% of errors)	-0.4% (-0.7% of errors)	$\chi^2(1)=9.6$, P=0.001981, φ=0.04	15/2124 = 0.7% (3.9% of errors)	28/2137 = 1.3% (6.0% of all errors)	0.6% (+2.1% of errors)	$\chi^2(1)=$ 3.8, P=0.051, φ=-0.03
Significant	339/3067= 11.1% (44.8% of errors)	80/2985 = 2.7% (47.6% of errors)	-8.4% (+2.8% of errors)	$\chi^2(1)=$143.6, p<0.005, φ=0.149	134/2124= 6.3% (35.1% of errors)	252/2137= 11.8% (54.3% of all errors)	5.5% (+19.2% of errors)	$\chi^2(1)=$ 32.4, P<0.05, =0.00187, φ=-0.084
Minor	402/3067= 13.1% (51.2%	86/2985 = 2.9% (51.2%	-10.2% (-2.0%	$\chi^2(1)=$182.2, p<0.00	231/2124= 10.9%	183/2137= 8.6% (39.4%	-2.3% (-21.0%	$\chi^2(1)=$ 5.3, P<0.0

	(53.2% of errors)	of errors)	of errors)	5, φ=0.167	(60.5% of errors)	of all errors)	of errors)	5, = =0.021, φ=-.034
Total errors	756/3067= 24.7%	168/2985= 5.6%	-19.0%	$\chi^2(1)=313.8$, P<0.05, φ=-0.212	382/2124= 18.0%	464/2137= (21.7% of all errors)	+3.7%	$\chi^2(1)=6.2$, P<0.05, = =0.013, φ=-0.035

7.2.11. Impact on prescribing error type

The frequency and percentage of each type of PE is presented in table 27 and figures 60 and 61 below.

To explore the impact of the intervention on distribution of PE type, chi-squared tests of homogeneity were used. In addition, chi-squared tests were used to determine the significance of any change in frequency of PE type within each group.

The null hypothesis is;

H_0: There is no difference in the distribution of error type between groups

For the intervention group, the chi-squared for homogeneity test $\chi^2(9) = 14.3$, p>0.05 (0.11, φ=0.124) accepts the null hypothesis and the distribution of PE types were the same before and after feedback.

For the control group, $\chi^2(9)=33.1$, p<0.05 (0.00013, φ=0.198) and so the null hypothesis is rejected. The distribution of PE type differs before and after the intervention period for the control group. Significant differences were identified for allergy status, excessive/unnecessary prescribing, omission of

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medication, excessive prescribing, clinical safety and miscellaneous error types.

Distribution of error type between control and intervention groups pre-test was significantly different, $\chi^2(9)=41.9$, $p<0.05$ (0.000003, $\varphi=0.192$).

Distribution of error type between control and intervention groups post-test was significantly different, $\chi^2(9)=12.0$, $p>0.05$ (0.212, $\varphi=0.138$).

Statistically significant reductions ($p<0.05$) in the frequency of all PE types were reported for the intervention group with writing errors and lack of clear directions showing the largest improvements (Table 27). For the control group, significant reductions were observed for the frequency of allergy status and miscellaneous types of PE. Significant increases in omission errors, excessive prescribing and clinical safety errors were also observed for the control group. Statistically non-significant increases in writing, duration, drug interaction errors, and lack of clear instructions were also observed for the control group (Table 27).

Table 27: Types and frequency of prescribing error pre- and post-intervention

Severity	Intervention group				Control Group			
	Pre-rate	Post-rate	Difference	p-value	Pre-rate	Post-rate	Difference	p-value
1. Dosing error	119/3067= 3.9%	32/2985= 1.1%	-2.8%	$\chi^2(1)=46.7$, p <0.005, $\varphi=0.087$	58/2124= 2.7%	82/2137= 3.8%	+1.1	$\chi^2(1)=3.8$, p = 0.05, $\varphi=-0.03$
2. Writing error	181/3067= 5.9%	42/2985= 1.4%	-4.5%	$\chi^2(1)=80.1$, p <0.005, $\varphi=0.113$	142/2124 = 6.7%	143/2137= 6.7%	+0.01 %	$\chi^2(1)=0.00$, p >0.05 (0.994), $\varphi=-0.00$
3. Allergy status	15/3067=	2/2985=	-0.4%	$\chi^2(1)=9.6$, p	12/2124=	3/2137 =	-0.5%	$\chi^2(1)=5.4$, p

	0.5%	0.1%		<0.05 (0.002) φ=0.040	0.6%	0.1%		<0.05 (0.020), φ=-0.036
4. Duration of treatment	81/3067= 2.6%	16/2985= 0.5%	-2.1%	$\chi^2(1)=41.2$, p <0.05, φ=0.082	48/2124= 2.3%	42/2137= 2.0%	-0.3%	$\chi^2(1)=0.428$, p >0.05 (0.513), φ=0.010
5. Drug Interactions	19/3067= 0.6%	3/2985= 0.1%	-0.5%	$\chi^2(1)=11.2$, p <0.05 (0.001), φ=0.043	3/2124= 0.1%	10/2137= 0.5%	+0.4%	$\chi^2(1)=3.7$, p >0.05 (0.054), φ=-0.29
6. Omission of medication	109/3067= 3.6%	17/2985= 0.6%	-3.0%	$\chi^2(1)=63.4$, p <0.05, φ=0.101	27/2124= 1.3%	52/2137= 2.4%	+1.1%	$\chi^2(1)=7.6$, p <0.05 (0.006), φ=-0.042
7. Excessive/unnecessary prescribing	48/3067= 1.6%	19/2985= 0.6%	-1.0%	$\chi^2(1)=11.73$, p <0.05 (0.001), φ=0.044	16/2124= 0.8%	38/2137= 1.8%	+1.0%	$\chi^2(1)=8.7$, p <0.05 (0.003), φ=-0.045
8. Clinical safety error	46/3067= 1.5%	14/2985= 0.5%	-1.0%	$\chi^2(1)=16.1$, p <0.05, φ=0.051	26/2124= 1.2%	45/2137= 2.1%	+0.9%	$\chi^2(1)=4.9$, p <0.05 (0.027), φ=-0.034
9. Lack of clear directions	114/3067= 3.7%	15/2985= 0.5%	-3.2%	$\chi^2(1)=71.8$, p <0.05, φ=0.108	36/2124= 1.7%	44/2137= 2.1%	+0.4%	$\chi^2(1)=0.7$, p >0.05 (0.39), φ=-0.013

10. Miscellaneous	24/3067 = 0.8%	8/2985 = 0.3%	-0.5%	$\chi^2(1)=7.5$, p <0.05, φ=0.035	14/2124= 0.7%	5/2137 = 0.2%	-0.5%	$\chi^2(1)=4.3$, p <0.05 (0.038), φ=0.032
Total errors	756/ 3067= 24.7%	168/ 2985 = 5.6%			382/ 2124 = 18.0 %	464/ 2137 = 21.7%		

Figure 60: Distribution of prescribing error type for the intervention group pre- and post-intervention
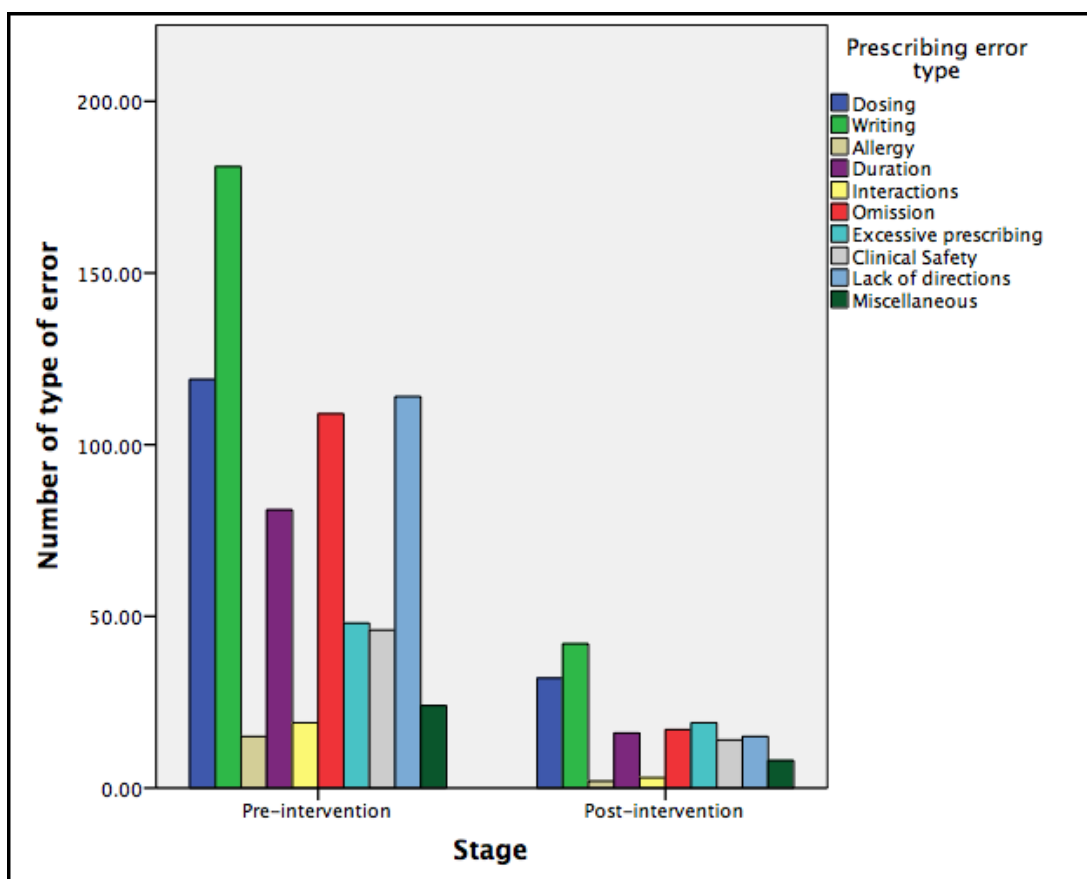
Figure 61: Bar chart illustrating prescribing error type for the control group pre- and post-intervention
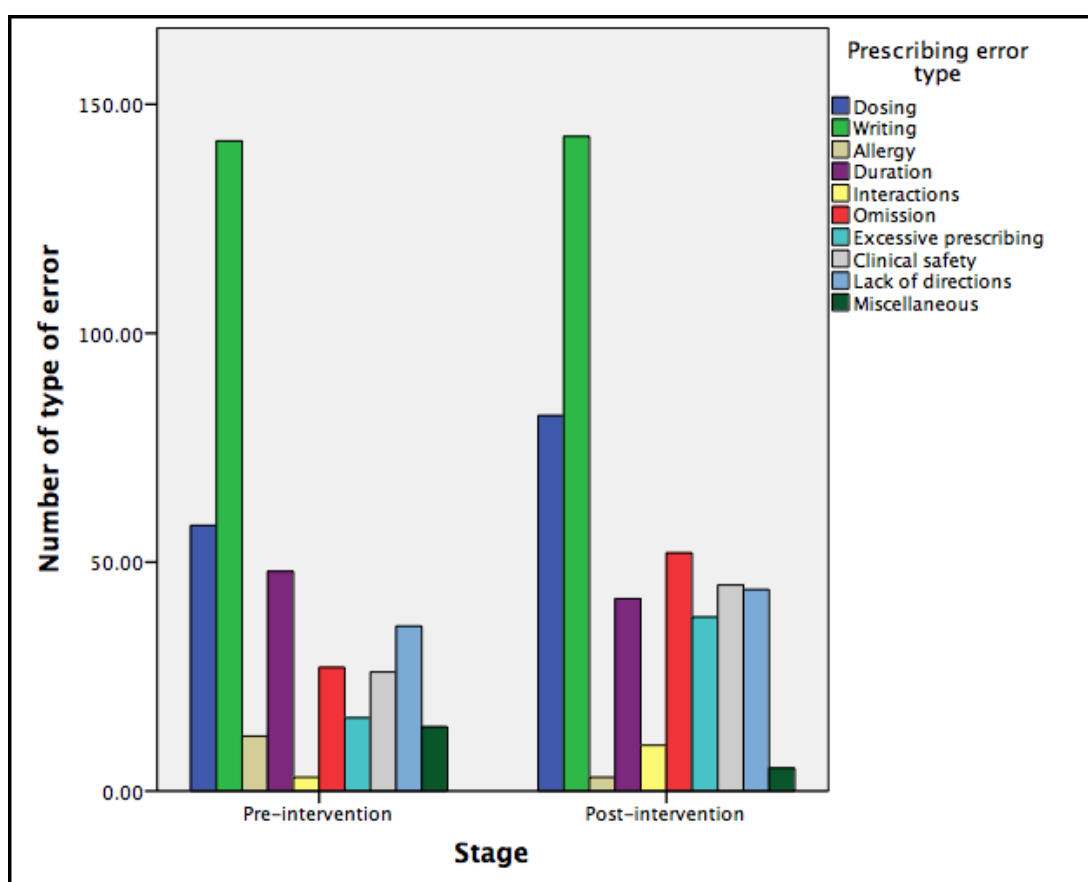
7.2.12. Impact on prescriber grade

The frequency and percentage of PEs for each prescriber grade is reported in table 28 and figures 62 and 63 below.

To explore the impact of feedback on PE frequency for each prescriber grade, chi-squared tests were used for both groups.

In the intervention group, foundation year one doctors prescribed most commonly pre- and post-intervention. Consultants had the lowest PE rate (0%), followed by FY2s (18.2%), FY1s (22.5%) and then CT/ST grade doctors (32.6%). CT/ST grade prescribers continued to have the highest PE rate post-intervention (6.5%), followed by FY2s (5.5%) and then FY1s (5.1%) and consultants (0%).

All prescriber grades in the intervention group demonstrated a significant reduction in PE frequency. Reflecting the baseline PE rates, CT/ST grade doctors demonstrated the greatest reduction in PE rates (-26.1%, $p<0.005$), followed by FY1s (-17.4%, $p<0.005$) and FY2s (-12.7%, $p<0.005$).

In the control group CT/ST grade doctors prescribed most commonly pre-intervention whilst FY2 prescribed most commonly post-intervention. Consultants had the highest PE rate (35.5%), followed by CT/STs (20.6%), FY2s (18.5%) and then non-medical prescribers (15.2%) with FY1 grade doctors having the lowest PE rate (13.3%). Consultants continued to have the highest PE rate post-intervention (33.3%) followed by CT/STs (23.3%), FY2s (23.2%) and then FY1 grade doctors (20.8%) with non-medical prescribers having the lowest PE rate (8.3%).

In the control group, non-medical (-6.9%, $p=0.167$) and consultant grade (-2.2%, $p=0.911$) prescribers demonstrated a non-significant reduction in PE rates. All other grades demonstrated significant increases in PE rates.

Table 28: Number of prescribed items, errors and error rates for each prescriber grade pre- and post-intervention

Prescriber Grade	Intervention group				Control Group			
	Pre-prescribing error rate (Items/errors)	Post-prescribing error rate	Difference	p-value	Pre-prescribing error rate	Post-prescribing error rate	Difference	p-value
FY1	326/1449= 22.5%	83/1629= 5.1%	-17.4%	$\chi^2(1)$= 153.8, P=<0.05, φ= 0.210	79/595= 13.3%	154/742= 20.8%	+7.5%	$\chi^2(1)$= 9.1, P=0.003, φ= -.076
FY2	118/647= 18.2%	12/219= 5.5%	-12.7%	$\chi^2(1)$= 16.4, P=<0.05, φ= 0.128	98/531= 18.5%	188/810= 23.2%	+4.7%	$\chi^2(1)$= 2.8, P=0.093 φ= -.042
CT/ST	312/957= 32.6%	73/1128= 6.5%	-26.1%	$\chi^2(1)$= 160.6, P=<0.05, φ= 0.255	179/868 = 20.6%	106/455= 23.3%	+2.7%	$\chi^2(1)$= 0.8, P=0.368, φ= -.022
Consultant	0/14 = 0%	0/9= 0%	0%	n/a	11/31= 35.5%	7/21= 33.3%	-2.2%	$\chi^2(1)$= 0.012, P=0.911, φ= 0.013
NMP	N/A	N/A	n/a	n/a	15/99= 15.2%	9/109= 8.3%	-6.9%	$\chi^2(1)$=1.9, P=0.167, φ= 0.091
Total	756/3067= 24.7%	168/2985 = 5.6%	-19.1%		382/2124= 18.0%	464/2137= 21.7%	+3.7%	

Figure 62: Prescribing error rate (%) by prescriber grade pre- and post-intervention for the intervention group [c]
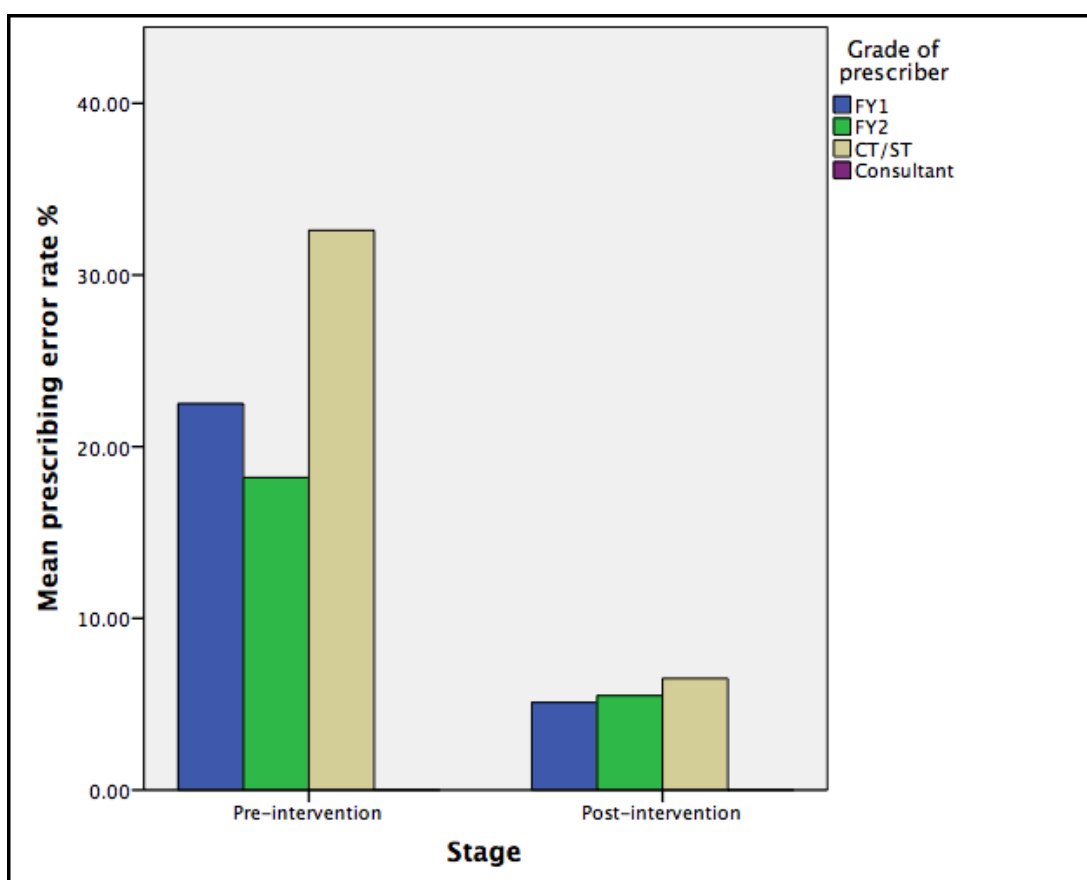
[c] NB consultant grade prescribers had a 0% PE rate at baseline and post intervention in the intervention group

Figure 63: Prescribing error rate (%) by prescriber grade pre- and post-intervention for the control group
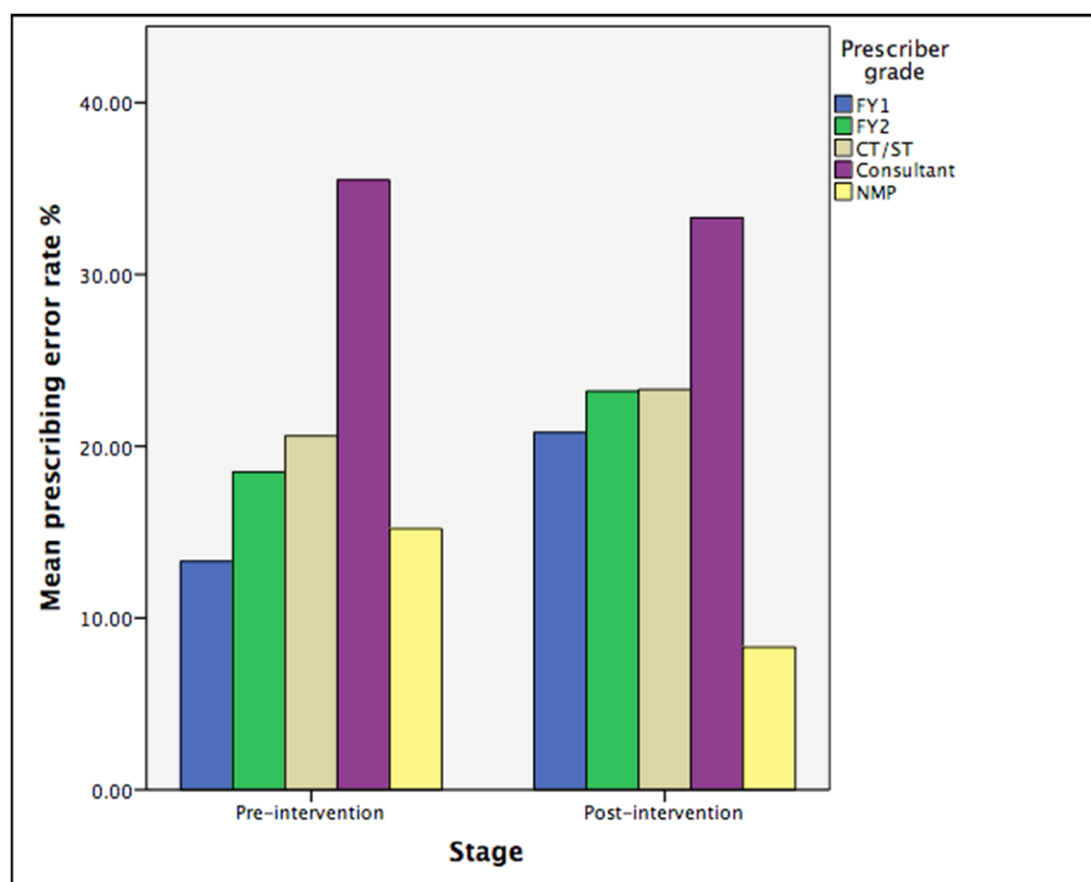
7.2.13. Summary of results

- Feedback was delivered to 36 doctors over 8 wards with prescribing compared to 41 doctors on another eight wards who continued with normal practice.

- A combination of descriptive and inferential statistics have been used to test the research hypotheses.

- There was an 18.3% reduction in overall PE rate in the intervention group and a 5.4% increase in PE rate in the control group following the intervention period. This was a statistically significant ($p<0.05$) change in PE rates of 23.7%.

- There was a 23.7% increase in overall EFP rate in the intervention group and a 5.9% increase in EFP rate in the control group following the intervention

period. This was a statistically significant (p<0.05) change in EFP rates of 29.5%.

- These results were consistent for inpatient and discharge prescribing with significant improvements in PE rates reported.

- No association was identified between PE rate change and number of feedback sessions

- All PE types and severity were significantly reduced in the intervention group

- All prescriber grades demonstrated an improvement in PE rate in the intervention group except for consultants, where no change was identified.

7.3. Chapter discussion

This chapter aimed to determine if the results from chapter five were reproducible on a larger scale. Results in this chapter demonstrate statistically significant improvements in both PE and EFP rates for the intervention group. Additional reductions in all PE types and severity for each prescriber grade have also been reported. PE rates increased in the control group with reductions in EFP rates also reported. PE rates were different between groups at baseline. The higher PE rate for the intervention group may be an artefact of the non-randomization of wards or equally a 'Hawthorne effect' of pharmacists being more motivated to collect audit data on the intervention wards.

Baseline PE rates in this chapter are higher than the average reported in one large UK PE study (Dornan *et al.* 2009) although it is acknowledged that PE rate is observer dependent (Dean Franklin *et al.* 2005). Furthermore, the PE rate is consistent with other PE studies (Bowers *et al.* 2009, Reynolds *et al.* 2016, Ross *et al.* 2009) and annual audits undertaken within STHKH. EFP rates were also consistent with that reported elsewhere (Seden *et al.* 2013).

PE rates in this chapter are similar to those reported in chapter 5. Whilst the PE rate improved in the intervention group, it increased by 5.4% in the control group. As proposed in chapter 5, this may be due to a lack of feedback or "prescribing etiquette". It should be noted that only trainee

grade prescribing error rates increased in the control group with consultants and NMPs showing non-significant improvements. Trainee grade prescribers are a transient population and it is possible that at the start of each rotation, perceived confidence or capability is lower than at the end of the rotation when prescribing was re-audited. A lack of feedback could therefore contribute to any mismatch (Ryan *et al.* 2014) between perceived and actual confidence influencing the observed increase in PE rates.

Studies evaluating the impact of feedback in hospital settings is limited. Recent studies in the hospital setting have suggested non-significant or small effects of feedback on PE rates (Reynolds *et al.* 2016, Ajemigbitse *et al.* 2016). However, as argued in chapter 2, the feedback content, process and frequency were not clear whilst prescriber identification was limited (Reynolds *et al.* 2016), a key barrier to delivery of any feedback. Large effect sizes of the intervention have been reported in this chapter. This is consistent with the findings reported in chapter 5 and perhaps reflects the fact that prescribers may not have been performing well initially. Furthermore, the feedback intervention reflects principles of effective feedback which may influence its efficacy. Additionally, where the feedback facilitator is ward based, they will have the advantage of recognizing prescriber signatures to both deliver feedback and collect relevant PE data.

A greater frequency of feedback is considered to be more successful in improving task performance (Ivers *et al.* 2012). However, no association was observed between change in PE rates and number of feedback sessions. This suggests that intensity of feedback is not the sole driving factor in reducing PE rates. The process outcomes and variations in feedback delivery reported in chapter 6 and as will be described in pharmacist interviews in chapter 8, could be masking any association.

The emerging complexity of the intervention is likely to be a contributing factor to improvements in PE rates although the impact of each individual component is unknown. McLellan *et al.* (2016) suggest "prescribing behaviour is adaptive and can be positively influenced by structured

feedback". Such adaptive processes are likely from the direct effects of feedback but it is also possible that prescribers may adapt their behaviour in anticipation of feedback as described in chapter 6. This may be to avoid unfavourable comparison to peers, unfavourable feedback (Brett and Atwater 2001), or to be viewed negatively by the ward pharmacist, a feedback 'cost' described elsewhere (Teunissen *et al.* 2009) or could simply be a positive 'Hawthorne effect' and beneficial unintended outcome. Further adaptive behaviours will be described in chapter 9.

Raising awareness of PEs may change prescriber practice simply to avoid loss of reputation or disciplinary action if reported (Gallagher *et al.* 2003) with similar views expressed by prescribers in chapter 6. Prescribers have reported being complacent about potential consequences of PEs (Ryan *et al.* 2014). Feedback can address this complacency, outlining the potential risk or impact on others if the PE was not intercepted; an approach consistent with feedback in this thesis.

Prescribers have reported a reliance on pharmacists to intercept PEs (Dornan *et al.* 2009) and a culture of non-interference with senior doctors' prescribing decisions (Charani *et al.* 2013). Equally, pharmacists have also reported correcting PEs without contacting the prescriber (Bertels *et al.* 2013). Such social prescribing rules have the potential to cause patient harm. Charani *et al.* (2014) argue that interventions aimed at junior doctors may be limited where there is a dichotomy between social and organizational norms. Broom *et al.* (2014) reported that antimicrobial prescribing decisions are influenced less by "bureaucratic routinisation" and more by hierarchies and securing of professional reputation. This resonates with previous work on antimicrobial prescribing etiquette (Charani *et al.* 2013) and fraternal obligation (Björnsdóttir and Hansen 2002) with suboptimal prescribing considered logical, realistic and acceptable (Broom *et al.* 2014, Mattick *et al.* 2014, McLellan *et al.* 2016) in workplace contexts.

Where these cultures exist, sub-optimal prescribing is likely to be influenced, especially where junior doctors prescribe the majority of items, yet the majority of prescribing decisions reside with a more senior prescriber (Ross *et al.* 2013a). This may be reflected in the increase in error rates in the control group and the larger effect size reported for discharge over inpatient prescribing that is more likely to be directed by senior colleagues. Discharge prescriptions in particular, have been reported as a tedious or boring task (Dornan *et al.* 2009). Where feedback raises awareness of the potential for error, the impact on others and how to reduce PEs, the tedium, an error provoking condition itself (Dornan *et al.* 2009), may be mitigated.

The results in this chapter suggest that feedback should be part of a new cultural norm with all prescriber grades receiving and expecting feedback on their prescribing as described in chapter 6 and reported by pharmacists in chapter 8. PEs are avoidable and so error free prescriptions should be an expected standard, a standard encouraged and reinforced through ongoing feedback.   Without feedback, the risk of ward specific practices or "prescribing rules" that deviate from best practice could become routine and this is one plausible reason why PEs increased in the control group in this study. Results of the interviews in chapters 6 and 8 support this suggestion with prescribers more engaged with the prescribing process and challenging accepted practice such as prescribing on ward rounds.

Whilst significant reductions in PEs have been reported in this chapter, PEs were still occurring. PE causation is complex and multifactorial (Dornan *et al.* 2009, Ross *et al.* 2013a, Tully *et al* 2009) and it would be naïve to assume that feedback can eliminate all PEs. Equally, prescribers may be less motivated to prevent potentially minor errors such as not dating a prescription, an example of a 'writing error' that predominated in this study and resonates with both prescriber and pharmacist views in chapters 6 and 7.

Junior doctor prescribing has been described as "part of a complex adaptive social system" where the system and its agents co-evolve in response to

change" (McLellan *et al.* 2016). In this setting, PE feedback has the potential to improve prescribing by challenging prescriber perceptions and outlining expected exemplary practice. If prescribing is a social experience (McLellan *et al.* 2016), where feedback provides not only the impetus for pharmacists and prescribers to interact, but the catalyst for further interaction as described in chapters 6 and 8, the potential for feedback to influence prescriber actions can be seen.

Additional confounding factors may have contributed to reductions in PE rates. Firstly, both pharmacists and prescribers in chapters 6 and 8 reported enhance rapport, teamwork and communication with greater information-seeking and feedback-seeking behaviour from prescribers. Where inter-professional interactions are developed following PE feedback, improvements in prescribing outcomes might be expected.

Additionally, educational interventions, including bespoke teaching sessions and provision of memory aids, were reported as an outcome of delivering feedback. The impact of educational outreach or pharmacist-led prescriber training has been reported to have small but positive impacts on prescribing practice (O'Brien *et al.* 2007).

Whilst these are welcome and valued outcomes of the feedback process, they may have equally influenced PE rates as they were not part of routine ward-based pharmacist practice beforehand, making inferences on the impact of feedback as a single intervention, difficult to interpret. Secondly, the author interviewed many of the prescribers throughout the intervention period on PEs they had received feedback on as described in chapter 9. This interview process may have encouraged further prescriber reflection and influenced prescriber practice.

Facilitation was required by the author to support ward pharmacists in delivery of feedback. This included, where requested, discussing delivery of feedback beforehand with the pharmacist. Additionally, the author checked with pharmacists what interventions had been made, if feedback was

required, and had been delivered. Whilst pharmacists will develop the confidence to prepare and deliver feedback autonomously, it is clear from the post-intervention results that the number of errors classified as significant or above (n=82) over one week did not reflect the number of errors that prescribers received feedback on over the three-month period (n=177) from ward pharmacists.

Time constraints are an obvious potential barrier to delivering feedback although prescribers and pharmacists acknowledge it is a worthwhile investment of their time in chapters 6 and 8 respectively. It should be noted that despite formalizing PE feedback, it is still in its relative infancy and the challenge will be to ensure it becomes part of routine practice, a challenge that will take time. However, the results are encouraging and support reductions in PE rates reported in the pilot study in chapter 5. Where PE rate are reduced, the intervention has potential to reduce harm and improve patient safety.

7.4. Strengths and limitations of this chapter

Evidence supporting the use of PE feedback in hospital settings is limited. Furthermore, such studies are typically limited to assessing an individual class of medications, have shown no effect, or the feedback intervention theoretically flawed. To the author's knowledge, this is the first known study of a PE feedback intervention reporting positive impacts on overall prescribing in a hospital setting, whilst detailing the content and process of PE feedback as described in chapter 3.

A wide range of prescriber grades (Table 14) were included in the research in this chapter, reflecting the typical skill mix on hospital wards. Whilst this is a case study, STHKH is a typical acute NHS hospital with standard ward pharmacy services and the results reported in this chapter are supported by triangulation with prescriber views in chapters 6 and 9, and pharmacist views in chapter 8.

Therefore, the author proposes that results are valid for inferences to be made in similar settings. However, as discussed, the intervention is complex and not simplistic; the PEs discussed, feedback process and social interaction, and negotiated outcomes could not be standardised. The ancillary outcomes on pharmacists, prescribers and pharmacist-prescriber relationships reported in chapters 6, 8 and 9 could well be interacting synergistically to produce an effect that is greater than feedback alone.

The principles of timely, pharmacist-led feedback that is delivered verbally and in writing in the clinical environment for a defined error can be transferred to similar settings. However, feedback is a dynamic process and the interaction between facilitator and recipient cannot be sanitized, one would expect variability and this flexibility reflects the nature of human interaction. The potential for a positive 'Hawthorne effect' cannot be discounted and may have influenced prescribing outcomes. Additionally, the variability in process outcomes reported in chapters 6,8 and 9 may not be replicated. However, equally, these process outcomes may resonate with known issues elsewhere and feedback for example, could be used to enhance communication and teamwork between pharmacists and prescribers and explored in parallel to the feedback intervention.

Whilst there was a slight imbalance between intervention and control group participant numbers, a 1.5-fold variation would be necessary to limit use of the t-test analysis reported in this chapter. Additionally, participants were not randomized as described in chapter 3 and any improvement could therefore reflect any differences between groups although statistically significant differences were reported. Equally, as argued in chapter 3, randomization does not always isolate variables whilst it would have been difficult to truly randomize prescribers without risk of diffusion of effect for example.

Ward type and turnover was not homogenous between groups. However, surgical wards typically have teams that works across wards and it would

have been difficult to homogenize all specialties between groups. Equally, two of the quickest turnover wards were in the control group and it could be argued that PE rate may be higher reflecting workload or environmental pressures. However, the control group also had two of the slowest turnover wards where it could be argued that PE rates could, in contrast be lower. Furthermore, the variety of wards can be viewed as a strength as they are typical of a large NHS acute hospital.

Greater numbers of prescribed items were recorded for the intervention group and it is possible therefore that not all prescribing data was collected for the control group. This could reflect greater pharmacist motivation to collect data on the intervention wards. This difference could also overestimate PE rate for control wards if more PEs, as opposed to correctly prescribed items, were recorded. However, number of prescriptions in each group were similar suggesting that prescriptions in the intervention group had more prescribed items per prescription. Considering a larger number of prescribed item numbers have been associated with an increased risk of a PE (Seden *et al.* 2013), this if anything would suggest that PE rates should be greater in the intervention group.

7.5. Chapter Summary

This chapter has presented the results of a controlled before and after study exploring the impact of constructive feedback on prescribing. Significant reductions in PE and EFP rates have been reported for prescribers in the intervention group. These benefits extended to reduction in error rates for all types of error, severity and prescriber grade for the intervention group. Potential reasons for these reductions have been discussed considering feedback as a complex intervention and unknown influences of unexpected outcomes. The next chapter will present the experiences of pharmacists towards delivering the PE feedback intervention, using results from semi-structured interviews.

Chapter 8. Pharmacist experiences of delivering formal prescribing error feedback

8.1. Chapter introduction

This chapter will present the results of eighteen pharmacist interviews exploring their experiences of delivering formal PE feedback. These views and experiences are poorly understood but are important to determine the feasibility of the intervention and the impact on pharmacists and prescribers alike.

The primary research aim of this chapter was to:

> Explore and determine pharmacists' attitudes of, and experiences towards delivering formalised prescribing error feedback

Seven key themes are reported from analysis of the interviews and are used to report pharmacist experiences of delivering prescribing error feedback. These results will be followed by a discussion of the findings and the implications for the research undertaken in this thesis.

8.2. Semi-structured interviews

Semi-structured interviews were used to provide the in-depth information required to answer the research question as described in chapter 3. Pharmacists involved with delivering feedback were provided with a participant information sheet (Appendix 7). Standard e-mails (Appendix 6) were also sent to pharmacists that included participant information letters and consent forms. All eligible (nineteen) pharmacists expressed an interest to participate.

Interviews were conducted in a private interview room within the pharmacy department at a convenient time negotiated with each pharmacist between November 2015 and January 2016. All pagers / mobile phones were turned off to prevent interruption. Protected time was negotiated with the clinical

pharmacy services manager beforehand. Prior to commencing the interview, the purpose of the study was covered again and both verbal and written consent obtained by the author. A topic guide (Appendix 4) was used to explore key themes and ensure consistent issues were discussed. Interview duration varied from 28 minutes to 1 hour 29 minutes (Table 29).

Table 29: Participant information for pharmacist interviews [a]

Interview code	Agenda for change band	Male or female	Years Qualified at time of interview	University	Pre-registration training	Interview duration
P1	7	Female	3	Medway	Hospital	28 minutes
P2	8a	Female	3	Manchester	Hospital	55 minutes
P3	7	Female	2	Manchester	Hospital	33 minutes
P4	8b	Female	17	Manchester	Community	45 minutes
P5	6	Female	2	Preston	Community	33 minutes
P6	8a	Female	7	Belfast	Hospital	38 minutes
P7	Locum	Male	8	Manchester	Hospital	32 minutes
P8	7	Female	12	Manchester	Hospital	32 minutes
P9	6	Female	3 months	Manchester	Hospital	30 minutes
P10	Locum	Male	8 years	Liverpool	Hospital	48 minutes
P11	Locum	Male	15 years	Liverpool	Community	1 hr 29 minutes
P12	7	Female	2 years	Liverpool	Hospital	33 minutes
P13	Locum	Female	7 years	Aston	Hospital	37 minutes

P14	7	Female	6 years	Norwich	Hospital	34 minutes
P15	6	Female	2 years	Manchester	Hospital	35 minutes
P16	6	Female	5 months	Norwich	Hospital	34 minutes
P17	8a	Female	8 years	Manchester	Hospital	45 minutes
P18	6	Female	1 year	Manchester	Hospital	45 minutes

a see chapter 1 for an overview of each pharmacist grade

8.3. Data analysis

All interviews were digitally recorded and transcribed verbatim by the author, except for anonymising person and place names. Interviews took between two and six hours to transcribe. Transcripts were read whilst simultaneously listening to the audio file to correct any transcription errors introduced by the author. Electronic copies of the transcripts were sent to SDW and SVOB for independent analysis.

Transcripts were coded line-by-line and analysed thematically following the framework approach as described in chapter 3. An initial inductive approach to coding was adopted with ideas and interpretations of the data indexed in the margins of the transcripts. Interpretive ideas and concepts were informed both *a priori* from research aims and the topic guide and *a posteriori* from participant views (Pope *et al.* 2000) that the author could not predict (Gale *et al.* 2013) such as 'self-efficacy', 'job-satisfaction' or 'goal motivating behaviour'. This abstraction and conceptualisation allows appreciation of the data as a 'whole'.

The research supervisors (SDW and SVOB) independently read and analysed transcripts for inter-coder reliability (Plummer-D'Amato 2008). Initial codes and themes were discussed with the research team with any discrepancies resolved for an analytical consensus on the initial thematic

framework (Appendix 24). This was then applied to the transcripts and refined with further inferences and meaning identified to produce the final thematic framework (Table 30). Relevant extracts of the transcripts were then copied and pasted under the relevant code for meaning, analysis and explanation.

8.4. Results

Eighteen pharmacists (three male and thirteen female) were recruited for interview out of a sample of eighteen pharmacists involved in delivering PE feedback. Participant details are presented in table 29. Pharmacist grade ranged from band 6 to band 8b (see chapter 1 for an overview of pharmacist grades) reflecting the skill mix of clinical, ward-based pharmacists in the department. For anonymity, pharmacists were allocated participant codes, P1-P18, as seen in table 29. It was considered by the author that data saturation (See chapter 3) had been achieved at interview 9, although further interviews were conducted to provide greater richness of material and allow all pharmacists involved the opportunity to discuss their experiences of the project.

Table 30: Thematic framework for pharmacist interviews

Theme	Code
1. Process Overview	Directive vs. facilitative feedback
	Setting
	Feedback process
	Barriers
	Sustainability
	Proforma
	Prescriber grade
2. Working relationship	Rapport
	Hierarchy

Theme	Code
	Team integration
	Trust in prescriber
	Prescriber communication
3. Benefits of feedback	Consistency in practice
	Role awareness
	Medicines optimisation
	Educational
4. Feedback facilitator	Feedback apprehension
	Facilitator training
	Job satisfaction
	Raised understanding of error
	Facilitator credibility
	Self-efficacy
5. Prescriber impact	Prescriber response
	Information seeking behaviour
	Feedback seeking behaviour
	Goal motivating behaviour
	Prescriber behaviour
6. Prescribing error	Error severity
	Timely feedback
	Supporting evidence
	Stage of prescription
	Error interpretation
7. Process improvement	Prescribing error procedure
	Formal vs. informal
	Shared learning

Theme	Code
	Protected time
	Facilitator feedback
	Incident report

The final thematic framework is presented in table 27. Seven key categories emerged from the data corpus, these were;

1. Process Overview
2. Working relationship
3. Benefits of feedback
4. Feedback facilitator
5. Prescriber impact
6. Prescribing error
7. Process improvement

Sample quotations are given under thematic headings to demonstrate participants views. It is not the intention of the author to present the full body of data but rather a selection of quotes that articulate the themes with greater clarity and lucidity. Quotes were agreed with the PhD supervisors SDW and SVOB.

In general, all pharmacists engaged openly and freely to discuss their experiences of delivering PE feedback. All pharmacists were overwhelmingly positive about the project discussing the impact on themselves and on the prescribers, with views surprisingly homogenous across interviews. Importantly, despite obvious time pressures, pharmacists suggested that the process was sustainable and was a worthwhile investment of their time, echoing prescriber views reported in chapter 6.

8.4.1. Process overview

Seven key codes were included within this category: Directive vs. facilitative feedback, setting, feedback process, barriers, sustainability, proforma and prescriber grade

1a. Directive vs. facilitative feedback

Pharmacists reported a shift in practice from providing directive feedback to a more constructive, facilitative process. Delivery of formal, constructive feedback was reported as being more meaningful, creating a memorable encounter that prescribers were more likely to learn from. This was supported by pharmacists outlining the potential impact of the error, actively exploring the error causation and negotiating solutions to the cause.

P13. *"Prior to this project then I don't think that I have really been giving them feedback. I've just been telling them that this is not right will you change it for me? So I wouldn't tell them the reason, this is important because… you know prior to this project the most of the time you would say can you change this for me? This is this and it should be that. But now, we go with a conscious plan to educate them and tell them why it's important"*

Pharmacists reported that, because of work pressures, a directive approach was still used to correct PEs immediately with facilitative feedback typically following at a later time.

P6. "*I think that it is good because that is what I was saying to you, I'd deliver it verbally then follow up with the written feedback and sitting down with them and getting them to sign it.*"

1b. Setting

Feedback appeared to be delivered in a range of areas on the ward depending on prescriber preference. Feedback was predominantly delivered in a private setting, typically a quiet room, to ensure confidentiality.

P2. "*It required a flexible approach depending on the prescriber and workload. It might be on the nurses' station, the end of a day, a specific time, in a side room…*"

Some pharmacists reported that prescribers were happy to receive feedback in the open ward area although they strived to ensure that other colleagues were not around to maintain confidentiality.

P15. "*It was on the ward, generally I tried to get a quiet spot with no one else around because no one wants to be told that they've made a mistake with other people around. So it was just a quick five minutes, I want to talk to you about this and provided them with some reassurance you know like everyone makes mistakes and this is for your own learning type of thing. So it was generally in the doctor's office if they were on their own or on a quiet part of the ward with no one else around.*"

Pharmacists reported that taking this time to discuss the error allowed focus on the feedback and facilitated further dialogue that would not have happened with a more directive approach.

P6. "*it gives them the time out to ask more questions or give the time to really explore the issue whereas a lot of time when you have to correct an error they are like yeah yeah no problem at all because they have to correct it in a certain time frame then get back to their jobs. Whereas taking time out, you know now these ten minutes are only about this you know away from all of the distractions gives them a 100% focus.*"

1c. Feedback process

Most pharmacists delivered the initial overall feedback individually whilst four pharmacists delivered feedback to a group of prescribers, at their request. Three pharmacists reported that this was received very well and could allow benchmarking, although one pharmacist expressed that they should have delivered individual feedback because of prescriber embarrassment.

P11. "*On reflection, I think that given the choice, I wouldn't give them the choice and I would just do it one on one in private because I look at how [core medical trainee grade doctor] reacted and I felt a bit mean on him. Now I'm not a mind reader and I didn't know that his expectations were higher but knowing his personality I should have realised that.*"

Pharmacists reported demonstrating empathy when talking to prescribers and following a structured approach, providing balanced feedback on good and poor aspects of prescribing. This included outlining the potential impact of the error, identifying the error causation and finally negotiating solutions to reduce the risk of error recurrence.

P6. "*You're not just saying to them you are doing this error you're actually sitting back with them and sympathising with them and going I know what it is like. You know it's crazy out there, and they say can see oh you don't want me to be a machine and write these TTOs and they see that you are being more sympathetic and understanding of workload, and their response has been better then too.*"

1d. Barriers

Pharmacists reported that workload and time pressures made delivering feedback difficult at times, although they reported adopting a flexible approach to find the time to deliver feedback.

P1. "*Some days it was difficult especially when they were throwing out TTOs [to take out or discharge prescription] but those were the days when the mistakes were happening so you'd have those days when they made loads of mistakes and significant errors were produced. The following day you'd be battling to see the new patients but once you had won that battle you could sit down with them and say I know that yesterday was busy but this, that and the other.*"

Several pharmacists stated that timely feedback was not always possible where the prescriber was on leave or working a night shift, making memory recall of the situation and prescription difficult.

P13. "*Sometimes it was the time, sometimes it was the doctor. You know, you would identify the error but sometimes the doctor mightn't be in for three or four days because they are on nights or off on leave and then when you… especially if you don't have a copy of the chart then you are trying to remember and they are trying to remember but…*"

1e. Sustainability

Pharmacists unanimously agreed that delivering formal feedback was worthwhile and sustainable, with one pharmacist arguing it should be a routine role of all hospital pharmacists.

P11. "*This shouldn't just be part of our practice but part of our job. Every single pharmacist in this department is going to encounter mistakes in this hospital every single day and so they are always going to need to deliver feedback and the minimum standard and nature of that feedback needs defining and this, this what we are doing is the framework in which we can define it.*"

Despite time pressures, feedback was considered sustainable and a valid use of pharmacist time with the prescribing feedback taking approximately

10-15 minutes for the initial overall feedback, and 5-10 minutes for each individual error.

P6. "Yeah I think it is sustainable I know that is more work but at the same time you have to think about the impact on the errors that you are correcting and that's why I'm saying that we have to roll it out."

Pharmacists agreed that the most demanding aspect of the process was data collection and analysis for the initial audit. Two pharmacists suggested that audit and feedback on all prescribing was unnecessary and that feedback on significant errors was only required. However, the majority of pharmacists felt that a baseline audit was necessary to discuss all aspects of prescribing and establish early working relationships.

P3. "It doesn't have to be a week [to audit prescribing] it can be a couple of days to get some numbers then deliver feedback and that creates that relationship then."

1f. Proforma

Pharmacists reported that the feedback proforma was a useful tool to support the process and provide a consistency and structure to the feedback, although two pharmacists felt it was distracting for the prescriber and only provided it after delivering the PE feedback.

P9. "Yeah and like I said the sheets I think really helped because it was sort of a focus point on these are the errors, these are the risks and you know what can go wrong and this is how you can improve it and I think that that was really, really useful."

Five pharmacists reported that prescribers requested copies of the proforma to use as reflective pieces of evidence in their training portfolios, whilst two pharmacists reported they kept copies as part of their own portfolios.

P1. *"I found it useful and kept a copy for my records and the doctors kept a copy for their records for their portfolio so they were asking me for a copy and I know one of the doctors who has included all of them in their training portfolio."*

Three pharmacists suggested that the proforma itself contributed to a change in prescribing practice, as it contributed to it being a more formal process and they had to sign the feedback form.

P10. *"So it becomes very real for the doctor when you tell them about the error, this is how significant it was and this is where you sign."*

1g. Prescriber Grade

Pharmacists reported that they delivered feedback mostly to junior doctors, reflecting their volume of prescribing, but that all grades would benefit where they have made a PE.

P1. *"I think it is across the board [what grade of prescriber will benefit]. I was talking to the consultants less and delivering less feedback but that's because they were prescribing less and so making less errors."*

8.4.2. Working relationship

Five key codes were included within this category: Rapport, hierarchy, team integration, trust in prescriber and prescriber communication

2a. Rapport

Pharmacists were consistent in outlining the importance of rapport in facilitating delivery of PE feedback, reporting that established prescriber rapport reduced apprehensions in both the delivery and receipt of feedback from prescribers.

P7. "*I felt quite comfortable and confident because I knew the doctors and you have to build that rapport with your doctors.*"

In addition, pharmacists consistently proposed that the feedback process accelerated rapport building to establish new working relationships with prescribers. This was because the formalised process encouraged greater communication and interaction between pharmacists and doctors.

P6. "*I think it is establishing it [working relationship] quicker whereas there probably wouldn't be any need for you to have as much interaction [without feedback] whereas you are having interaction from word go so that is your rapport going from word go*"

Three pharmacists who covered additional wards compared the two processes of feedback, noting positive differences in how pharmacists were perceived and utilised as a result of delivering constructive feedback.

P13. "*Because you tend to communicate more then it improves your rapport and communication and I think they have more respect… maybe that isn't the right word but they think oh she knows much more than I thought. Or at least that is what I think, because they tend to ask more questions. I think that the pilot wards [feedback intervention wards] tend to ask more questions than the other wards and they are aware of the presence of the pharmacist than on other wards.*"

2b. Hierarchy

There appeared to be an inter-professional hierarchy with pharmacists initially concerned that their feedback would be dismissed by prescribers. Hierarchical influences with prescriber grades were also noted with pharmacists reporting greater apprehension when approaching consultants with feedback as opposed to junior doctors.

P1. "*It was more intimidating with the senior grades than it was with the basic grades because I was a basic grade pharmacist or had just moved up to a band 7 and I was never really doing anything like this as such.*"

One pharmacist suggested this was less about their status but more about having a more fragmented working relationship.

P4. "*There is a bit of that yeah and I mean there is a way in that consultants tend to behave and there's almost a sort of a professional barrier, there are no… they don't really laugh and joke and let you into their personal space whereas with some of the juniors you see some of their human side.*"

Two pharmacists reported that they felt only junior doctors made mistakes and were embarrassed to be highlighting errors to the head of the team.

P14. "*I was a bit apprehensive about doing it to the consultant because they tend to… the junior doctors then you tend to expect them to make an error whereas with the consultants then you feel a bit silly saying do you know that you have made this error and they are okay about it but not that many of my consultants prescribe either.*"

However, four pharmacists reported that consultants were happy to receive feedback in front of their juniors and this acceptance of the pharmacist and the feedback raised the profile of the pharmacist on the ward further.

P4*. "[Consultant name] had the group session so the esteem for the pharmacist after that would have gone up massively from the junior doctors and it's the same when you are on the ward round and you make a suggestion and the consultant agrees with you and they action it then it raises your credibility.*"

2c. Team integration

The majority of pharmacists reported feeling more integrated in the team as a result of the feedback process.

P11. *"I think that the immediate impact for me is that I feel immediately more integrated into the healthcare world at ward level and… just reflecting on it afterwards as you are more integrated just the position of pharmacy and how it has changed so it has changed massively."*

Various reasons for this were proposed including increased communication and shared decision making, self-confidence of the pharmacist, raised credibility of the pharmacists and information seeking behaviours.

P12. *"I find as well, especially when on [intervention ward] that it was easier to integrate yourself into the team really and they were involving me in their decisions and asking me for my opinion."*

2d. Trust in prescriber

Three pharmacists reported that they didn't need to worry about PEs for their doctors because they knew they had improved and were discussing the prescribing decision with them beforehand.

P7. *"I don't have to worry about the doctors' prescribing errors because they have already discussed it with me."*

2e. Prescriber communication

There was a clear uplift in communication between pharmacists and prescribers both directly from the feedback sessions, but also indirectly as a result of increased confidence of both pharmacists and prescribers to ask questions of each other.

P10. "*I think it has helped with approaching them, it does help, and even the other way the doctors come up to you as well and I think that that is another main change in that the doctors recognise you as a source of information.*"

Several pharmacists reported that some prescribers were anticipating questions on new or unusual prescribing decisions and involving them in the prescribing decision from the start.

P1. *"They'd [consultant] be like oh [pharmacist's name] have you heard of this rare regimen or have you read this paper or spoken to this rep [drug representative]. Like one of the consultant's printed out a paper and said I'd like to use this on here."*

8.4.3. Benefits of feedback

Four key codes were included within this category: Consistency in practice, role awareness, medicines optimisation, educational

3a. Consistency in practice

Pharmacists acknowledged that they encountered PEs daily and agreed that the process provided a consistent approach to feedback. Several pharmacists reported that this consistency raised expectations of prescribers to receive feedback where it became routine practice. Three pharmacists also suggested that this standardisation can improve the quality of communication of pharmacists with prescribers.

P11. *"Well first and foremost the biggest stand out thing for me is that it standardises pharmacist behaviour or attempts to provide some consistency. I think this formal process will help the people who have struggled previously you know who are too timid and you know what I am getting at it will bring them up to a level where we will have a baseline to work from."*

3b. Role awareness

Pharmacists consistently reported that delivering PE feedback was raising awareness of the role of hospital pharmacists with prescribers. Pharmacists felt their knowledge and skills were recognised more, raising their identity at ward level and facilitating information seeking behaviour.

P12. *"I also think that sometimes people sort of overlook you and are just like oh all they do is the drug histories and they don't know anything about drugs and specific conditions so you kind of… not that you are trying to get what you do noticed as such, but it is sort of noted that actually the pharmacist knows about those conditions so let's sort of ask them and get their opinion as well."*

Some pharmacists suggested this raised awareness of their role and team integration and was shifting their role from a peripheral, to a more integrated member of the team, which was helping to establish the professional role and identity of pharmacists.

P11. *"This is another opportunity to establish yourself professionally… because this defines the relationship. With Pharmacy, I think that it has been slightly kind of nebulous and no one is really sure of what pharmacy does. But now as part of their education, and ongoing professional development then, they have got this interaction, this formalised interaction with pharmacists."*

Other pharmacists suggested it was the formal interaction which contributed to acknowledging the role of the pharmacist.

P15. *"I think that it gives you a sort of a contribution to a team as opposed to someone who goes around and checks all of the kardexes and then just walks off the ward."*

3c. Medicines optimisation

Pharmacists were unanimously effusive that delivering constructive feedback was an improvement on previous practice. They reported that prescribers were not repeating the same errors and were getting it right the first time, although different errors were still being observed.

P12. *"I have found that up on [medical ward] when I had delivered feedback that they were still making mistakes but not on the area that I had fed back so it does teach them the way of prescribing one thing…obviously the main outcome of that is that we are improving patient care and patient safety so I do think that it is really, really useful."*

This was reported to have several benefits including increased patient safety and efficient use of pharmacist's time as they could focus more time on patient care and not correcting PEs.

P1. *"I don't have to correct every drug interaction or Seretide [inhaler device] or reducing dose [of steroids], the antibiotic is coming through with the duration and indication and they are reviewed after twenty four hours. I know that they are minor things but it takes so much workload off of you because you don't have to check if they are using an accuhaler or evohaler [inhaler devices] for example because the doctor has done it already."*

3d. Educational

Pharmacists reported that the process was educational for prescribers, encouraging reflection and personal development. This was facilitated by them having time to ask questions and clarify key points. Pharmacists also reported delivering ad hoc teaching where knowledge gaps were identified during the feedback session.

P7. *"It also allows me to gather information like with that [doctor name] and inhalers like not only deliver feedback but give her training then I was able to train her on different inhalers and devices and stuff."*

Furthermore, some pharmacists developed additional prescribing aids for repetitive PEs or educational sessions at the request of prescribers and delivered at a later time.

P1. *"Well a lot of them weren't doing reducing regimens of steroids and things like that so I just made a little hand-out for them which they carried around."*

The potential for learning was reciprocal with several pharmacists reporting that they were developing and learning from delivering feedback. Pharmacists reported they were spending more time researching and preparing for the feedback in comparison to a more directive approach which helped their own professional development.

P3. *"Well I'm learning obviously as well. Like with errors when we identify something on the drug chart then we have to go away and research it and look it up even more to try and give them the feedback do you get what I'm saying?"*

Several pharmacists suggested this also placed them at a vantage point as they had time to prepare for the session and anticipate potential questions.

P12. *"We're also in a really good position as pharmacists because we are not under pressure to give them an answer there and then so you can kind of look something up and then take it to the doctor and it looks like you know it all and you're like yeah we know all about this."*

8.4.4. Feedback facilitator

Six key codes were identified within this category: Feedback apprehension, facilitator training, job satisfaction, raised understanding of error, facilitator credibility and self-efficacy

4a. Feedback apprehension

All pharmacists reported an initial apprehension towards the process as it was a new role and they lacked self-confidence in their own knowledge or abilities as a facilitator.

P15. *"I had to psyche myself up a bit initially because that just comes down to self-confidence in delivering feedback because it was a new thing [expected of pharmacist to do]."*

Pharmacists also reported an anxiety towards potentially upsetting a prescriber, or compromising their working relationship if it was perceived punitively or poorly. However, any initial apprehension subsided following delivery of their first feedback session and they realised the positive outcomes of feedback.

P6. *"I think initial anxiety because normally there is a good dynamic on the ward and we had a good relationship and I didn't want to change that dynamic with them thinking oh here's [pharmacist] again… and you going to tell me that I have done something else wrong and then your dynamic could change but if anything it just got better and they are two things that … that's what I'm saying that surprised me a wee bit."*

4b. Facilitator training

Pharmacists reported that facilitator training provided them with the confidence to deliver the feedback. Role play scenarios were cited as being particularly useful whilst an understanding of prescriber views on receiving

feedback also helped. Pharmacists agreed that the training and use of a feedback proforma, provided a structure and consistency to the process.

P4. *"Just you know, your power point presentation and just having a few simple suggestions laid out for you that just helps you shape how you are gonna…it just shapes how you… and it gives a confidence boost you know you go oh okay that makes sense you know I go in with this then I talk about that subject and it just gives you structure to follow. And you know it's a bit rusty to start with and you're like oh what do I do now but then that eventually becomes second nature as with most things so no definitely."*

Several junior pharmacists also reported finding it useful to use a second person as a soundboard before delivering the feedback.

P15. *"I felt prepared, the training helps and I particularly liked that if I sort of came to you for advice on how to deliver it then I liked the way that you delivered it, you would set the context and provide background and set reflective questions to ask and obviously suggest some ideas to prevent it from happening again so I preferred it coming from you first before I gave the feedback. Like I knew what the problem was but needed a little bit of guidance on how to deliver it."*

4c. Job satisfaction

Pharmacists reported feeling a greater sense of job satisfaction from delivering PE feedback.

P10. *"Job satisfaction is much higher than if you are working individually in the corner and phoning doctors or paging them or asking them to just change stuff or just changing stuff yourself like minor errors. But once you get that whole picture with the doctors and the impact on the patient then you do feel more part of the team and I do think that that is biggest change for me."*

There appeared to be a number of reasons for this with pharmacists saying they felt more valued and part of the team where their contributions were recognised.   They also reported feeling more confident and useful as a result of increased communication with prescribers.

P14. *"Well it makes you feel really valued as a pharmacist and you go 'do you know what I am making a difference'. Maybe it's not to the patients directly but indirectly by improving their prescribing that we are making a difference and I think that pharmacists get overlooked most of the time and on the ward it would be the doctors, nurses, physios [physiotherapists] who get the thanks but pharmacy don't."*

4d. Raised understanding of error

Pharmacists reported an increased awareness and understanding of error causation, with some expressing surprise at the number of errors that were not knowledge based. This in turn influenced pharmacists approach to PEs with a shift from needing to correct the error, to wanting to understand the error and prevent it recurring.

P6. *"We are too focused on knowledge based errors and that has really opened my eyes up a bit more you know so if it is a knowledge based error is fair enough that a knowledge deficiency and that's what pharmacists are used to dealing with but I think the one that I did most delivery about this time was thinking about your human factors you know so thinking about your ways we do TTOs on the ward and thinking about your prescribing and then taking more time with it in a quiet environment. So I thought that that was a really good angle this time that I wouldn't have thought about delivering feedback on that before."*

Pharmacists reported that this awareness supported a solution focused approach to the feedback including identifying solutions to error provoking conditions that may be contributing to the PE.

P1. *"Definitely so, [foundation doctor] knew she was dyslexic so always sat on the pharmacy computer [quiet side room] because she was always selecting the wrong drugs because I kept saying you've picked this drug instead of this drug on the TTO [to take our or discharge prescription] so she kicked me off my computer and I used to go somewhere else when she was writing her TTOs. That was a sacrifice I made because the TTOs always came out right."*

4e. Facilitator credibility

Pharmacists agreed that they were credible facilitators as they intercepted the PEs, had established working relationships with the prescribers and were perceived as experts in medication use by prescribers.

P12. *"I think that we are in a good position to be doing it really especially if we are the ones picking up the errors which is what our job is really isn't it? So I think that we are in a good position to deliver feedback really. You could say that we should be feeding back to the consultants and then they have to feed it down to their juniors but that could be quite intimidating for the juniors and so maybe that's why it's better coming from us. Some people describe us as the experts in medicine so maybe we could do a little teaching session as well while we are there."*

Pharmacists advanced that by delivering feedback, their credibility as experts in medicines use was raised at a local level, raising the awareness of the pharmacist's role as reported earlier. However, two pharmacists also reported that feedback was a dynamic process with the prescriber asking many additional questions and where the facilitator could not answer these, their credibility was diminished.

P3. *"Well the way that I have seen it they have asked other pharmacists on the ward and they come back and say oh well I don't want to ask them again because they don't know so they are going to stop asking them."*

4f. Self-efficacy

Pharmacists reported a raised awareness of, and confidence in their own skills from delivering feedback.

P12. *"You don't know how much you know until you have to start telling other people. So, you probably do start becoming self-confident and are like wow I do actually know my stuff and I should start trusting myself."*

Some pharmacists reported surprise at how little prescribers appeared to know about medications which appeared to influence their self-efficacy, raising their awareness of their potential role as educators at the prescribing level and providing the confidence to engage more with the medical teams.

8.4.5. Prescriber impact

Five key codes were identified within this category: Prescriber response, information seeking behaviour, feedback seeking behaviour, goal motivating behaviour and prescribing behaviour.

5a. Prescriber response

Pharmacists reported that prescribers were overwhelmingly open to feedback, showing a genuine interest in their performance, asking further questions and seeking further feedback which surprised some pharmacists.

P6. *"Great, I mean I think that it is brilliant one of my biggest shocks well not shocks actually is that the prescribers liked it they actually loved it."*

Pharmacists acknowledged that their apprehensions regarding negative impacts on their working relationships where misplaced.

P9. *"I think that I had a preconception that it would deteriorate our relationship but no they took it really well and I think that they were really*

pleased to hear about it as well. Like [doctor] was absolutely fine with it and I went through the sheet with him and he was absolutely fine."

Pharmacists noted an initial anxiety from prescribers who were new to the process but equally acknowledged that those who had received feedback previously in the pilot study were expecting it as part of routine practice.

P7. "*The doctors that have already done it in previous years they will be expecting it and will be used to it like… you started it last year didn't you and so the senior doctors were already expecting that and even the junior doctors when you approach them they have already been told oh this is what we do so it's nothing new."*

Several pharmacists suggested that this prescriber response, and increased self-efficacy as reported earlier, motivated them to deliver further feedback and invest more time in their preparation.

P1: "*I don't think that I would have given it as much love because I would feel like I was wasting my time. But I was able to give it my love because I would go away and research it and answer as many questions as I did with them."*

5b. Information seeking behaviour

A prominent theme throughout was an increase in information seeking behaviour from prescribers. Pharmacists reported that feedback was interactive with prescribers seeking further information and clarification.

P1. "*When they saw me they would be like ok but why and why … it wasn't just feedback, I was hit with about twenty questions."*

Several pharmacists suggested this was because the feedback was often delivered in a setting away from clinical areas, allowing time to ask questions.

P6.   *"They were like oh I didn't know about this so can you tell me some more and they used it as an opportunity to maybe ask all of those questions that maybe they wouldn't."*

Advancing on this, most pharmacists noted a change in prescriber behaviour at the point of prescribing with a notable increase in use of medicines information resources such as the BNF, prescribing guidelines or the pharmacists themselves.

P15. *"Yeah definitely what I noticed, especially with the junior doctors on my last ward then I was being asked what to prescribe and how to prescribe and that's been consistent with the last two sets [who have had feedback] so yeah they would be standing there with their pen ready to prescribe and asking you for advice."*

5c. Feedback seeking behaviour

Ten pharmacists reported that prescribers were seeking further feedback verbally on their prescribing. This appeared to be both directly:

P1.   *"Like, [core trainee] came around and was like ok what feedback have you got for me? What have I done wrong this week?"*

Or indirectly when seeking clarification and confirmation that their prescription was correct.

P6. *"They done their TTOs beside me and they were saying can I double check this with you and double check this here as they were going through it and therefore asking and they said to me when they had done their TTOs can you check for any errors and I said no and they went there you go happy days."*

5d. Goal motivating behaviour

Pharmacists advocated that they felt prescribers were improving and making less PEs following feedback.   They suggested that this may have been because of reasons already reported, improved knowledge, awareness of error provoking conditions and information seeking behaviour. However, five pharmacists also suggested that improvements in prescribing may have been because prescribers were acutely aware that their prescribing was being monitored with the potential for feedback on any PE.

P13. *"I think they are more aware of what they are prescribing. So far, for the doctors that I have given feedback to they are aware that whatever they have written then someone else is looking at it and monitoring it and that makes them more conscious of what they are writing."*

5e. Prescribing behaviour

Pharmacists consistently described a change in prescribing behaviour and attitude with prescriptions given a greater priority by prescribers.   As reported, there was a notable increase in information and feedback seeking behaviour but pharmacists also noted a more considered approach to prescribing as opposed to a routine task. This included challenging senior doctors on prescribing decisions, reviewing the medication chart before prescribing and checking their prescription afterwards.

P7. *"The main thing that has changed has been attitude like I say… attitude towards prescribing is the main thing they won't just recklessly prescribe, I don't think that they do that now."*

Several pharmacists noted prescribers changing location for their prescribing to limit error provoking conditions, solutions that had been negotiated during the feedback session.

P6. *"One prescriber has said to me oh do you know how bad my prescribing error rate was and then when they were doing TTOs they said they weren't doing TTOs on the ward round and then they waited and done the TTOs at the end to the nursing staff which didn't go down too well [laughter] but that's what they said they were doing."*

8.4.6. Prescribing error

Five key codes were identified within this category: Error severity, timely feedback, supporting evidence, stage of prescription and error interpretation

6a. Error severity

Pharmacists agreed that all PEs required feedback and could be captured as an initial audit and feedback process. For on-going feedback, pharmacists agreed that feedback should be for significant errors only to limit diluting the message or being perceived as pedantic as one pharmacist suggested.

P11. *"I think that you have got the right level to go in at the right level for significant errors, if you go in with minor errors too then they will just switch off. It's the impact of the error so it's the severity. It has to register. I think that you become a bit… If you start delivering feedback on every single error then you become a bit of a… of a… if you go back to the punitive nature then they'll just be like oh here we go here is [pharmacist] with another mistake and no matter how much he dresses it up its just another mistake and the message is lost."*

The majority of pharmacists felt the training helped them to classify the errors appropriately although some felt it was still subjective and could lead to inconsistencies in what feedback is delivered.   Two pharmacists acknowledged they had probably been under-rating errors because they misinterpreted what a significant error was. Some pharmacists reported that prescribers did not always appear to agree with the severity rating and

suggested the severity rating was distracting for prescribers and that prescribers needed education on the error rating process.

P17. *"It is interesting because they don't think lansoprazole od [once daily] instead of bd [twice daily] is the same severity as the wrong drug. I mean I could write that one down but I know what I'll get with [registrar name] Ohhhh yes I know, I know yes yes and then he's all too helpful to get the pen off you and change it quick."*

6b. Timely feedback

Pharmacists agreed that timely feedback was essential to recollect the event and optimise the learning. Timely feedback appeared to be delivered in the majority of cases although pharmacists acknowledged that it was difficult at times when the prescriber had gone on nights or was on leave.

P8*. "If I had the forms it would be that day or the next day but sometimes it could be later if I just missed them before going on nights."*

6c. Supporting evidence

Where the PE was identified by a different pharmacist, in the dispensary for example, and they asked the ward based pharmacist to deliver the feedback, pharmacists reported that evidence of the PE was needed to contextualise the feedback and facilitate memory recall of the prescriber.

P2. *"Yeah definitely sometimes when you are trying to explain to somebody about an error that has been made and its complicated, they haven't written it in the right place or something then it is easier to see it even if you just get a photocopy before you get the feedback sheet so you say what do you think is wrong with that and see if you match up."*

6d. Stage of prescription

Pharmacists reported that there was a noticeable improvement in the quality of prescribing especially discharge prescriptions and rewritten medication charts with doctors changing where they undertook these tasks on the ward as described earlier.

8.4.7. Process improvement

Four codes were identified within this category: Formal vs. informal, shared learning, protected time and facilitator feedback

Pharmacists were supportive of the process with the majority suggesting no improvements were necessary although some plausible initiatives to be explored were identified from the data.

7a. Formal vs. informal

Pharmacists were consistent in advocating that the formalised process created consistency in both delivery and expectation of receipt of feedback on PEs. However, some pharmacists suggested that the term 'formalised' created apprehension and that it should just be described as feedback and delivered informally.

P4. *"It doesn't really have to be very formal. I think that when we say formalised then you get this impression of you know we're going to take you into this dark room and it's going to be very serious but it doesn't need to be like that."*

Equally, three pharmacists recognised the need to have a robust system in place where concerns could be escalated where prescribers were not improving.

P2. *"If you have got a doctor with a lot of errors coming through and have received feedback and they are not improving then you do need to go to their consultant and say look this is happening and you maybe need to step in now and have a word. I hate getting people into trouble. I wouldn't want to feel that I was grassing anybody up. But if it's not being sorted in the first instance then I'm going to go someone else."*

Some pharmacists questioned whether incident reports should be completed for any errors that require feedback but others suggested such a system was not designed for these purposes and could be perceived punitively.

P10. *"I have been doing datixes [incident reports] on patients coming in from MAU [Medical Assessment Unit] if they have missed any critical meds. But the problem there is that it doesn't really tell you who done it and it asks you about pressure sores and was it a slip or a fall."*

Other pharmacists suggested a more centralised process was required with a database for auditing what errors had been identified and what feedback had been given.

7b. Shared learning

There was clear potential for shared learning where PEs were discussed in general to a group of prescribers although some pharmacists felt this was not specific enough and could be dismissed as irrelevant by individual prescribers. Several pharmacists suggested however that serious, prominent, or recurrent errors could be highlighted to all prescriber grades periodically at team meetings or via e-mail.

P17. *"What you could do is every Monday talk to them [doctors] in the meeting and I could say that the error of the month is…"*

Other pharmacist's recognised that they were delivering feedback on the same PEs, suggesting local inductions could be created and delivered to

prescribers when they rotate into each ward area to raise awareness of area specific PEs.

P15. *"I think a ward based induction including common errors to that ward would be useful particularly coming off endocrinology then you see problems with GKI, insulin infusion, different insulin's so I think that that would be useful and show them what you know and how useful you can be from the start."*

7c. Protected time

Some pharmacists suggested that having protected time to deliver feedback would be useful to limit the impact on their workload. However, the majority of pharmacists felt that whilst this would be ideal, it was unlikely to work as you would not be delivering timely feedback. Others suggested that the feedback may not be constructive where multiple messages on multiple PEs had to be delivered.

P12. *"The only problem I can see with that is that you are saving up everything until one specific time and I don't know if that would bombard them with too much information and whether or not they would be able to remember everything that they did on say Monday if you did it on Friday. Especially with the patient moving then you wouldn't have the drug charts to show them and prompt their memory it would just be a case of oh do you remember Mr. Bloggs who came in with an AKI [Acute Kidney Injury] and sepsis but then that's what everyone comes in with."*

7d. Facilitator feedback

Some pharmacists reported that they would like feedback on the process to allow them to deliver feedback more effectively. Others argued that there was a lack of feedback within pharmacy but that pharmacy staff would all benefit from receiving similar feedback on their performance.

P2. *"I think as well though that there should be a 360 feedback about how I approached them on the ward. I'd like feedback about how they would like to be approached. Do they want a list of jobs to do at the end of the day? Do they want me to come to them after I've seen every patient? In the doctor's jobs book? [a list of tasks to complete]."*

8.5. Chapter discussion

The aim of this chapter was to explore and determine the experiences of hospital pharmacists of delivering PE feedback. The interviews used have provided the rich qualitative data to illuminate this aim and will be discussed below.

8.5.1. The process

The initiative was welcomed from all participants allowing consistent delivery of PE feedback echoing the findings of Bertels *et al.* (2013), where pharmacists agreed that individualised feedback on PEs was "both acceptable and desirable". Pharmacists are considered experts in medicines use (Ojeleye *et al.* 2014) and information providers (Elvey *et al.* 2013) with a key role considered that of a 'teacher' (Wiedenmayer 2006). Considering this, it is perhaps no surprise that participants felt they were credible feedback facilitators, echoing prescriber views in chapter 6.

Pharmacists reported a shift from a process of corrective, or directive feedback to one of facilitative feedback. This was often supported by delivery of confidential feedback away from the clinical area. This "safe climate" allowed open dialogue for prescribers to question and clarify any feedback points, important considerations for the process to be successful (Bok *et al.* 2013). Pharmacists also reported keeping the feedback 'informal' to mitigate potential anxieties. Where such feedback is seen as supportive with clear benefits to the prescriber, they are more likely to seek further feedback (Teunissen *et al.* 2009), an outcome reported in these interviews and in chapter 6.

Difficulties in delivering timely feedback were reported by pharmacists with similar prescriber views in chapter 6, because of working patterns or annual leave. Untimely feedback limits memory recall (Hysong *et al.* 2006), whilst no feedback is a missed learning opportunity. Further feedback modalities such as e-mailed feedback could be explored, although they do not reflect the principles of effective feedback which should be delivered verbally and in writing (Ivers *et al.* 2012). The NHS has proposed seven day working for consistent working practices, patient care and improved quality (NHS 2014). Such consistency in service provision could extend to the provision of consistent ancillary ward-based education and response to PEs, with feedback delivered consistently 7-days a week.

8.5.2. Impact on prescribing

Participants observed improvements in prescribing, corroborating the consistent reductions in PE rates reported in chapters 5 and 7, and views of prescribers in chapter 6. Elsewhere, 11.7% of pharmacist time wastages have been attributed to correcting PEs (Green *et al.* 2015). Where the average time to correct a PE has been reported to be fifteen minutes (Sullivan *et al.* 2013), the time pharmacists, nurses and doctors spend correcting PEs is considerable. If pharmacists spend less time correcting PEs, their skills and resources can be focused on other patient centred tasks to improve the quality of care. The Carter report (DOH 2016) advocates more effective use of hospital pharmacists, recommending that hospital trusts ensure that more than 80% of pharmacist resources are utilised for direct medicines optimisation activities. Where feedback has the potential to improve prescribing and patient safety, then delivery of constructive feedback as part of a clinical pharmacy service should become routine practice.

Improvements in prescribing could be directly related to the feedback where knowledge based gaps were identified. However, knowledge based mistakes do not always predominate as described in chapter 1.

Furthermore, pharmacists interviewed in this chapter expressed surprise at how many PEs were not knowledge based. Prescribers of all grades make PEs (Ashcroft *et al.* 2015), suggesting knowledge or at least prescribing education is only part of the problem (Maxwell *et al.* 2007).

Pharmacists noted a change in prescriber behaviour with prescribers seeking more information and feedback to inform prescribing. Similar outcomes were reported by prescribers suggesting feedback is influencing skills beyond a cognitive level. Feedback can raise self-awareness, reducing the gap between perceived and actual prescribing performance (Randolph *et al.* 2009). For learning goal-oriented individuals, this may be motivation enough to learn, engage with solution focused activities (Brett and Atwater 2001) and become exemplary prescribers with further feedback inquiry (Teunissen *et al.* 2009). For others, the primary driving goal may be to avoid receiving unfavourable feedback (Brett and Atwater 2001) or their performance perceived in a negative light, an outcome described as a feedback 'cost' in performance oriented individuals (Teunissen *et al.* 2009). The use of credible feedback facilitators who have observed prescribing practice may also be influencing prescriber motivation (Bok *et al.* 2013), underpinning the use of ward based pharmacists as feedback facilitators.

It has been reported that much of a trainee doctors learning occurs in practice in an apprenticeship model (Dornan *et al.* 2009, Brazil *et al.* 2002) with Garbutt *et al.* (2005) reporting junior doctors learn about safe prescribing by "copying orders written by other physicians". Such a model is prone to error where the prescriber does not prescribe in context for the next patient's renal function, co-morbidities or medications for example, or when the original prescription is erroneous to begin with. The conscious competence learning model suggests that learners may progress through four stages of competence from unconsciously incompetent, to unconsciously competent (Figure 64).

Figure 64: Conscious competence learning model

Conscious Incompetence
- Prescriber understands the importance of a particular aspect of prescribing, but completes prescription incorrectly

Unconscious Incompetence
- Prescriber unaware of a partiuclar deficit in prescribing performance

Conscious Competence
- Prescriber completes each step of the prescribing process but has to think about each step

Unconscious Competence
- Prescriber prescribes correctly without much thought

Constructive prescribing performance feedback

Delivery of constructive feedback has been described as optimizing learning by junior doctors (Kroll *et al.* 2008). Considering this, prescribers' learning and development will be limited or they may assume their performance is satisfactory, unless a significant event occurs or they receive feedback; that is, they are "unconsciously incompetent". Feedback can raise self-awareness and highlight the importance and value of prescribing accurately and safely; the prescriber becomes "consciously incompetent". Constructive feedback provides solutions and ideas to improve practice, where prescribers implement these, it is likely to require greater focus or concentration; that is, they are "consciously competent"; a more considered approach reported in this chapter or raised discretionary effort reported in chapter 6. For prescribers to reach the final stage of competence, it is likely to take further time than has been allowed in this project but can be facilitated with a commitment to lifelong learning and ongoing feedback to encourage permanent changes in prescribing behaviours. Considering this and given the benefits on PEs reported in this thesis, where PE feedback is not delivered, are pharmacists derelict in their duties?

8.5.3. Impact on pharmacists

A prominent theme reported in these interviews was increased self-efficacy and self-worth, influencing the perceived value and job satisfaction of pharmacists.

Self-efficacy is a core component of social cognitive theory (Bandura 1997). Individuals are capable of altering their behaviour and environment through their perceived self-efficacy, and ability to achieve results with their tasks or roles (Bandura 1977). People have a tendency to engage in activities in which they feel confident and competent in, and avoid those in which they do not (Pajares 1996). In chapter 4, pharmacists described apprehensions in communicating with prescribers and delivering feedback. Following formalisation of PE feedback, pharmacists reported improved prescriber rapport and communication, actively attending ward rounds, seeking out feedback opportunities, delivering bespoke training sessions and being utilised more as an information source. Here, they altered their own behaviour and environment. Considering this, the greater their sense of self-efficacy, the more effort pharmacists invested into delivering feedback and becoming involved in other ward-based activities. As one pharmacist described, they gave it more of their 'love', resonating with social cognitive theory where individuals are more likely to commit to action where they believe they can solve a problem (Bandura 1997). These outcomes contrast with the apprehensions reported by pharmacists in chapter 4 with the intervention increasing their self-confidence to engage with prescribers and influence prescribing further.

Pharmacist motivation also resonates with the five-stage hierarchy of needs (Maslow 1943) where people are motivated to achieve certain needs (Figure 65). Before progressing to higher level growth needs, lower level needs must be fulfilled or as a pharmacist fulfils one need, they seek to fulfil the next one. Where pharmacists feel more integrated in the clinical team there will be a greater sense of 'belonging'. Where they have improved 'esteem' and confidence from professional achievements, and recognition and respect

from prescribers as reported in chapter 6, they can climb the hierarchy to realize their potential and develop as a professional. In both the pharmacist interviews in this chapter and prescriber interviews in chapter 6, additional educational interventions and prescribing support tools were reported as outcomes of feedback: pharmacists were innovating practice. If hospital pharmacist skills are to be utilized to optimize medicines use as outlined in the Carter report (DOH 2016), raising their self-efficacy to empower interaction and integration with clinical teams can only help.

Figure 65: Maslow's hierarchy of needs (Maslow 1943)

Constructive feedback is a dynamic, interactive conversation to facilitate learning (Lloyd *et al.* 2016a). The focus should be on the task and individual receiving feedback. It should not be a passive process (Archer 2010, Lloyd 2016) to encourage "a full circle of shared responsibility" (Sullivan *et al.* 2013) through active participation and dialogue. Within the socio-constructivist paradigm, feedback enables learners to gain fresh insight and understanding, emphasising that the facilitator does not dictate the process (Evans 2013, Archer 2010). A co-constructivist approach advances this

further suggesting that the dynamic nature of delivering feedback creates a reciprocal learning process where both facilitator, and learner, learn from each other (Carless *et al.* 2011). More recently, Telio *et al.* (2015) proposed an "educational alliance" framework for feedback delivery. In chapter 6 prescribers reported the educational outcomes of feedback and in these interviews, pharmacists have similarly reported delivering PE feedback supports their own personal development.

Such interactions could be considered as part of a "community of practice" (Lave and Wenger 1991). Here, prescribers and pharmacists are interacting to enhance a collective understanding of each other, prescribing issues and their meaning in the context of the clinical environment. This context will include the social, cultural and environmental factors that all interact to influence prescribing.

8.5.4. Impact on pharmacist-prescriber relationships

A dominant theme in these interviews was improved rapport with prescribers and greater team integration, comments echoed by prescribers interviewed in chapter 6. Appreciating the reasons for PEs and the pressures that prescribers are under increased pharmacist empathy with prescribers, informing a less critical approach to PEs, with similar views reported elsewhere (McGuire *et al.* 2015).

Pharmacists consistently advocated that they were more integrated in the clinical team which was accelerating rapport building with prescribers: an important consideration for teamwork when junior doctors typically rotate every four months. Directly, feedback opens dialogue with prescribers, creating a community of learning that can foster rapport and establish working relationships. Indirectly, where this increases self-confidence and self-efficacy of pharmacists, they would be more likely to engage with the clinical team. Another plausible consideration is that by acting as facilitators of PE feedback, an educational teacher-student (pharmacist-prescriber)

hierarchy is created providing pharmacists with the confidence to challenge prescribing more.

These process outcomes for pharmacists are all plausible positive influencers on prescribing. This resonates with the variable outcomes reported by prescribers in chapter 6 and underscores the complexity of the feedback intervention. An unintended negative consequence was reported, with the credibility of one pharmacist questioned where they were unable to answer relevant questions. A similar minority view was expressed by prescribers in chapter 6 and here, the knowledge, skills, experience and confidence of individual pharmacists would be an additional variable.

In complexity theory, the system is connected (Cohen *et al.* 2011). Pharmacists, prescribers, nurses, patients, resources, equipment and the environment are all key components of a complex ecology. The prescribing process, and learning to prescribe, is part of a "complex adaptive social system" (McLellan *et al.* 2015). If an element of these components changes, a '*butterfly effect*' occurs and the system changes. These components co-evolve in response to change, and are auto-catalytic with any resultant new order a result of internal self-organization. Each component in the system interacts and in this research, feedback has altered that interaction and amplified pharmacist and prescriber behaviours. For "self-organized criticality" (Bak 1996, Cohen *et al.* 2011), a single, seemingly simple intervention, in this case PE feedback, can create a large effect from interactivity and non-linear connections.

The variables that influence a prescribing decision are complex (Aronson 2009a) and PE interpretation can be subjective (Dean franklin *et al.* 2005). Where or if the decision to provide feedback is initiated, how the pharmacist and prescriber engage and interact will vary, with dialogue and discourse non-linear. What solutions are negotiated and how these affect prescriber or pharmacist practice or interaction with the clinical environment, is unknown. The potential for a cascade amplification of these variables is illustrated in figure 66.

Figure 66: Variability of process outcomes from prescribing error feedback
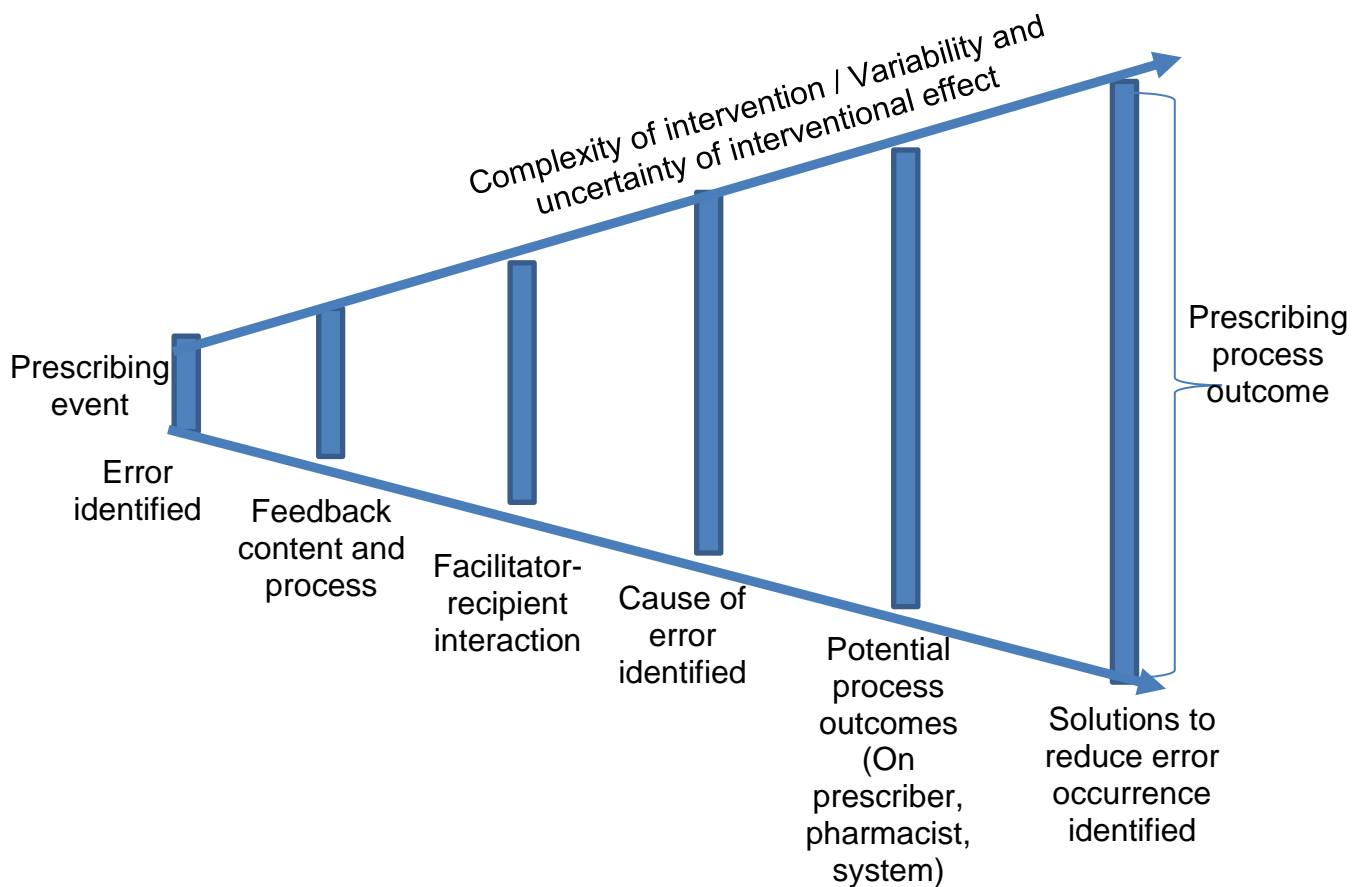
Therefore, the true affecters of change on prescribing are elusive, and could be any number or combination of variables reported here or in chapters 6 or 9 interacting synergistically, creating a cascade of uncertainty of the true effect of prescribing error feedback.

Where a complex system has "connectedness", changes to this connectedness through increased teamwork will produce changes in prescribing. Where pharmacists are more integrated or involved in prescribing decisions, the system will self-organize. Where feedback, either positive or negative is provided, the interaction between the prescriber, senior colleagues, patients, the prescription chart and pharmacist will change. Where prescribers seek further feedback, the system will continue to evolve or "self-organize". Here PE feedback can be catalysing the system

or could simply be a perturbation that pushes the system beyond a 'tipping point' for seismic change.

For example, where feedback raises role awareness or usefulness of a pharmacist, this is likely to influence teamwork and information-seeking behaviour at point of prescribing. Where this raises the confidence of pharmacists, they are more likely to engage with prescribers and innovate practice which will influence prescribing outcomes. Equally, the social process of feedback can create motivation for prescribers to improve and the support to do so. The setting and environment are components of the system and the role of the ward-based pharmacist will influence motivation of prescribers to learn, and the pharmacist to deliver any bespoke education.

Which of these multiple outcomes manifests or has the greatest influence on prescribing would be supposition, but offers possibilities for further research and avenues of enquiry. However, the author proposes that several process outcomes are more likely to influence prescribing. Firstly, good teamwork alone can improve patient safety (Firth-Cozens 1998) and where pharmacists deliver prescribing education as part of any feedback process, teamwork could be improved (Lewis and Tully 2009). Teamwork includes information and feedback-seeking behaviour as reported in this research. Secondly, feedback can raise self-awareness of prescribing competence with enhanced situational awareness informing self-regulation of prescribing. Finally, the importance of self-checking to identify slips and lapses is reported and is a simple intervention to identify skill-based errors.

These behaviours could support the prescribing process both before, during and after completion and suggest possibilities for prescribing education. They also tell us that the feedback can influence multiple components of a complex social prescribing system, and that the outcomes are potentially greater than its individual component parts.

Considering these variances, where the feedback intervention is applied uncritically in other settings, similar outcomes may not be obtained. For

example if the feedback process differs or the conditions of the system vary (for example pharmacist and prescriber relationships are already optimised or there are more non-medical prescribers who may respond differently to feedback) then similar prescribing outcomes may not be observed.

Some pharmacists suggested information seeking from prescribers was excessive and created an overreliance on them in some cases. Here it could be argued that prescribers are sharing responsibility with the pharmacist for the prescribing decision if they perceive it to be risky (Di Caccavo *et al.* 1995) or likely to result in feedback. A similar phenomenon has been reported in primary care where GPs pass responsibility to hospital consultants (Armstrong and Ogden 2006), a term coined 'defensive avoidance' (Di Caccavo *et al.* 1995) where prescribing decisions are 'deferred'. However, equally, seeking accurate medicines information at the point of prescribing is a core element of effective prescribing (Maxwell and Walley 2003). Where senior prescribers are unavailable for advice, such lack of supervision has been associated with PEs (Dean *et al.* 2002). Pharmacists recognise themselves as information providers (Elvey *et al.* 2013) as reported in these interviews and the focus groups in chapter 4, and where this role is recognised by prescribers, their potential to both inform and negotiate prescribing should be utilised.

Inter-professional ward-based interactions have been described elsewhere as ad-hoc, task-oriented and terse (Lewin and Reeves 2011). Doctor-nurse relationships in particular have been described as 'parallel' with limited information sharing or effective collaborative working (Lewin and Reeves 2011). There appears potential for feedback to influence teamwork, changing from a process of parallel working where pharmacists feel like they are anonymous and working on the periphery of clinical teams, to a more centralised and co-operative process with shared decision making. In "To Err Is Human: Building a safer health system" (Institute of Medicine 1999), as part of a triangulated approach to PEs, it was recommended that pharmacists should be part of the 'rounding' (ward round) process. Such a team approach can allow prescribers to prescribe correctly every time where

the pharmacist informs prescribing choice, dose, frequency and monitoring with clear benefits for patient care. Such an approach can provide a culture where the prescriber and pharmacist act as counter balances and checks, improving the prescribing safety net and driving development of each others' practice.

Being an effective communicator has been proposed as an essential role of pharmacists (Wiedenmayer 2006). However, it has been suggested that pharmacists are often anonymous characters, or perceived negatively in the media (Elvey *et al.* 2013, Poirier *et al* 1987), views that do not support the status of the profession. Patients have reported a lack of understanding of the role of hospital pharmacists in their care (Morecroft *et al.* 2015), views expressed by other healthcare professionals (Healthcare commission 2007). Such professional ambiguity and anonymity could be exacerbated by the communication apprehensions and limited communication with prescribers reported in chapter 4. Concerns over pharmacist's social skills have been reported previously with hospital pharmacists described as 'aloof' (Elvey *et al.* 2013). This echoes the views of student healthcare professionals elsewhere with pharmacists receiving low ratings for perceived social skills (Hean *et al.* 2006). Considering the multi-professional approach to patient care, the implications of such findings have ramifications for teamwork and patient care. Delivery of PE feedback creates a platform for pharmacists and prescribers to interact and catalyse further communication. Hospital pharmacists have been striving for professional recognition and in these interviews, pharmacists described an increased awareness of their roles by and communication with prescribers. These outcomes are consistent with prescriber views reported in chapter 6 and can contribute to developing the professional identity and professional recognition that pharmacists strive for.

8.5.5. Sustainability

Pharmacists agreed that PE feedback was gauged correctly for significant errors, with a risk of diluting the message and making the interaction less

memorable for minor errors. This is consistent with prescriber views reported in chapter 6 and findings published elsewhere (Bertels *et al.* 2013).

The initiative was considered sustainable with little demand on pharmacist time. Individual PE feedback typically took less than five minute, with overall PE feedback lasting less than fifteen minutes although this required little investment of pharmacist's time, echoing findings elsewhere (Sullivan *et al.* 2013, Gordon and Bose-Haider 2012). Furthermore, it was considered that the potential benefits of feedback warranted investment of pharmacist time, with some pharmacists suggested it was more relevant than other responsibilities.

The process of auditing prescribing and drafting feedback reports was considered more time consuming, consistent with limitations of audit and feedback reported elsewhere (Montesi and Lechi 2009). However, pharmacists did advocate that audit and feedback at the start of prescriber rotations facilitated rapport building and was essential. Reducing the audit period from five to two days could allow collection of some prescribing data that would be less labour intensive, minimising the risk of data collection fatigue (Ashcroft *et al.* 2015) whilst still supporting PE feedback.

8.5.6. Improving feedback

The potential for shared learning was reported echoing findings in chapters 4 and 6 and could facilitate group discussion, a feedback approach considered likely to influence future prescribing (Ferguson *et al.* 2017). Group discussion could allow benchmarking to other prescribers, creating further goal-oriented behaviour to modify practice (Jamtvedt *et al.* 2006). However, an individualised approach is considered more effective as described in chapter 2.

Lewis *et al.* (2014) suggested that prescribers need to be aware of the support that pharmacy can offer at hospital induction. Advancing on this, each clinical area will have unique prescribing problems and a more

proactive approach to 'feedback' could be local ward-based inductions for prescribers. This could support initial rapport building, highlight prescribing problems and how to avoid them, and the role and support that pharmacy provide. This approach could be considered as feeding-forward where certain PEs are anticipated and solutions to avoid them negotiated. It has been proposed previously that regular formal and informal communication can encourage good team working (Firth-Cozens 1998) with Lewis and Tully (2009) suggesting that pharmacist-led training on medications could improve teamwork at a local level.

8.6. Strengths and limitations of these interviews

This is the first qualitative study exploring the in-depth views of pharmacists to delivering formalised PE feedback. The semi-structured interviews have provided the qualitative depth needed to illuminate the research aims.

This study has confirmed reports of improvements and changes in prescriber behaviour from chapter 6. However, building on the reported themes from chapter 6, there are multiple variables that could be influencing prescribing outcomes.

These unintended positive outcomes make inferences on the true effect of what is a complex intervention difficult to interpret. Feedback can provide information for the system to change and grow but equally it may be no more than a perturbance (Cohen *et al.* 2011) that catalyses a chain of events in what is a complex and adaptive system. Therefore, the same outcomes may not be obtained with this intervention in other settings where pharmacist, prescriber or other service provision differs.

Whilst there was a limited number of interviewees, data saturation was achieved with redundancy of themes, confirming adequacy of the recruited sample (Guest 2006). Equally, not all pharmacist grades were interviewed although participant views are likely representative of the wider department.

Qualitative data analysis is open to interpretation, and this limitation was mitigated by independent second coding by the supervisory team (SDW and SVOB).

Whilst the author knew the pharmacists in a professional capacity, the risks of halo or Hawthorne effects (Basit 2010) were limited by clarification of responses. Furthermore, as described in chapter 3, having rapport with interviewees and understanding the background and context of the research is a potential strength and not weakness.

8.7. Implications of these interview findings

Pharmacists value the PE feedback intervention and consider it sustainable. Echoing prescriber views in chapter 6, the concerns reported by pharmacists in chapter 4 appear unfounded. In contrast, delivering PE feedback has positive impacts on pharmacist-prescriber relationships and pharmacists themselves, supporting the need for routine practice of pharmacist-led PE feedback in STHKH. These outcomes may also be having unanticipated positive effects on prescribing practice and, whilst feedback can be the accelerator to amplify change, the true effect of the intervention as a single process cannot be determined with any certainty.

8.8. Chapter Summary

A key aim of these interviews was to understand the experiences of hospital pharmacists of delivering formalised PE feedback. This chapter has presented relevant participant details, data collection and analysis techniques, and an overview and discussion of the results.

Pharmacists value and welcome the feedback intervention considering it worthwhile and sustainable. Benefits extend beyond improved prescribing with enhanced prescriber rapport and communication, team integration and shared decision making for prescribing reported. These outcomes appear to positively influence the self-efficacy, confidence and job satisfaction of

pharmacists.   It is possible that these process outcomes are contributing to the reported changes in prescribing error rates and underlines the complexity of the intervention.   Chapter 9 will now explore the impact of feedback on prescribing behaviour.

Chapter 9. Exploring the impact of feedback on prescribing behaviour

9.1. Chapter Introduction

This penultimate chapter will explore the impact of PE feedback on prescribing behaviour.

The primary research aim of this chapter was to:

Explore the impact of feedback on prescribing behaviour

An overview of the interview process will be described initially followed by presentation of the results with relevant interview quotes. These results will then be discussed, compared and contrasted to the wider literature and other findings in this thesis, outlining the impact of pharmacist-led feedback on prescribing practice. The chapter will then conclude with a summary of these findings.

It has been proposed that future research into prescribing education needs to "enhance our understanding of what underpins observed behaviour changes" (Brennan and Mattick 2013, Craig *et al.* 2008) by including a qualitative process evaluation within quantitative study designs. The results of chapters 5 and 7 reported significant impacts on PE rates whilst the experiences of receiving and delivering feedback have been described in chapters 6 and 8. However, whilst changes in prescribing behaviour were reported, these changes were not explored in detail. An understanding of these changes will highlight why the intervention is having an effect, and could support both the feedback process and PE reduction interventions further.

9.2 Semi-structured interviews

Semi-structured interviews were used to provide the in-depth information required as described in chapter 3.

9.2.1 Eligibility for interview

Forty-seven prescribers worked on the intervention wards. Of these, thirty-seven received feedback on overall prescribing as reported in chapter 7. Prescribers were eligible to be interviewed if they received feedback on an individual significant PE in the previous week. This was to ensure they had sufficient memory recall to discuss the PE. Receipt of feedback on overall prescribing was not a pre-requisite. Pharmacists were trained in delivery of PE feedback as discussed in chapter 4.

9.2.2. Prescriber recruitment

Prescribers were recruited by ward pharmacists who provided participant information sheets (Appendix 10) following delivery of feedback to the prescribers. Where prescribers expressed an interest to participate, the author followed up with a face-to-face discussion at ward level before arranging a mutually convenient time to conduct the interview. All prescribers who were approached during recruitment expressed an interest to participate. Twenty-four prescribers expressed an interest to participate following PE feedback. A total of 23 prescribers were interviewed (Table 31) and 65 errors discussed over 38 interviews between September and December 2015. One prescriber (Grade CT1) could not be interviewed during the recruitment phase as the error had occurred more than a week ago. Similarly, three prescribers (R1, R6 and R10) were illegible for further interviews but were not approached as the PE had occurred over a week previously. The reasons for the time delay were typically the prescriber being on annual leave or working night shifts. Additionally, two prescribers (prescriber R6 and R16) refused further interviews as they had already participated at least once in the interviews in this chapter. Once it was considered that data saturation was achieved as described in chapter 3, no further prescribers were recruited.

Table 31: Participant information for semi-structured interviews [a]

Prescriber code	Prescriber grade	Male or female	Years Qualified at time of interview	University	Number of interviews	Number of errors discussed
R1	FY1	Female	1	Liverpool	4	9
R2	FY1	Female	1	Norwich	2	3
R3	FY1	Female	1	Keele	3	3
R4	FY2	Male	2	Liverpool	3	3
R5	FY1	Female	1	Liverpool	1	1
R6	FY2	Female	2	Liverpool	2	3
R7	CT2	Female	4	Liverpool	2	2
R8	CT2	Male	5	Leicester	1	2
R9	FY1	Male	1	St. George's	3	3
R10	ST6	Male	8	Liverpool	1	3
R11	ST4	Male	6	Liverpool	1	1
R12	FY1	Male	1	Liverpool	1	2
R13	CT1	Male	3	Liverpool	1	3
R14	FY1	Female	1	Czech Republic	1	3
R15	FY1	Female	1	King's College	1	1
R16	FY1	Male	1	Ireland	1	3
R17	FY1	Female	1	Liverpool	1	2
R18	FY1	Female	1	Liverpool	2	5
R19	FY1	Female	1	Liverpool	1	3
R20	FY2	Female	2	Warwick	1	1
R21	CT1	Female	3	London	1	4
R22	CT1	Male	3	Liverpool	2	2
R23	FY1	Female	1	Liverpool	2	3
				Total	38	65

[a] An overview of each prescriber grade is provided in chapter 1

9.2.3. Interview process

Interview duration varied between 8 and 33 minutes (Table 32). Interviews were conducted in a private interview room, typically on the ward although several interviews were also conducted in an interview room in the pharmacy department at the discretion of the prescriber. Ward staff were informed of the interview in an attempt to limit disruptions. Prior to commencing the interview, the purpose of the study was covered again and both verbal and written consent obtained by the author. A topic guide (Appendix 5) was used to explore key themes and ensure consistent issues were discussed.

Table 32: Overview of prescriber interviews

Interview	Duration (mins)	Prescriber	Prescriber grade	Error	Stage of prescription (InP = inpatient, TTO = discharge)	Active failure
1	11:45	R1	FY1	Rivaroxaban renal dose	InP	KBM
2	11:22	R1	FY1	Amlodipine 10mg vs 5mg Seretide 500 2 bd vs 250/25 2 bd	TTO TTO	Slip Violation
3	22:53	R2	FY1	Latanoprost omitted Amlodipine 20mg prescribed	TTO TTO	Slip Slip
4	16:12	R3	FY1	Omeprazole od vs bd	TTO	RBM
5	18:27	R3	FY1	Enoxaparin omitted on re-write	InP	Slip
6	12:38	R4	FY2	Amiodarone and simvastatin 40mg (IP)	InP	KBM

Interview	Duration (mins)	Prescriber	Prescriber grade	Error	Stage of prescription (InP = inpatient, TTO = discharge)	Active failure
7	14:08	R5	FY1	Losartan/HCTZ Rxd vs losartan (TTO)	TTO	Lapse
8	15:26	R6	FY2	Amlodipine and simvastatin 40mg	TTO	Lapse
9	18:42	R7	CT2	Doxycycline in 1st tri pregnancy	InP	RBM
10	14:52	R8	CT1	Olanzapine instead of osalazine Kayceel but K+ >4	TTO TTO	Slip Lapse
11	17:04	R9	FY1	Ramipril on TTO but stopped on kardex	TTO	Slip
12	15:30	R10	CT6	Nine items Rxd for Incorrect patient (TTO) Pregabalin 75mg od vs bd Atorvastatin omitted	TTO TTO TTO	Slip Slip Slip
13	13:32	R6	FY2	Mirtazepine 45mg po bd vs od Omeprazole 20mg po od vs 40mg	TTO TTO	Slip Slip
14	19:01	R7	CT2	Tramadol Rxd wrong patient	InP	Slip
15	12:38	R4	FY2	Rivaroxaban and enoxaparin	InP	Lapse
16	21:31	R11	ST4	Humalog bd vs Humalog mix	InP	RBM
17	19:02	R12	FY1	Fluvoxamine bd	TTO	Slip

Interview	Duration (mins)	Prescriber	Prescriber grade	Error	Stage of prescription (InP = inpatient, TTO = discharge)	Active failure
				instead of od	TTO	
				Quetiapine omitted		Slip
18	13:04	R1	FY1	Bisacodyl 10mg bd vs od	TTO	Slip
					TTO	
				Adcal D3 tds vs bd	TTO	Slip
				Dorzolamide vs dorzolamide/timolol		Slip
19	17:37	R13	CT1	Metoclopramide no duration	TTO	KBM
					TTO	
				Amitriptyline 50mg on vs 100mg		Slip
					TTO	
				Modafanil 100mg on vs om and 100mg pm		Slip
20	18:27	R14	FY1	Tramadol transcribed 50mg po tds instead of qds	TTO	Slip
				Gaviscon Advance transcribed 10mL po tds instead of qds	TTO	Slip
				Flucloxacillin prescribed as 500mg po tds	TTO	KBM
21	19:40	R15	FY1	Incorrect insulin dose for hyperkalaemia	InP	KBM
22	18:56	R16	FY1	Meropenem 1g IV tds. should have been 1g IV bd (GFR)	InP	KBM
					TTO	
				Prednisolone 30mg po od prescribed.		Slip

Interview	Duration (mins)	Prescriber	Prescriber grade	Error	Stage of prescription (InP = inpatient, TTO = discharge)	Active failure
				No reducing course prescribed but needed in this patient. Amoxicillin 500mg po tds for five days but course was complete	TTO	Slip
23	11:42	R1	FY1	Metformin 1g bd vs 500mg bd Doxycyline and iron Cephalexin on TTO but C&S = R	TTO InP TTO	Slip KBM Slip
24	19:49	R3	FY1	Nicorandil 150mg od vs 10mg bd (TTO)	TTO	Slip
25	14:47	R9	FY1	Digoxin on TTO but stopped as inpatient (TTO)	TTO	RBM
26	23:20	R17	FY1	Clexane Tx dose with fondaparinux Spiriva 2puffs bd vs I od	InP InP	Lapse KBM
27	23:28	R18	FY1	Sulfadiazine vs sulfasalazine Lansoprazole omitted from TTO	TTO TTO	Slip Slip
28	19:10	R18	FY1	Metoclopramide prescribed regularly no duration Incorrect Lithium	TTO TTO TTO	KBM Slip

Interview	Duration (mins)	Prescriber	Prescriber grade	Error	Stage of prescription (InP = inpatient, TTO = discharge)	Active failure
				dose on TTO Lansoprazole prescribed on TTO but discontinued		Slip
29	14:21	R19	FY1	Seretide device incorrect Midazolam Rx duplicated Latanoprost / timolol transcribed as latanoprost only.	TTO TTO InP	Slip Slip Slip
30	20:22	R20	FY2	Madopar CR 125 po qds vs madopar (TTO)		Slip
31	21:04	R21	CT1	Insulin infusion 1mL/kg/hr Levetiracetam multiple doses prescribed on one medication chart entry. Sodium Valprotae multiple doses prescribed on one medication chart entry. Novorapid [short acting insulin] prescribed with an insulin infusion	InP InP InP InP	KBM RBM RBM KBM
32	33:26	R2	FY1	Dabigatran Rxd	TTO	Slip

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Interview	Duration (mins)	Prescriber	Prescriber grade	Error	Stage of prescription (InP = inpatient, TTO = discharge)	Active failure
				instead of darifenacin		
33	18:07	R9	FY1	Novomix 30 instead of Novorapid	TTO	Slip
34	08:27	R4	FY1	Humalog instead on Humalog Mix25	InP	RBM
35	17:11	R22	CT1	Prednisolone reduced to zero. Should be 10mg maintenance	TTO	RBM
36	12:20	R22	CT1	Stalevo no strength	TTO	Slip
37	14:09	R23	FY1	Thiamine od vs tds	TTO	Slip
38	12:11	R23	FY1	Latanoprost vs latanoprost/timolol	TTO	Slip
				Amoxicillin bd vs tds	TTO	Slip

9.2.4. Data analysis

All interviews were digitally recorded and transcribed verbatim by the author, with the exception of anonymising person and place names. Interviews took between one and two hours to transcribe. Transcripts were read whilst simultaneously listening to the audio file to correct any transcription errors.

All transcripts were independently read by the supervisory team, SDW and SVOB.

Transcripts were coded line-by-line and analysed thematically by the author as described in chapter 3. This included open coding of transcripts for relevant data with codes identified both deductively from the topic guide and results from chapters 6 and 8, and inductively, for codes that could not be predicated beforehand.

An initial inductive approach to coding was adopted with ideas and interpretations of the data indexed in the margins of the transcripts. Interpretive ideas and concepts were informed both *a priori* from research aims and *a posteriori* from participant views (Pope *et al.* 2000) that the researcher could not predict (Gale *et al.* 2013) such as 'assertive behaviour', 'task-prioritisation', 'mindful prescribing', 'self-regulation' or 'self-detection of errors'. Codes were then amalgamated into larger categories to produce an initial thematic framework (Appendix 25).

Categories and codes were discussed with the PhD supervisors at regular team meetings. Inter-coder discrepancies were resolved for an analytical consensus. The framework was then applied to transcripts to measure the fit, with further inferences and refinements typical of the framework approach. Relevant transcript extracts were then copied and pasted under the relevant code in the final thematic framework for further analysis and meaning in relation to the research question.

9.2.4.1. Prescribing error classification

Errors were initially categorised by the author following descriptions outlined in chapter 1. Where the prescriber described situations reflecting more than one type of error (for example a KBM and a slip), the error was classified according to the most prevalent typology described by the prescriber. Error classification was also undertaken independently by SDW and SVOB with any discrepancies resolved through discussion. An overview of PEs discussed is presented in tables 32 and 33.

Table 33: Overview of active failures discussed during prescriber interviews

Prescriber grade	Error type	Prescriber Grade			
		FY1 (n=13)	FY2 (n=3)	CT/ST (n=7)	Total (n=23)
Mistake	KBM	7 (16.3%)	1 (16.7%)	3 (18.8%)	11 (16.9%)
	RBM	4 (9.3%)		4 (25.0%)	8 (12.3%)
Skill bases error	Slip	29 (67.4%)	3 (50.0%)	8 (50.0%)	40 (61.5%)
	Lapse	2 (4.7%)	2 (33.3%)	1 (6.3%)	5 (7.7%)
Violation		1 (2.3%)	0	0	1 (1.5%)
Total		43	6	16	65

9.3. Results

Twenty-three prescribers were recruited with a range of prescriber grades from FY1 to CT6 (Tables 32 and 33). Prescribers were allocated codes for anonymity (Table 32). It was considered by the author and PhD supervisors that data saturation had been achieved by interview 20, although further interviews were conducted to provide greater richness of material for each active failure. Relevant qualitative extracts are referred to by transcript number T1-T38.

Table 34: Thematic framework for prescriber interviews

Category	Code	Code occurrence (and number of interviewees)				
		KBM	RBM	Slip	Lapse	Violation
Affective behaviour	Assertive behaviour	2(2)		5(4)	7(4)	0
	Reflective practice	4(4)	3(5)	7(5)	7(5)	0
	Self-awareness	5(5)	4(5)	27(18)	4(4)	1(1)
	Self-regulation	1(1)	6(5)	7(6)	3(2)	0
	Emotional impact	6(6)	13(6)	29(16)	10(5)	0
	Task prioritisation	0	2(2)	9(7)	3(2)	0
Learning outcome	Prescribing knowledge	13(6)	3(3)	2(2)	0	0
	Self-detection of errors	0	3(3)	7(6)	2(2)	1(1)
	Raised situational awareness	0	0	6(6)	3(2)	0
	Prescribing practice	Separate category see below				
Prescribing practice	Information seeking behaviour	9(8)	3(2)	12(9)	0	0
	Mindful prescribing	0	10(7)	25(16)	8(4)	1(1)
	Systematic approach to	0	5(3)	20(15)	3(2)	0

Category	Code	Code occurrence (and number of interviewees)				
		KBM	RBM	Slip	Lapse	Violation
	prescribing					
	Prescribing location	0	0	10(6)	4(4)	0
Error recurrence	Specific vs. general learning	19(11)	20(9)	38(18)	11(6)	1(1)
	Facilitator variability	3(2)	2(2)	4(4)	0	0

The complete thematic framework with themes and secondary codes can be seen in table 34. Four key categories emerged from the data corpus, these were:

1. Affective behaviour
2. Learning outcome
3. Prescribing practice
4. Error recurrence

Sample quotations are given under thematic headings to demonstrate the experiences and views of participants. These quotes were agreed with the research team SDW and SVOB and will be reported below in the context of mistakes and skill-based errors.

In general, prescribers discussed their PEs openly and candidly acknowledging the error as their own and the need to learn and improve their prescribing practice. One prescriber (R15) was somewhat defensive when discussing their PE although they had also had a formal conversation with

their senior over a particular PE that may have influenced their attitude. All prescribers were overwhelmingly positive about the project, echoing findings of chapter 6, and openly discussed the potential impact that feedback was having on their prescribing practice.

9.3.1. Affective behaviour

Six codes were included in this category: assertive behaviour, reflective practice, self-awareness, self-regulation, emotional impact and task prioritisation.

1a. Assertive behaviour

For mistakes, prescribers reported being more assertive in challenging hierarchy and prescriber etiquette: avoiding assumptions that more senior prescribers are always correct or in seeking further information to inform their prescribing as discussed later.

T22: *"If they say oh go with 1g tds [three times a day] then I would usually go with what they say like if they said go with this, they are the experts… that [feedback] would be like a prompt now I guess for me to say and by the way they have a reduced creatinine clearance what dose would you go for?"* [**KBM**]

For skill-based errors such as slips and lapses, prescribers reported being more assertive in managing disruptions and communicating such issues with team members for example.

T26: *"After [ward pharmacist] pointed that out then I have…like when I am doing a kardex re-write or something and someone interrupts me I'll say no! [puts hand up] and I did that to [consultant] the other day… he had a group of medical students and I was writing this complicated digoxin loading dose and I just said "I'm sorry, but I'm doing this otherwise I'll make a mistake"* [laughter]." [Lapse]

It was acknowledged however that distractions were always likely and that in some cases it can be difficult to challenge the status quo as a junior doctor.

T15: "*I think maybe only in terms of being more forceful now and saying give me a list and I'll sort it later but sometimes especially on [acute medical ward] it can be difficult with the environment and it's a very nurse led environment and so as the doctor or the junior doctor especially, then you are just following the line rather than challenging the status quo.*" [Lapse]

1b. Reflective practice

For all error types, prescribers reported reflecting on action to determine the error causation and for action required, to ascertain how they need to perform differently next time to minimise error recurrence.

T32: "*It's good because really this is the kind of thing that you should be talking … about isn't it and you know what are you doing wrong, what can you do to address it?*" [Slip]

Advancing on this, where prescribers reported prescribing a similar drug or being in a similar situation, they were reflecting-in-action to become more mindful and inform their decisions with the feedback session functioning like a flag or cue to further focus them on their prescribing.

T34: "*I was thinking about what [ward pharmacist name] said and checking the dose, frequency and stuff and writing fifteen minutes before their meal.*" [KBM]

1c. Self-awareness

For all error types, prescribers consistently reported a raised awareness of PEs for both their own practice and in general, understanding the risk of, and

ease at which PEs can occur. For mistakes, it was clear that feedback was informing practice and highlighting what they didn't know.

T16: "*Yeah I thought it was useful I've had the learning point from it and it just reminds you how easy it is to make errors because with the law of averages you must go through an average year making x amount of mistakes and no one ever tells you about it and until you get an intervention such as this you don't learn.*" [RBM]

Feedback equally highlighted "blind spots" for skill-based errors. Several prescribers reported that discharge prescriptions or rewriting of medication charts was a routine and monotonous task but equally one they did not realise had the potential for error.

T20: "*TTOs, I think that it is just… a robotic task that you have to do and you don't really have to use your brain and that was how I was thinking about it when I first started and when I watched other doctors do it I just thought oh okay it's very easy and you don't really have to think about it and you just copy it and that was my first impression! [Laughter] But it is easy to make a mistake and you do have to think.*" [Slip]

This self-awareness highlighted prescribing competence, limitations in practice and areas for improvement as one prescriber articulated.

T26: "*I hope that the feedback continues because without it you are unconsciously incompetent and with it you are consciously incompetent and you can change! [Laughter] And you can't learn without feedback!*" [KBM]

1d) Self-regulation

By raising self-awareness, it was consistently advocated that feedback informed prescribing, allowing prescribers to regulate their prescribing practice and adapt their prescribing behaviours, facilitated by the solution focused outcome of feedback.

T28: *"I do also think that it is useful to get feedback and pull out specific things because it's quite difficult to make a change unless you have that feedback and know what you have done and what you need to do."* [Slip]

For mistakes, prescribers acknowledged the need for greater information seeking behaviour whilst for skill-based errors, the need for more mindful prescribing was acknowledged although there was a general sense amongst prescribers that prescribing can become a mindless task.

T14: *"I always thought that I was a dead good prescriber but I have perhaps become a little more lax."* [RBM]

Considering this, prescribers advanced that feedback needed to be on-going, routine and consistent to continually self-regulate prescribing and prevent bad habits from resurfacing or creeping back into practice, especially for skill-based errors.

T24: *"We haven't had that many TTO errors recently so we're improving… I have been checking more again although I don't know if that is just a rebound effect of getting criticised and then you go a wee while and you're like oh that's okay I'm alright now."* [Slip]

1e) Emotional impact

Constructive feedback was unanimously welcomed and valued for all error types. For mistakes, there was a sense of embarrassment, disappointment and self-criticism for deficits in their own prescribing knowledge.

T6: *"I was glad to have got the feedback because there are going to be lots of people on simvastatin and amiodarone here [cardiology ward] potentially. I was disappointed perhaps that I hadn't known it in the first place but that was purely a knowledge base but you can't know everything and learning from it is the most important thing."* [KBM]

T9: *"I was really, really upset. I pride myself on usually being a good prescriber and it was a lapse and I'm not overly confident in pregnancy so I should just check everything that I prescribe in pregnancy because I know that it is not something that I confident in and I don't know why I didn't to be fair."* [RBM]

For slips and lapses there was a sense of guilt and frustration at making an avoidable error.

T13: *"I think… this is just a slip really so it is just a bit frustrating really that I didn't identify it and I think that the feedback is a positive thing rather than a negative thing."* [Slip]

T8: *"I was a bit annoyed that I didn't identify it myself."* [Lapse]

This frustration was accelerated where the prescriber, through feedback, identified error provoking conditions as key causative factors.

T27: *"I got upset when I saw this because I knew that was just a ticking time bomb and it was just a matter of time before something like this was going to happen"* [Slip]

1f) Task prioritisation

It was acknowledged that prescribing was sometimes considered a lower priority task than other responsibilities. For slips, prescribers reported greater prioritisation of the prescribing task to limit PEs. Several prescribers reported commencing discharge prescriptions in advance of discharge to ease pressures on their workload later and avoidance of multi-tasking. This appeared to be in countenance to previous practice where prescribing was routinely undertaken at the same time as another task or during a busy ward round for example.

T12: *"I think that it can definitely help them I think that errors will always occur but I do think that it helps you to prioritise your TTO's, don't bunch them and be more errr… thorough, to save any further embarrassment."* [Slip]

For lapses, prescribers reported acting on prescribing jobs immediately instead of leaving them to a later time and risking forgetting to change a prescription or commence a new medication for example.

T3: *"I should have written it down and prescribed it there and then and then at least it would have been prescribed instead of saying oh I must do that."* [Lapse]

For skill-based errors, the need to prioritise prescribing created conflict at times with junior doctors in particular struggling to prioritise tasks.

T5: *"You know so in this case this patient in this bed needs their TTOs done or just a letter from me because I've just spent twenty minutes with the discharge facilitator now trying to work out what they want me to do now when they had ten things and I was like well what do you want me to do first? That's quite difficult to prioritise then because they just want you to do everything which obviously you can't."* [Slip]

9.3.2. Learning outcome

Three codes were included within this category: prescribing knowledge, self-detection of errors and raised situational awareness. A fourth code, prescribing practice was moved into its own category (3a-d) as there were several tertiary codes associated with it upon analysis as described below.

2a) Prescribing knowledge

Whilst prescribers acknowledged they could learn from any error, it was largely mistakes that were reported to improve their drug related knowledge with education making the process more meaningful and memorable.

T6: *"Well you get the form and the contextualisation in terms of the interaction and what it is makes it helpful and you then remember it because you can't just remember a list of numbers oh this dose with this and this dose with this. So knowing the pharmacology behind it helps you to remember and so you can then apply it to other situations and it reminds you about the inducers and inhibitors [of enzymes] situations."* [KBM]

This was not restricted to specific medications but also to specific situations such as dosing in pregnancy, renal impairment or checking for drug interactions.

T1. *"Especially being on a care of elderly ward I know now that I should be checking renal function more often."* [KBM]

For slips, it was clear that feedback improved specific drug related knowledge when the incorrect dose or frequency was chosen for example. Some prescribers suggested that it would be difficult to look up the dose of every single medication they had to prescribe or transcribe from one chart to another, although it was acknowledged that this should be best practice.

T24: *"It was useful and the fact that it was bd [twice daily] and also it reminded me to look up what drugs are in general yeah because I know the common ones but I wouldn't have known something like that to be honest."* [Slip]

2b) Self-detection of errors

Prescribers reported identifying more of their own errors after receiving feedback especially on skill-based errors, although prescribers who received feedback on mistakes also reported self-detection of errors from being more careful and mindful with their prescribing.

T4: *"And I have actually found a couple of times when I have made mistakes and like when a dose was ten but actually it was forty and stuff like that so I have picked up some of my own errors from rechecking it. So, that is worthwhile doing."* [RBM]

For mistakes, it was acknowledged that it can be difficult to identify an error where you are confident it is correct.

T21: *"So when you are sure of something then you don't look it up for example you don't look up every dose of every drug that you prescribe. For example you prescribe Tazocin and you know the dose is 4.5g so you don't look it up. You prescribe paracetamol you know the dose is 1g so you don't look it up, you know if you are sure of something then you don't look it up."* [KBM]

Through raising awareness of their own PEs and prescribing knowledge, some junior doctors reported challenging senior prescribers and seeking further information from them to inform their prescribing.

T22: *"I have to admit with regards to the amoxicillin and reducing regimen that was a mistake that I was making when I first started and now I have realised that then when I am prescribing it I am looking through the drug chart and speaking to the consultant and saying what are we doing with this? How many days do you want?"* [Slip]

2c) Raised situational awareness

For skill-based errors, prescribers reported having a raised awareness of the situation when they are prescribing, such as distractions and other error provoking conditions, and the need to be vigilant to manage these causative factors.

T26: *"Distraction wise, I have an increased awareness now and perhaps better communication with the nursing staff too just please don't interrupt me when I am prescribing."* [Lapse]

This was not limited to external factors with several prescribers reporting taking forced breaks following feedback discussions when tired, hungry or stressed to limit the impact on their prescribing.

2d) Prescribing practice

Prescribing practice appeared to be influenced at many levels by feedback with improved knowledge informing future prescribing decisions. Equally, prescribers reported refining their prescribing skills at a non-technical level. This latter outcome was considered a more prominent learning outcome theme and will be discussed separately below.

9.3.3. Prescribing practice

Four codes were included within this category: information seeking behaviour, mindful prescribing, systematic prescribing and prescribing location.

Overall, feedback was considered a positive intervention that would facilitate prescribing improvements at the knowledge and technical level. One prescriber articulated the impact on their prescribing quite adroitly.

T4: *"With [ward pharmacist] I feel like at the end of my four-month rotation I will be a better prescriber."* [RBM]

3a) Information seeking behaviour

For mistakes, prescribers were consistent in advocating that they were seeking information at the point of prescribing to guide and inform their decisions. This included communicating with pharmacists more and where they were guided by a more senior prescriber to initiate a medication, prescribers reported seeking more information on the dose and duration. This extended beyond drug specific medicines information, to seeking technical information on renal function and reviewing the medication chart for potential drug interactions or duplication for example.

T9: *"I think as well now that I will be extra cautious and if I can't find the information or get on toxbase then I'll just call the on-call pharmacist for advice. You don't want to bother them but it is very easy to make mistakes especially when I'm not confident in a specific area."* [RBM]

Prescribers reported asking pharmacists to check their prescribing prior to submitting discharge prescriptions in particular. Prescribers also reported proactively seeking and acting on written pharmacy communication in the medical notes or on the medication chart, information that they may have previously not paid attention to.

T28: *"Today when I was looking at the kardexes I was making sure that I was super-duper doubly looking through them and I saw that there were pharmacy comments and I do find that I now look for green pen whereas I perhaps wouldn't have been… not interested as… not disinterested but I wouldn't have really thought to look."* [Slip]

3b) Mindful prescribing

For KBMs, prescribers reported greater information seeking behaviour as reported. However, there was also a clear sense of more careful, considered or 'mindful' prescribing for RBMs.

Prescribers reported being more conscious of their prescribing instead of it being a routine task and the need for second opinions. This was informed by a raised awareness of errors and the potential emotional impact from making the error.

T4: *"I think that I'm more aware that it is being looked at and for example I'm paying more attention than if you wasn't doing it. Now I'm like if this is wrong it costs time for somebody else and if it isn't it gets done quicker and you don't end up in that position because I'm thinking well if I can get it right the first time then I don't have to get it fixed later and I don't have to have it as a black mark as such… I knew that she would spot the error and come and tell me off so I would put a bit more effort in."* [RBM]

As reported, prescribers were prioritising their prescribing more to maintain required standards and not multi-tasking at the expense of PEs. This extended to taking more time and care with the task. For skill-based errors in particular, prescribers reported investing more time and not rushing the task to ensure their prescription was correct first time.

T27: *"I try to be a lot more careful and I try to slow down with them."* [Slip]

Again, this practice appeared to be motivated by not only the potential emotional impact of the PE:

T3: *"I mean that [prescribing error] freaked me out massively and I know that you think it's not that significant, but to me it was because if I done that with something else and killed someone then that is a massive problem and I*

wouldn't like to be in that kind of position so there are benefits for taking a bit of extra time and care then actually you can avoid that can't you?" [Slip]

But the potential embarrassment of receiving feedback on avoidable errors:

T22: *"I've been discussing this with [another FY1] and we've been saying that because we know that [ward pharmacist] is watching then we do take that little bit of extra time and you know now I'll double check my prescriptions whereas before I wouldn't and I was making these silly little errors because I knew that pharmacy would come and check it after me."* [Slip]

3c) Systematic prescribing

In addition to being more mindful and investing more time in prescribing, prescribers also reported adapting their prescribing behaviour, adopting a more systematic approach and introducing safeguards to minimise error. As one prescriber reported, it was about going back to basics with each prescription to maintain standards.

T14: *"I think that it is just about being methodical so even if you are busy you keep going through those basics and making sure that you are not missing anything and double checking so I think that it is transferrable across the board."* [RBM]

Another prescriber suggested that feedback is a prompt to continue with these basic principles that may be missed over time.

T8: *"I need to get a little bit better …. I mean I was perhaps a little bit better at this when I first started and now I'm a little bit more…. I need to get back to reviewing my medications more after I have done the TTO. You know when you try and do it as quick as you can and submit whereas now I need to go through it and review them [the medications] and go back and look at the kardex [medication chart]."* [Lapse]

For KBMs, this approach reinforced the need to seek appropriate information to inform prescribing as reported. For RBMs, prescribers reported reviewing others' prescribing and not assuming it was correct. For example, on discharge prescriptions that other prescribers have been involved with and not just items that they have prescribed.

T25: *"I guess the solution is just not to assume that the TTO is fine and I need to look through every single time that I use then before I submit it and that's all …and I mean even from today, this morning with a TTO I made sure that it was right, I corrected myself… when I had a patient that needed discharging today, then I printed off both lists and went through and compared and made sure that I had everything on that TTO because that TTO was done a couple of weeks ago when that patient was ready to go home so I made sure that I didn't make this again."* [RBM]

Prescribers reported that skill-based errors would be difficult to eliminate entirely. However, a raised self-awareness of their own errors appeared to re-iterate the need for safeguards in their own prescribing practice. In particular, prescribers reported introducing a second check of their prescriptions once completed to identify avoidable errors: errors they have reported detecting more following feedback as discussed earlier.

T13: *"I think that this has just reinforced the need to re-check my TTOs which I do now after the last one [previous interview] and it doesn't take that long to just take a quick glance to make sure it's okay and it just makes sense in my head as well because it is so easy isn't it to make a simple slip when you haven't read it and then you read it again and think why the hell have I prescribe it like that you know why have I done it twice when I know that it is once a day"* [Slip]

Specific changes to prescribing processes included printing off the discharge summary to check their prescribing as opposed to previously checking it on the computer screen. Other changes in practice included typing in the full

drug name as opposed to a few letters to avoid choosing the incorrect item from drop boxes on electronic prescribing systems. Several prescribers reported performing a particular aspect of their prescribing first to make sure they didn't repeat a particular slip, such as the transcribing of enoxaparin for venous thromboembolism prophylaxis, or not ticking boxes for frequencies of medications. These changes appeared to be coping mechanisms to avoid specific types of errors. Building on this, feedback for skill-based errors appeared to refine prescribing with subtle but important changes in their prescribing practice as proposed by one prescriber.

T11: *"Well I think that the feedback is definitely improving the way that I prescribe you know it's just like little things here and there"* [Slip]

3d) Prescribing location

Echoing earlier results where the ease of error was recognised and the need to afford greater priority to prescribing, the suitability of the working environment for prescribing was questioned. Prescribing was considered ubiquitous with prescribers acknowledging that they would often prescribe mid-ward round or on busy clinical stations.

T15: *"It was on ward round and I was going through patients. It's not an ideal environment it's a busy ward round and you're not remembering to check back on things. I think that at the time there were a few instances where nurses were coming up to you and saying can you do the TTO for this one and at the same time can you write them up for some laxatives so it was a very busy ward round with lots of interference"* [Lapse]

Whilst this did not appear to influence mistakes, the impact on skill-based errors was telling. Prescribers described increased assertive behaviour in response to distractions as already reported with some refusing to complete discharges or re-write discharge prescriptions mid ward-round.

T26: *"I won't re-write a kardex on the ward round now, I'll put it on my list and I'll do that later because I can't multi-task."* [Lapse]

Several prescribers reported changing locations where distractions could not be mitigated.

T7: *"I've changed computers or I'll use this room more [a quiet doctor's office] and I'll read through them again, even read through the TTO aloud when I'm doing the TTOs so very much so."* [Lapse]

9.3.4. Error recurrence

Two sub-categories were included in this category: Specific vs. general learning and facilitator variability

4a) Specific vs. generic learning

Prescribers reported that they were unlikely to repeat the same mistake twice and that they would be actively looking for that specific issue in future when prescribing the same medication. This was informed by improved knowledge for mistakes and also reflection-in-action for specific errors and situations as reported earlier.

T6: *"It is certainly something that I will look for and have a glance to see if they are on simvastatin. I'm certainly looking for it now. Yeah I mean I'm more aware now and so will look for it [the interaction]…. But it was drug specific."* [KBM]

However, despite outlining the importance of seeking appropriate medicines information to reduce mistakes, prescribers acknowledged that any error reduction was likely to be limited to specific situations discussed during feedback such as dosing in renal failure or pregnancy for example.

T9: *"I think that this particular case and the tools that I have been given would really just stick with the pregnancy because I do know that there are renal formularies and stuff but I still don't know how to get hold of them!"* [RBM]

For skill-based errors, prescribers reported that the learning outcomes should be generic and would not be limited to the specific error or medication. By taking more time, prioritising prescriptions and adopting a more systematic approach to their prescribing, all skill-based errors could be reduced.

T17: *"With these it's not a mistake or a knowledge issue, it's about the skill of prescribing"* [Slip]

Equally, for skill-based errors in particular, there was a sense of futility regarding feedback amongst some prescribers where PEs were always likely to occur, unless the system was changed to support prescribing and eliminate the error provoking conditions.

T15: *"The previous error that we discussed last time was more of a knowledge thing so that was why whereas this one was just a distraction... a work-based or workload one so risk will be reduced but risk will always be there."* [Lapse]

4b) Facilitator variability

Variations in facilitator approach to feedback were reported. For mistakes, it was reported that some pharmacists discussed the detail behind a specific drug interaction, choice of dose or contraindication for example. Others appeared to take this further by delivering bespoke educational sessions or provide further examples to contextualise the learning.

T34: *"The feedback was very good and I was glad to have the feedback, you need to know about your errors so you can correct them. We discussed the*

differences and why it happened and she talked through the insulin education aid although I had had that last year as well." [RBM]

For skill-based errors with some pharmacists appeared to advise prescribers of the need to 'be more careful'. This echoes findings from interviews with pharmacists in chapter 8 with some pharmacists reporting they had nothing 'juicy' to work with. Other pharmacists appeared to be far more constructive with their feedback, identifying specific solutions to mitigate further problems, provided other examples or education for example.

T29: *"For the Seretide [an inhaler] device, [ward pharmacist] also brought up some inhalers to show me the difference. It does just remind you that they are different and what one patient can use isn't always the same as what another patient can use."* [Slip]

Prescribers acknowledged that the latter style of feedback would be more constructive and meaningful.

T33: *"We had a small talk about it, nothing specifically on differences or timings… I think some [education] would just sort of drill it into you really."* [Slip]

Two prescribers suggested that where feedback was not particularly constructive, the potential impact went beyond the learning outcome and influenced the rapport and working relationship with the pharmacist, key ancillary outcomes of the feedback process reported in chapters 8 and 4.

T4: *"When the new pharmacist was there I didn't feel under as much pressure because I wasn't very intimidated by her because she was quite junior and quite nervous and it was quite hard to get that professional relationship with her whereas when [ward pharmacist] was there I knew that she would spot the error and come and tell me off so I would put a bit more effort in. Whereas with my newly qualified pharmacist she would be like oh well you've done this wrong but it's okay I'll just fix it for you so there was*

less pressure on me to get it right the first time. Whereas… I'm not intimated by [ward pharmacist] you know but she is clearly very good at her job and you want to emulate that yourself." [RBM]

9.4. Chapter discussion

These interviews were undertaken to understand and determine the impact of feedback on prescribing behaviour and to help explain the quantitative results reported in chapters 5 and 7. The results suggest that whilst feedback is influencing prescribing practice and skill development at a knowledge and technical level, delivery of feedback is having a greater influence on development of non-technical skills (NTS).

Echoing results of prescriber interviews in chapter 6, feedback provides a formal intervention for prescribers to reflect on the situation, identify causative factors and plan adaptive strategies to prevent the error from recurring: an agenda-led, outcome based approach to feedback advocated for teaching of prescribing competencies (Lum *et al.* 2013). As part of their commitment to professional development, prescribers should reflect on their practice and identify learning outcomes empirically and iteratively. Feedback reduces the gap between perceived and actual performance (Randolph *et al.* 2009) and can catalyse progression around the experiential learning cycle (Hill 2007) to accelerate development of prescribing competency (Figure 67).

Figure 67: Experiential learning cycle (from Lloyd *et al.* 2016b)
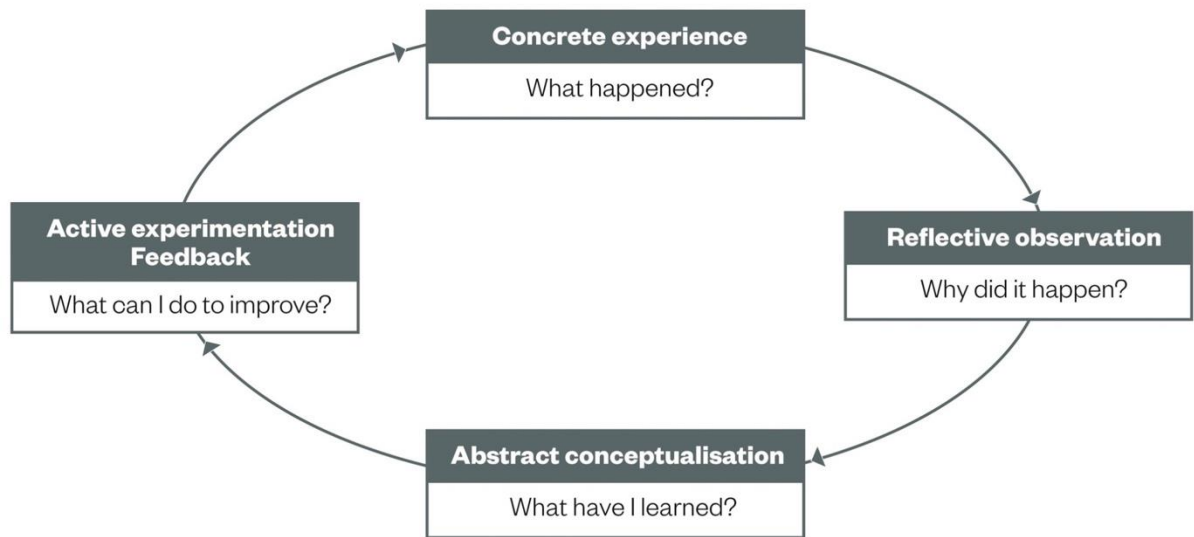
Prescribers in these interviews reported amending their prescribing behaviour with a range of adaptive behaviours. Some of these behaviours are reported in table 32 below and highlight some of the NTS required to prescribe appropriately and limit mistakes and skill-based errors.

The majority of PEs were classified by the author as skill-based errors and not mistakes, findings consistent with previous publications (Dean *et al.* 2002, Lewis *et al.* 2009). In these cases, a lack of knowledge is not the sole underpinning reason behind the error (Tully *et al.* 2009, McLellan *et al.* 2012). This is perhaps not surprising considering current medical education for undergraduates and foundation grade doctors, is reported to focus on technical and knowledge based aspects of prescribing (Kirkham *et al.* 2015).

As articulated recently (Gordon *et al.* 2013b): "*A technically perfect prescriber can and will still persistently carry out aberrant prescribing*". Building on this, education or improved knowledge, as argued elsewhere (Ross, Patey and Flin 2013), is not the panacea of PE reduction strategies. This is perhaps why the prescribing safety assessment is so curious:- in 2014 there was a 94% pass rate (Sayburn 2015) suggesting that prescriber knowledge in general is to be commended. However, the assessment

gauges the lowest form of competence, 'knows', whereas in clinical practice we are more concerned with the doing, a level of competence that is influenced by far more than the knowledge and technical aspects of prescribing.

That said, where education is required, the feedback facilitator can help to educate and improve a prescriber's knowledge. Indeed, educational outcomes of feedback have been reported in this chapter and also prescriber interviews in chapter 6. As discussed in chapter 8, this can be a co-constructed event or "educational alliance" with the feedback facilitator also learning.

However, many of the adaptive behaviours and skills reported in this chapter resonate with the nontechnical skills (NTS) required to prescribe safely and accurately. Perhaps in this regard, education should be considered as part of a wider skills acquisition, of which NTS will be one facet of prescribing competence. NTS include the social skills of communication, team working and leadership and the cognitive skills of situational awareness and decision making (Ross *et al.* 2013). These skills also include error awareness and professional responsibility and are increasingly recognised as integral to safe prescribing (Gordon *et al.* 2013a, Kirkham *et al.* 2015). In other high-risk industries such as aviation, the need to address NTS of individuals, as well as technical expertise and system-wide issues to reduce error, has been reported (Lerner *et al.* 2009).

Several prescribers reported that they just needed to return to 'basics' and arguably each individual component of prescribing could be considered a 'basic' skill. However, as a whole, prescribing is a complex skill (Aronson 2006) with multiple steps and processes. This complexity makes the prescribing process littered with opportunities for PEs, making it a high-risk task (Coombes *et al.* 2007, Gordon *et al.* 2013a). The EQUIP study reported that learning to prescribe is a social experience (Dornan *et al.* 2009), one that is part of the clinical environment in which prescribers learn. Therefore, it is inappropriate to teach prescribing exclusively in isolated silos away from

clinical areas. Recently, McClellan *et al.* (2012) have articulated this eloquently (Figure 68) illustrating prescribing as an integrated set of complex skills involved in the expert performance of it. The model illustrates how knowledge, skills and attitudes interact with the environment (social context) in which they are applied. These skills are self-regulated to enable the prescriber to adapt to the changing demands of their environment and clinical situations. Such self-regulation requires self-reflection, with feedback a potential catalyst to accelerate development as described at the beginning of this discussion.

Figure 68: Theoretical model based on theories of expertise development and instructional design theory for complex skills (from McLellan *et al.* 2012)
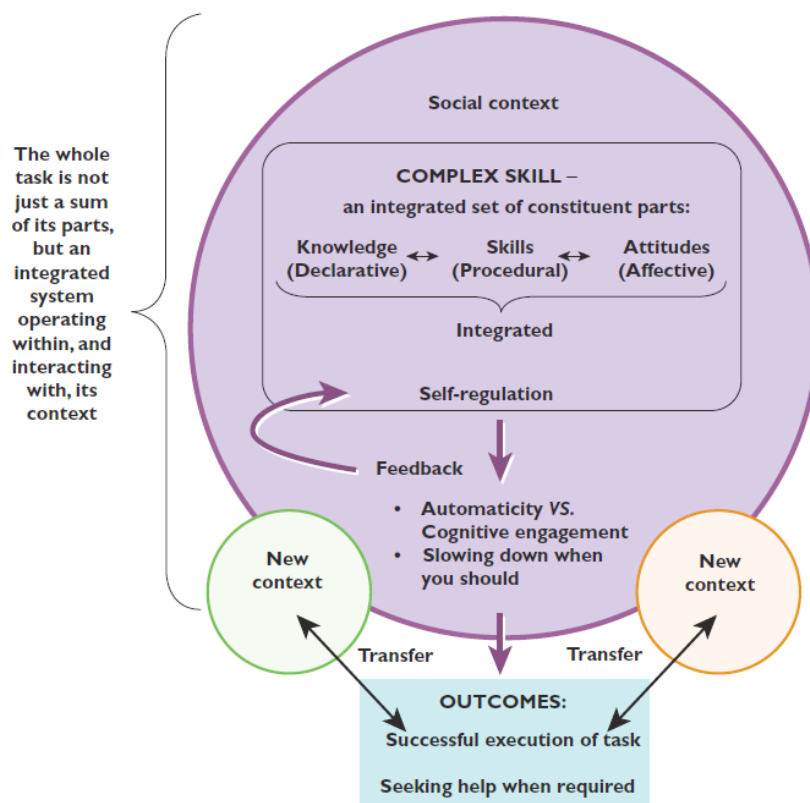
This theoretical model proposed by McLellan *et al.* (2012) advocates that the skill of prescribing is greater than the sum of its parts but it should be highlighted that it does not explicitly include NTS as a 'part' that can influence unsuccessful execution of the prescribing task. NTS reported as

contributing to PEs include poor communication, managing workload, poor teamwork and supervision, and impaired prescriber well-being (Dornan *et al.* 2009, Ross *et al.* 2013b). A taxonomy of NTS required to prescribe safely has been proposed (Dearden *et al.* 2015) and includes:

- Situational Awareness
- Decision making
- Communication and team working
- Task management

This taxonomy resonates with the findings reported in this chapter with NTS reported mapped against relevant active failures in table 35 below. The diversity of outcomes builds on findings from chapters 6 and 8 that the feedback intervention is complex with multiple process outcomes.

Table 35: Reported prescriber behaviours following feedback on specific error types

Error type	Non-technical skill	Reported NTS outcome of feedback
Mistakes (KBMs and RBMs)	**Situational Awareness**	• Raised awareness of own limitations • Information seeking behaviour • Access pharmacist more • Request second opinion on prescribing
	Decision making	• Information seeking at point of prescribing to inform decisions • Access relevant guidelines and information resources
	Communication and team working	• Documenting course duration for antibiotics or steroids for example • Clarifying prescribing decisions with senior colleagues • Feedback seeking behaviour to inform practice
	Task management	• Prescribe in context i.e. review all

Error type	Non-technical skill	Reported NTS outcome of feedback
		medications not just what you prescribe • Check allergy status, renal function, co-morbidities before prescribing • Adhere to best prescribing practice
Skill based errors (slips and lapses)	**Situational Awareness**	• Raised awareness of error provoking conditions • Raised self-awareness of own errors • Be 'mindful' of prescribing task (especially when on-call) • Check relevant bloods and observations routinely • Aware of impact on patient safety and team members • Prescribing mindfully and treating prescribing as a high-risk task • Introduce safeguarding practices such as accuracy check of own work • Control emotions when under stress or remove self from area until calmed down • Force self to take a break when tired / hungry / thirsty • Avoid completing discharges immediately after a long / busy ward round • Prescribing in a quiet location • Slow down when aware that they are rushing
	Decision making	• Information seeking at point of prescribing to inform decision more • Access relevant guidelines • Change location if cannot manage distractions

Error type	Non-technical skill	Reported NTS outcome of feedback
	Communication and team working	• Asking for second checks before completing / submitting discharge prescriptions • Communicating risks of distractions with colleagues • Challenge distracting / disruptive behaviour • Refining working practices (i.e. jobs lists) to limit distractions • Communicate workload demands with seniors • Ask for jobs to be documented to prevent lapses in memory • Seek more information when prescribing unfamiliar medications
	Task management	• Changing routine of prescribing to limit previous mistakes (i.e. check allergy status first) • Change location if cannot manage distractions • Develop a more systematic routine for own prescribing • Try and commence discharges in anticipation of discharge to limit impact on workload • Utilise other non-medical prescribing staff when workload high • Avoid multi-tasking • Avoid completing discharges or re-writing medication charts on a ward round • Prioritise workload to minimise risk of rushing • Slow down when aware that they are rushing • Print off electronic prescriptions to check on paper before submitting to

Error type	Non-technical skill	Reported NTS outcome of feedback
		pharmacy • Do not assume pharmacists will correct errors for you

Duncan *et al.* (2012) identified nine domains that could be targeted in interventions to improve prescribing:

- social/professional role and identity
- social influences
- knowledge
- skills
- environmental context and resources
- memory, attention and decision process
- behavioural regulation
- beliefs about capabilities and;
- beliefs about consequences.

The authors acknowledged that the domains were interrelated and provided example behaviour change techniques with feedback suggested to raise awareness of capabilities. However, as the domains are related, the results of this thesis suggest that PE feedback can influence each of these domains.

Chapters 6 and 8 established that feedback was a social process with enhanced teamwork and communication reported (social role and social influences). Feedback raised awareness of PEs and their risks and outcomes (beliefs about consequences), whilst the process and provision of bespoke education by facilitators enhanced prescribing knowledge. Feedback raised awareness of deficits in prescriber performance (beliefs about capabilities) whilst identifying any relevant error causation (environmental context). This allowed prescribers to reflect and regulate their own practice (memory, attention, decision process) with action plans allowing refinement of skills.

There was a clear change in reported prescriber behaviour with consistent reference to a raised situational and self-awareness informing greater information seeking behaviour at the point of prescribing.

A raised awareness of PEs may influence the conscious effort of prescribers with an enhanced professional responsibility to avoid harm, views reported elsewhere as a result of negative prescribing (Gordon *et al.* 2013a). This motivation can improve the appropriateness of prescribing and compliance with relevant standards. Considering the application of NTS as a feedback outcome to the prescribing improvement domains, the complexity of the intervention can be seen. These feedback outcomes may have all resulted in changes to prescribing behaviour. Which one has the greatest or least effect is unknown, and would require further investigation with emphasis on each behaviour enhanced or reduced and outcomes measured accordingly.

McLellan *et al.* (2012) propose that the prescribing task interacts with the system and the author agrees with this unreservedly. However, the results of these interviews suggest that it is the NTS that are dynamically engaged with the system to influence other tenets of prescribing and prescribing outcomes. Irrespective of cognitive and technical prescribing abilities, errors are likely to occur where NTS are deficient. In figure 69 below the author proposes a revised relationship and reflexivity between the working environment, application of both technical and nontechnical prescribing skills and the prescribing outcome. The NTS are separate from other prescribing skills as they are latent and interact with the clinical environment, guided by situational awareness, and could be considered a hidden skill set for safe prescribing. This echoes the sentiments of McLellan *et al.* (2012) who propose that the level of prescribing effort or 'cognitive engagement' for a successful prescribing outcome will vary depending on the situation, mirroring the proposal that the level of skill required for a successful prescribing outcome will vary depending on the working environment, social context and error provoking conditions.

Figure 69: Model of prescribing illustrating integration of technical and nontechnical skills with the working environment and in response to feedback
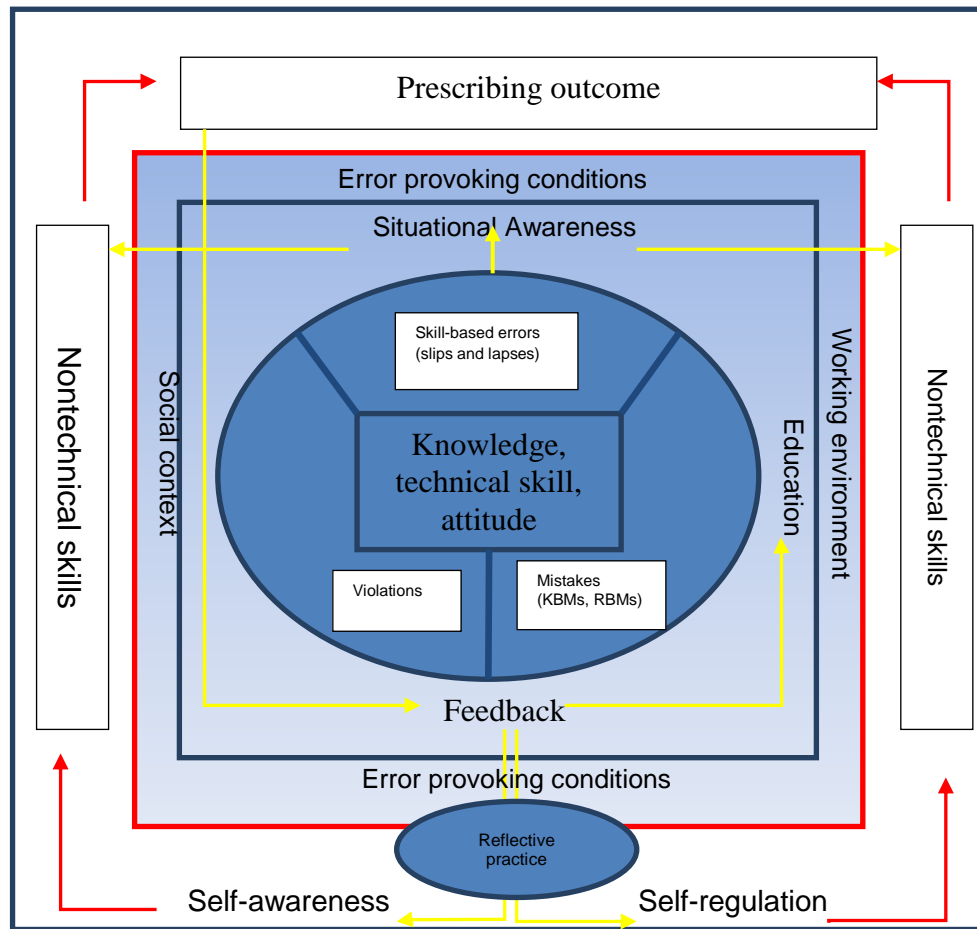
There was a clear sense in these interviews that prescribing was a more conscious and mindful process, and was no longer a routine, automatic task. Through feedback, prescribers were putting more effort into their prescribing: they were more "cognitively engaged" (McLellan *et al.* 2012). Feedback was encouraging reflection on, for and in-action for prescribing with prescribers taking a step back to pause for thought. This reflection informs self-regulation of prescribers to control their cognitive processes as illustrated in figure 68 above. Such meta-cognitive processes have been reported to minimise cognitive error and invoke the "conscious mind" (Graber 2009), with reflection facilitating recall of previous problems and limitations in practice (Croskerry 2003): outcomes reported in this chapter. Prescribers reported changes in communication with team members including clarification of

prescribing information with senior prescribers and greater teamwork. This echoes reports from interviews with pharmacists in chapter 8 who reported improved teamwork following delivery of feedback. Prescribers also reported improved time management and prescribing prioritisation following feedback, all NTS that are integral to safe prescribing.

Gordon *et al.* (2013a) suggest that "*there might be value in structured education to ensure uniform safety and nontechnical skill acquisition*". The results of these interviews would support this argument. However, given the isolation of NTS from other prescribing skills proposed here and their interplay with the clinical environment, the difficulties in teaching prescribing in context to undergraduates can be seen. That said, such skill acquisition could commence through simulated scenario training, inter-professional learning, or 'pre-prescribing' (Smith *et al.* 2012) for example. This could raise role awareness of team members and facilitate communication and teamwork. However, equally, they are likely to be labour intensive whilst lacking the fidelity of the clinical environment. Any NTS intervention and evaluation should consider their complex interactions with the prescribing system and ideally measure the effectiveness of each group of NTS to inform future prescribing pedagogy.

There is unlikely to be a single intervention to solve what is a challenging problem but feedback is one adjunctive intervention that can support acquisition and mastery of the NTS essential for safe prescribing. Indeed, it is advocated that agenda-led, outcome based feedback, such as that used throughout this project, should be used to facilitate achievement of prescriber competence (Lum *et al.* 2013) via a mentor who, in the case of this research, is a ward-based pharmacist. This feedback should ideally commence at undergraduate level. It should form part of an integrated prescribing curriculum with immediate feedback following contextualised learning. This should persist into their formative prescribing years as they serve their prescribing apprenticeship and beyond, to develop the NTS required to prescribe safely. The logistics of such a programme of course would be challenging.

PEs reflect a complex interplay of active failures, latent conditions, system failures and error provoking conditions (Tully *et al.* 2009). It has been suggested that training in the understanding of cognitive errors and factors contributing to human error is a plausible intervention to target PEs (Lewis *et al.* 2014). In these interviews, when asked about distractions and error causation, prescribers expressed that they should have a raised situational awareness and understanding of error provoking conditions because of their training in advanced life support for example. However, this training is out of context for a different skill and situation, and the transfer to prescribing scenarios may well be limited. Equally, it is reported that feedback may support performance in a given task but not the transfer of knowledge to other tasks (Archer 2010).

With guidance on human factors in development to promote patient safety (MHRA 2015), the potential for greater integration of human factors into prescribing curricula could be realized in the future. The EQUIP study reported that "a "safety culture" was conspicuous by its absence from respondents' discourses of their prescribing errors". (Dornan *et al.* 2009) Such a culture needs to be embedded within undergraduate curricula and postgraduate prescribing guidance and norms. Training in the understanding of cognitive errors in relation to prescribing can support the knowledge based and technical aspects of prescribing as defined elsewhere (British Pharmacological Society 2016, de Vries *et al.* 1994). As discussed, immediate feedback can be used to contextualize any underpinning knowledge and allow application and grounding in each prescriber's practice. Indeed, the need for prescribers to seek and act upon constructive feedback, outcomes reported in interviews in chapters 6 and 8, has been described as an underpinning element of prescribing competencies elsewhere (Lum *et al.* 2013).

In chapter 4, pharmacists expressed initial anxieties in interviews that delivery of formal feedback could be destructive to their inter-professional working relationships with prescribers. This fear could be influenced by a

perception that pharmacists may 'police' prescribing, a role that hospital pharmacists elsewhere have reported being keen to avoid (Williams *et al.* 2013, Weiss 1994). A 'policing' role is undoubtedly necessary to be vigilant of potentially fraudulent behaviour for example, but clearly isn't the focus of what hospital pharmacists can, and should be doing, in clinical areas. They are also safeguards: defences in the error chain to identify and intercept errors. In chapters 6 and 8, there was a clear sense from both prescriber and pharmacist interviews that the role of the pharmacist was increasingly recognised by prescribers with greater team integration and communication reported, and perhaps iterating the need for greater inter-professional learning at undergraduate level.

The modern pharmacist performs multiple roles as outlined in figure 70 below. As a feedback facilitator, they draw on all of these roles to enhance delivery of feedback. Their role as caregivers and leaders in medicines use raises their credibility. Their role as a teacher and communicator informs effective delivery of feedback. However, it is their role as a manager that perhaps warrants further consideration given prescribers were more motivated and engaged with the prescribing process following feedback.

An effective manager will set direction and communicate clear targets and expectations. They will also provide recognition for good performance and commit to developing individuals through effective feedback. In doing so, employees (prescribers) are more engaged, take more pride in their work and will be more productive. These principles and outcomes resonate with the ethos of effective constructive feedback delivered throughout this project, and the results reported in this chapter. Pharmacists are no longer simply safeguards, information providers or the prescribing 'police', they are managing the prescribing process to engage and motivate prescribers, raise their discretionary efforts and improve their prescribing performance, outcomes reported in the interviews in chapters 6 and 8.

Figure 70: The roles of the eight-star pharmacist (Adapted from the Wiedenmayer *et al.* 2006)
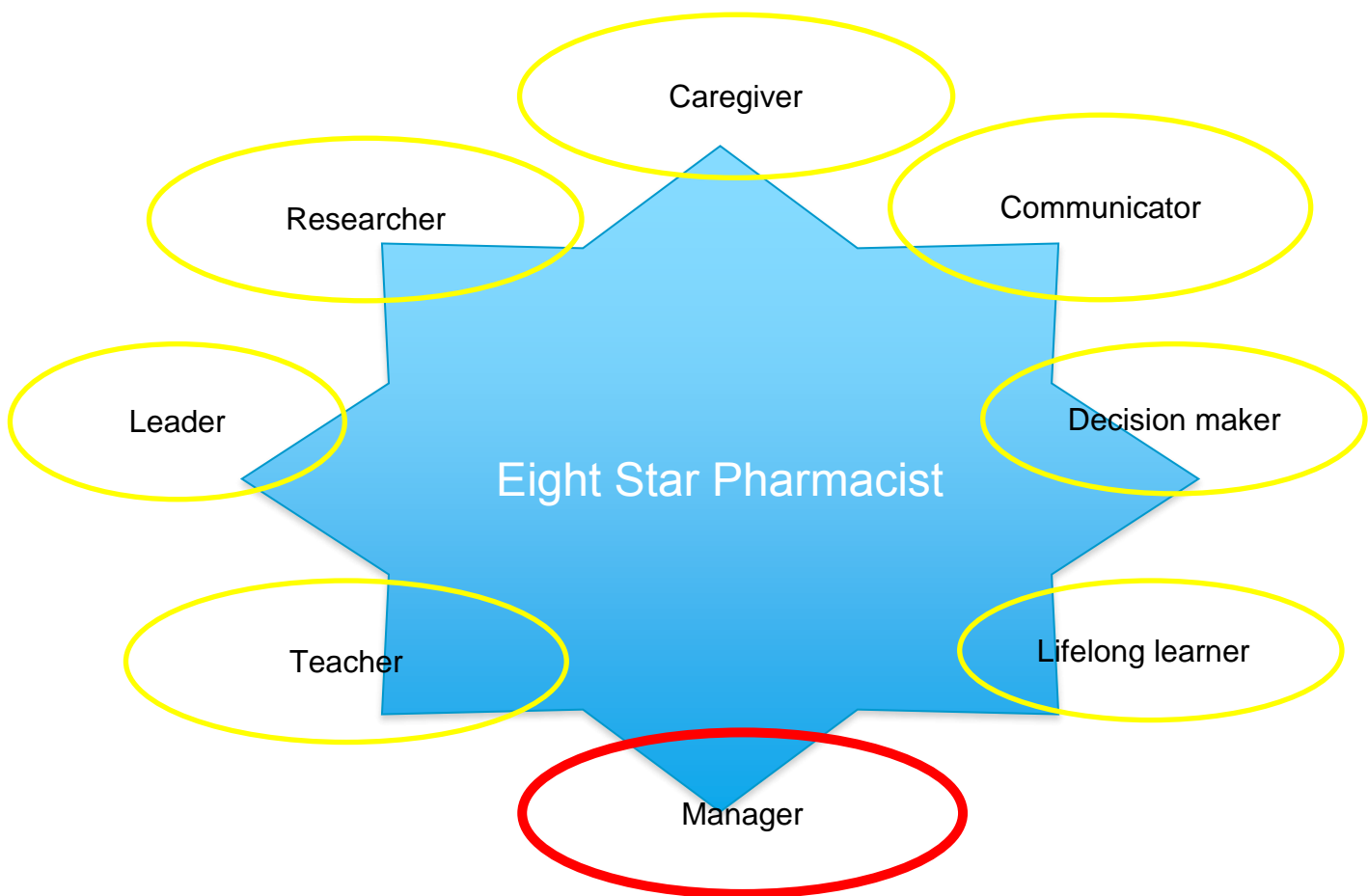
The results of this chapter suggested some inconsistencies in facilitator approach, particularly with skill-based errors where vague feedback such as "just be more careful" was reported. It is possible that pharmacists lacked the tacit understanding of human factors to deconstruct the subtleties of the error and negotiate creative solutions to minimize error recurrence. Equally, prescribers reported that errors were always likely to recur where the conditions or system failures do not change. Considering this, it would seem prudent that PE feedback facilitators are also trained in human factors so that prescribing safety is understood and continually integrated and reinforced. The results from interviews in chapter 8 would support this argument with pharmacists expressing surprise at the number of non-knowledge based errors and the influence of human factors.

9.5. implications of these findings

Throughout this thesis there has been an ever-emerging picture of a complex intervention. Prescribers, pharmacists, clinical teams and the clinical environment and structures that they work within are all connected. How prescribers interact within the system is influenced by their NTS with feedback influencing the application and development of these skills. This raises the complexity of the feedback intervention further whilst casting further uncertainty as to what part of the process or outcome is having an impact on PE rates. Given the breadth of NTS, training in and evaluation of the effectiveness of each domain (Situational awareness, decision making, communication and team working) on prescribing outcomes would be useful.

Additionally, considering the influence of the environment on NTS and prescribing outcomes, prescribing education should be taught in context and not in isolation. Whilst this can be difficult to achieve at undergraduate level, pharmacists, through prescribing error feedback could provide the appropriate 'scaffolding' (Cohen *et al.* 2011) to develop prescriber skills and competence.

Facilitator training should include contextualising prescribing education in human factors. This could enhance the feedback process further whilst empowering pharmacists to address environmental issues that could be contributing to suboptimal prescribing. Similar training could be explored for prescribers at undergraduate and postgraduate level to facilitate awareness of error, error provoking conditions and how to respond to them.

9.6. Strengths and limitations

This is the first known qualitative study exploring the impact of feedback on different active failures. The semi-structured approach to the interviews provided the qualitative depth needed to answer the research aims. Importantly, the qualitative results supports understanding of any underpinning reason for change in PE rates reported in chapters 5 and 7.

Qualitative data analysis is open to interpretation, a limitation the author was cognisant of and one mitigated by independent second coding by the supervisory team (SDW and SVOB). Additionally, data saturation was achieved with redundancy of themes as reported, confirming adequacy of the recruited sample of participants (Guest 2006). Equally, classification of active failures was open to interpretation where the prescriber references different failures but this potential limitation was mitigated by the PhD supervisors also reviewing the PE classification.

Prescribers were required to recall specifics of an individual error to inform classification. This may have been hindered by memory failure and recall but equally mitigated by only interviewing prescribers who had both made a PE, and received feedback in the previous week.

The risks of halo or Hawthorne effects (Basit 2010) were limited by clarification of responses to limit potential bias. This was facilitated by the semi-structured topic guide allowing further probing and clarification of responses. In addition, use of critical incident theory in the opening stages of the interview facilitated exploration of the error causation in detail. This may have been supported by pharmacists trained in and using similar techniques as part of their facilitator training.

A potential limitation of the study is that the active failures reported were not evenly distributed, especially for violations with only one case reported. However, the distribution was comparable to that of previous studies (Dean *et al.* 2002, Lewis *et al.* 2009) on error causation whilst the research team was satisfied that data saturation was achieved with further recruitment unlikely to illuminate further inferences from the data. Equally, it should be acknowledged that only PEs classified as significant or above required individualised feedback and the motivators to change practice may not be as powerful for minor errors, despite these being the most frequent error severity reported.

Not all prescriber grades, for example consultants, were interviewed. However, a range of foundation, core and specialty training grade doctors were and it is this cohort that prescribe the majority of medications. It should also be noted that most error causation research has focused on foundation doctors so inclusion of more experienced prescribers provides added depth and quality.

A further strength of this study is that the results can be triangulated with quantitative findings in chapters 5 and 7. In this regard, the mixed methodology supports and corroborates findings with these results "mutually illuminating" (Bryman 2007) what the impact on prescribing is and why it has occurred.

Finally, as this is a case study, and participants were recruited from one NHS hospital only, the results cannot be generalised to other settings. However, the purpose of the research was always to understand the impact of PE feedback in STHKH and this has been achieved whilst triangulation with other quantitative and qualitative results in this thesis provide greater inferences for similar settings.

9.7. Chapter summary

This chapter has reported the impact of feedback on prescribing behaviour from semi-structured interviews. PE feedback supports prescriber development at a knowledge level and facilitates utilisation and development of the NTS required for safe and appropriate prescribing.

The following and concluding chapter, will summarise the findings of this thesis, outlining the overall strengths and limitations of the research, personal reflections of the author, and concluding with a consideration of the implications for practice and further research.

Chapter 10. Overall conclusions, implications for practice and further research

10.1. Chapter introduction

This concluding chapter will summarize the overall results and implications of the research in this thesis for practice. The strengths and limitations of the research will also be summarized and reflections of the author and their role in the research presented. Finally, further programmes of enquiry to advance understanding of this field of study will be presented.

10.2. Overall discussion

This thesis has explored the impact and effectiveness of pharmacist-led PE feedback in a hospital setting. The results from this thesis have contributed to what little is known on this subject.

The intervention is valued, welcomed and importantly, considered sustainable with the intervention now part of routine practice at STHKH. The intervention has had positive influences on prescribing. The pilot study demonstrated a mean reduction in overall PE rates of 11.5% in the intervention group and an increase of 5.9% in the control group, a significant change in PE rates of 17.4% (SD 4.7, 95% CI, -27.3 to –7.6, $p<0.05$, d=1.6) between groups. For the larger cohort in chapter 7, there was a mean reduction in overall PE rates of 18.3% in the intervention group and an increase of 5.4% in the control group, a significant change in PE rates of 23.7% (SD 3.5, 95% CI, -30.6 to -16.8, $p<0.05$, d=1.57) between groups. Qualitative results illuminated the potential reasons for improvements in prescribing and that PE feedback is a complex intervention. Prescribers were using the NTS of prescribing more. Feedback raised self-awareness of prescribing performance and encouraged reflection to modify prescribing behaviour. Both prescribers and pharmacists reported ancillary interventions from the feedback process, with bespoke educational sessions for example

delivered by ward pharmacists to support prescribing further and enhanced teamwork.

There was a paradigmatic shift from a system of directed feedback to one of facilitative feedback. This underpins the considered design of the feedback intervention and choice of feedback facilitator to resonate with principles of effective feedback.

Feedback has been identified as a priority for developing diagnostic decision making (Elstein 2009) and considered transferrable to prescribing (Mattick *et al.* 2014). The results presented in this thesis support this hypothesis with prescribers and pharmacists advocating that the benefits of PE feedback demanded their time and that the process should continue.

Opportunities to refine the art of prescribing have been described as "patchy" at ward level (Mattick *et al.* 2014). Where formal dialogue on prescribing is non-existent, the risk of prescribers copying what others do increases, with such processes becoming an important way to learn prescribing in the clinical area (Garbutt *et al.* 2006). However, given known PE rates, this method is less favourable to learn the principles of safe prescribing, and underpins the need for on-going feedback on prescribing from credible facilitators such as pharmacists.

Hafferty (1998) describes a formal, informal and hidden curriculum that apply to doctors' workplace learning. The formal curriculum is what is taught away from the clinical area, such as weekly teaching. The informal curriculum is often opportunistic, delivered at ward level whilst the hidden curriculum is that of the healthcare culture, unique to each clinical setting and where a great deal of what is taught and most of what is learned takes place (Hafferty 1998). Each organization and clinical area will have its own identity and local practices that perhaps cannot be taught or learnt from a textbook and echoes the sentiment that effective feedback is the "cornerstone of clinical teaching" (Cantillon and Sargeant 2008). Hafferty (1998) suggest that we should "create structures that allow individuals to reflect upon the larger structural

picture of which they are a part". When delivered constructively, PE feedback has potential to create this structure, providing a platform to achieve the prescribing standards demanded in healthcare.

Advancing this argument, prescribing competency frameworks (RPS 2016, Lum *et al.* 2013) outline that prescribers should seek and act upon feedback to improve prescribing. This should be delivered in a blame free environment with protected time allocated (Likic and Maxwell 2009). The results in this thesis support these recommendations with pharmacists and prescribers advocating a non-punitive approach was necessary and that feedback should focus on developmental needs. Whilst not "protected", delivery of feedback away from routine clinical tasks allows prescribers time to reflect and engage openly with the pharmacist.

For prescribers to receive or seek feedback on their prescribing, appropriate facilitators are required for the process to be effective (Ivers *et al.* 2012) with pharmacists considered credible PE feedback facilitators. They have expert drug-related knowledge whilst prescribers interviewed in this thesis consider feedback an extension of their role. Effective feedback is influenced by whether the facilitator is a colleague (Ivers *et al.* 2012), has observed practice and if it is delivered as part of everyday practice (Cantillon and Sargeant 2008). Therefore, ward pharmacists have the additional advantage of working with the prescriber and observing their prescribing practice whilst being able to deliver timely and frequent feedback.

Pharmacists have been described as 'change agents' previously (Cresswell *et al.* 2012, Avery *et al.* 2012) to influence safe prescribing decisions in a desirable direction. In this research, pharmacists can be considered change agents to improve the quality and safety of prescribing, with their role in affecting change accepted as credible facilitators of PE feedback.

Initial apprehensions of pharmacists surrounding the intervention were unfounded. Pharmacists reported greater self-confidence, self-worth and job satisfaction with enhanced prescriber communication and teamwork

reported. Good teamwork alone is considered to improve patient care and safety (Firth-Cozens and Moss 1998, Baker *et al.* 2006) and the results in this thesis outline the need for good rapport, and communication, for effective delivery of PE feedback. Furthermore, the additional educational interventions developed following PE feedback can only help with educational outreach for example (O'Brien *et al.* 2007), having positive effects on prescribing. Where pharmacists innovate ward-based activities and deliver further prescribing education as an outcome of PE feedback, this can only help to harness the skills of pharmacists more effectively and improve prescribing safety.

The need to understand what underpins "observed behaviour changes" has been reported (Brennan and Mattick 2013, Craig *et al.* 2008) and the qualitative results of this thesis have informed the potential prescribing behaviours that underpin changes in PE rates.

The process outcomes reported for pharmacists, prescribing and prescribing behaviour highlight the complexity of the feedback intervention. Whilst significant improvements in PE rates were observed, it is not a simple closed loop system with a clearly defined cause and effect relationship, and perhaps feedback is simply a catalyst to accelerate change. All of the reported process outcomes are "connected" and will influence each other as the system self-organizes. The positive outcomes reported are welcome outcomes but equally they provide uncertainty as to whether it is the feedback or another one of these outcomes that is improving prescribing.

PE feedback is educational and can support professional development and this may be enough motivation to change prescribing behaviour for learning goal oriented prescribers. For other performance oriented prescribers, it was clear that avoiding feedback or being perceived in a negative light by a colleague was a motivating behaviour.

The educational outcomes of feedback extended beyond knowledge of the medication or clinical condition, with reported changes in prescribing

behaviour resonating with the NTS of prescribing. PE feedback allowed identification of PE causation through reflection, and this in turn increased self-awareness and situational awareness of prescribers.   Prescribers were more engaged in prescribing tasks with greater communication, teamwork, information and feedback seeking behaviour, decision making, and task prioritisation reported to optimise prescribing outcomes.

These skills are increasingly recognised as integral to safe prescribing (Gordon *et al.* 2013a, Kirkham *et al.* 2015) and the results of this thesis outline the importance of acquiring these skills in more formative years.

Non-technical skill acquisition should form part of a wider prescribing pedagogy to complement the cognitive and technical aspects of prescribing. Whilst such training will be challenging, the benefits could be substantial and potentially developed though enhanced simulation based training, inter-professional learning and feedback on any pre-prescribing. Such feedback should continue into professional practice where it is both expected and delivered as part of routine clinical practice in hospital settings.

10.3. Implications for practice

Audit and feedback on PEs can provide the framework for a proactive approach to prescribing safety. Prescribers have previously reported that 'no news is good news' (Mattick *et al.* 2014) although arguably 'no news is no news' and prescribers cannot change prescribing practice if they do not know what to change.   Formalising PE feedback can provide a consistency to feedback to reduce the gap between perceived and actual performance (Randolph *et al.* 2009). Where this happens, prescribers have the potential to improve and regulate their prescribing behaviour, but the process requires investment, commitment and diligence of participants and facilitators of feedback to affect change.   As a complex, non-linear system, each time feedback is delivered, the system or clinical environment will evolve or "self-organize" with a culture of feedback facilitating a culture of safety.

Process outcomes reported in this thesis raise important considerations for prescribing education. Developing prescribing skills at the cognitive, technical and non-technical level are all important curriculum components. Training in human factors to raise awareness of how prescribers interact with their environment could also be useful. Some of the reported outcomes in this thesis pose more significant questions for the context of any prescribing pedagogy.

Prescribing education has recently been conceptualised as a complex system encompassing both individualistic cognitive, and socio-cultural learning theories (McLellan *et al.* 2015). In clinical practice, a prescriber will engage and interact with the system, patients and other healthcare professionals. These interactions are complex and varied, as are the behaviours required to successfully navigate them, resonating with the varied outcomes reported in this thesis.

Prescribing is a complex skill and social experience (Dornan *et al.* 2009), and prescribing should not be taught in isolated silos. Where prescribing is taught out of context, the task will be reduced to individual constituent parts that may not be transferrable to the clinical environment. The whole task is far more than the sum of its parts (McLellan *et al.* 2012) and prescribing should be learnt in context to accommodate the variances and nuances of real-life prescribing. Key themes reported in this thesis have included improved teamwork and rapport, communication, information-seeking and feedback-seeking behaviour and role awareness. This iterates the importance of contextualised learning as an undergraduate through exposure to inter-professional learning and pre-prescribing either in the clinical environment or high fidelity simulated scenarios. Here, PE feedback could act as "scaffolding" (Coehn *et al.* 2011) to encourage reflection and provide the support and infrastructure for prescribers to develop.

Delivery of constructive pharmacist-led PE feedback is now part of routine clinical practice in STHKH where prescribers receive frequent feedback from ward-based pharmacists. A similar model of feedback could be adopted in

similar settings with ward-based pharmacists used as facilitators of PE feedback. Feedback facilitators require training in delivery of PE feedback and this should include an understanding of human factors to inform negotiation of potential solutions to PEs. Given the role of pharmacists to intercept and correct PEs, such training should begin at undergraduate level.

Where pharmacist-led PE feedback is adopted, this will optimally include funded support to facilitate this, and other ward based educational interventions to develop a triangulated, multi-faceted approach to targeting PEs.

10.4. Strengths and limitations

As with any research, the research undertaken in this thesis has strengths and limitations. These have been discussed individually in each results chapter but will be summarised here.

10.4.1. Study strengths

This is a mixed methods study and this approach is a key strength of this research. The quantitative results have been triangulated with the results from pharmacist and prescriber interviews in chapters 6, 8 and 9. For example, both prescribers and pharmacists reported improvements in prescribing following feedback, comments substantiated with the quantitative results. Additionally, the qualitative results have illuminated why prescribing has changed and that it is a complex intervention. Enhanced use of NTS was reported by prescribers, echoing reports of increased teamwork and information seeking behaviour by pharmacists in chapter 8 for example. This provides the richness of data to inform what behaviours underpin the changes in PE rates reported in chapters 5 and 7, whilst understanding the impact of the intervention on prescribers and pharmacists. Additionally, the model of prescribing (figure 69) presented in chapter 9 and non-technical prescribing behaviours (table 35) provides a framework to inform further prescribing education to enhance these skills and evaluate any impact on

prescribing performance. This triangulation of research methods has afforded a comprehensive understanding of the PE feedback intervention in STHKH.

The intervention has been implemented in a large acute hospital with clinical pharmacy services on most wards. This intervention should be transferrable to similar settings although variations in outcomes might be expected given the complexity of the intervention described throughout this thesis.

10.4.2. Study limitations

The qualitative sample sizes in chapters 6, 8 and 9 could be considered small, although the research was explorative and the sample size adequate to answer the research questions, with data saturation achieved as described in chapter 3 and each relevant results chapter.

The issue of transferability has been discussed in relevant chapters. Briefly the complexity of the intervention and variability in outcomes may limit transferability to other settings. Where the system, participants, principles of feedback, facilitator training or staff engagement vary, the outcomes may not be replicable. For example, where pharmacists and prescribers already work to a high degree of collegiality, would the same benefits be realised? Where pharmacists already attend ward rounds or deliver educational outreach at ward level, would the same effect size be observed? However, equally, the qualitative results provide rich data for others to decide if the intervention and its unintended outcomes, could be transferrable elsewhere.

The author interviewed all prescribers and pharmacists. Whilst this limits potential inter-interviewer variability, it is possible that the author has not identified all relevant codes and themes, or that they are biased by their experiences and understanding of the literature. This limitation was mitigated by the PhD supervisors, who are experienced qualitative researchers, reading all transcripts independently and initial codes and themes discussed with the author for an analytical consensus.

Results of the qualitative studies are limited to STHKH and may not be generalized to other settings. However, this was not the purpose of the research with participants recruited to understand the context of the PE intervention in the organisation. Any inferences that others can take from research publications will be an added bonus. Equally, triangulation with the quantitative results provides a platform for others to understand the process and effect of pharmacist-led individualised PE feedback.

As described in chapters 3, 5 and 7, prescribers were non-randomized and it is possible that improvements have occurred because of differences between groups. Whilst this is a potential limitation, randomization of participants to an educational intervention does not always eliminate potential bias. Equally, a similar range of prescribers were involved across control and intervention wards, whilst it should be noted that PE rate in the control group increased, whilst PE rate in the intervention group improved.

Finally, whilst a mixed ecology of medical, care of elderly and acute wards were involved in the research, the impact of feedback in all settings was not assessed for example on surgical wards. However, the wards do reflect the mixed ecology of a typical acute hospital and surgical wards have similar ward-based pharmacy services so it is likely that the intervention will have similar outcomes in these settings.

10.5. Personal reflections

Researchers are part of the social world that they are researching (Cohen *et al.* 2011:225). Experiences define who we are and researchers have their own world views that can influence their role in any research. As outlined in chapter 3, the epistemological view of the author depends on the research question, a view that reflects the mixed methods approach in this thesis.

The author is a clinical pharmacist and medical educator and these roles have had inextricable influences on this thesis. Firstly, the concept for this

thesis was kindled from the author's role as a clinical pharmacist with significant experience of PE interception and resolution, and as a medical educator with a keen interest in prescribing education.

Secondly, as described in chapter 3, the author was aware of potential power asymmetry in interviews that could impede the depth and authenticity of interviewee responses. Additionally, as a pharmacist and medical educator, the author was cognisant of the risk of a Hawthorne effect (Basit 2010), with interviewees attempting to avoid, impress or reject the researcher questions. To counter these issues, a topic guide was used for consistency whilst a semi-structured approach allowed clarification of participant responses. Additionally, the author attempted to build rapport with interviewees and used a conversational approach throughout to engage participants. This was facilitated by the semi-structured approach allowing deviation from the topic guide and put interviewees at ease, allowing more introspective information to be obtained from them. Furthermore, the author's role as a pharmacist and medical educator facilitated this conversational tone and candour and is considered a potential strength in this context and not a weakness.

Finally, in analysing the qualitative data, the author's experience as a clinical pharmacist and knowledge of the subject area may bias interpretations. To this end, the author remained as objective as possible with independent review of the transcripts, codes and themes by the PhD supervisors, who are not pharmacists, adding additional validity to the results.

On a personal level, the journey towards completion of this PhD has been exhilarating and demanding in equal measures. On reflection, it has been a steep learning curve and one that has stretched my intellect and catalysed my development. The journey has served as an apprenticeship in research and this thesis demonstrates some of the skills that have been developed and refined over the past three years. These skills have been transformative in developing as an independent researcher and most importantly, provided the self-confidence and belief to continue as a clinical researcher. As a pharmacist and educationalist, the motivations to undertake this PhD were

described in chapter 1. The skills and abilities developed throughout this research have kindled further desire and motivation to lead on research into prescribing errors and optimise prescribing, and patient safety.

10.6. Future research

The research presented in this thesis has produced important results to address the research questions. However equally, they have raised further research questions and avenues of enquiry.

Both the prescribers and pharmacists interviewed in this thesis outlined the potential for shared learning on PEs. Whilst this does not reflect the principles of effective feedback, its comparison as an alternative or in combination to individualised PE feedback should be explored. Given the complexity and uncertainty of the process outcomes, variations in emphasis on teamwork, reflection, situational awareness or self-checking for example could be carefully incorporated into future feedback research or investigated individually to evaluate their impact on prescribing practice.

Future research should aim to increase the intensity of PE feedback from pharmacists whilst the impact and effectiveness on NMPs is unknown.

PE feedback is now delivered routinely at STHKH and a further study using a questionnaire would be useful to elicit the views of a wider range of prescribers in a wider range of clinical areas towards receiving formalised PE feedback.

The potential for PE feedback in undergraduate prescribing education should be explored perhaps as part of inter-professional or simulation-based teaching.

PEs were not eliminated by feedback in this research and the optimal combination of feedback with other PE reduction initiatives should be explored.

This research is limited to STHKH, it would be useful to determine what PE feedback is delivered, how, when and by whom across the North-West deanery and the impact if any on their prescribing practices.

Finally, this study was limited to the hospital setting and the potential of individualised PE feedback in other settings such as primary care could be explored.

10.7. Overall conclusion

The research aims outlined in this thesis have been addressed with the impact of PE feedback on prescribing, prescribers and the facilitators of feedback, pharmacists, described.

Feedback has positive influences on prescribing with statistically significant reductions in PE rates reported. Where PEs are reduced, patient safety and outcomes can be improved and optimised. Feedback has encouraged greater interaction between pharmacists and prescribers through enhanced teamwork and prescribing support. Feedback supports the professional development of both prescribers and pharmacists at a knowledge based level with potential for PE feedback to also increase the self-efficacy and confidence of pharmacists. Feedback also supports development of non-technical prescribing skills, with potential for further context specific training in these skills to enhance prescribing education further.

By designing the feedback intervention to reflect principles of effective feedback, a pragmatic educational framework is provided to support development of prescribing skills through feedback in the clinical environment that is timely, frequent, delivered verbally and in writing by a credible facilitator. However, PE feedback is a complex intervention with variations and unexpected positive outcomes and these variations and outcomes may be influencing prescribing outcomes.

Finally, the intervention is unanimously valued and welcomed by prescribers and pharmacists and considered sustainable, with the intervention now part of routine clinical practice at STHKH. This intervention is transferrable to similar settings with ward based clinical pharmacy services to support prescribing, reduce PEs and improve patient safety across secondary care settings.

Word count: 99950 excluding references

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12. Appendices

Appendix 1: Overall prescribing feedback proforma

St Helens and Knowsley Teaching Hospitals
NHS Trust Intranet NHS

Prescribing Review Feedback

Date: ___/___/___   Prescription review period ____ / ____ / _____
Prescriber Name:_____ Bleep: _ _ _ _   Grade:_____
Educational Supervisor / consultant: _____
Ward area: _____

Total number of prescriptions reviewed: _____ (InP= , TTO =)
Total number error free: _____ (InP= , TTO =)
Error free %_____ (InP= , TTO =)
Total number of items prescribed _____ (InP= , TTO =)
Total number of item errors _____ (InP= , TTO =)   Overall error rate _____%

Inpatient error rate _____% **Discharge** error rate _____ %
Error severity; Minor (n= , %), significant (n= , %), serious (n= , %), potentially lethal (n= , %)

Good areas of prescribing to build on:

Suggestions for improvement:

Examples of prescribing errors:

Include relevant examples here
NB Where there are very few errors, provide some general errors / themes for your ward area

Notes:

Pharmacist Signature: _____   Prescriber signature: _____
Educational Supervisor / Consultant Informed: Yes □ No □

Doctor to include reflective statement on prescribing in portfolio of evidence for professional development

Appendix 2: Individual prescribing error feedback proforma

Date: ___/___/___ **Prescriber Name:** _____ **Bleep:** _____

Grade: _____ **Educational Supervisor / consultant:** _____

Ward / Clinical area: _____ **Error stage:** Admission ☐ Throughout stay ☐ Discharge ☐

Prescribing error Details

Drug name / dose / frequency			Severity rating
Potential Risk:	**Potential error causation/contributing factors:**	**Actions to prevent error recurring:**	
Learning outcomes:			

Pharmacist Signature: _____ **Date** _____

Prescriber signature: _____ **Date** _____

Educational Supervisor to be informed

*Doctor to include reflective statement on prescribing in portfolio of evidence for professional development

Appendix 3: Interview topic guide for prescriber views of receiving feedback

Venue: On site in Hospital at convenient time for Foundation doctor
Ensure undisturbed i.e. pagers, phones etc turned off
Likely Duration: 20-30 minutes.   Follow up interviews may be required to clarify discrepancies in the interviews

Preliminary: Greet, establish rapport and candour. Summarise study purpose again, including need for consent. Obtain written consent and allow opportunity to ask any questions before commencing the interview.

Advise that as all questions must be asked. Hence, it may seem that some are repeated as we progress through the interview where you have provided an answer earlier.

Themes are in **bold.** Follow up prompting questions are denoted by **P)**

Perceptions of formalised Prescribing Error Feedback

Q) Is the formalised process an improvement on the current system?
Q) What have been the main advantages and disadvantages of the formalised process?
Q) How important is receiving prescribing error feedback to you?
    P) What are the main benefits?
    P) Who benefits?
Q) What do you think are the benefits of receiving feedback on prescribing errors?
Q) Have there been any practical barriers to receiving feedback on prescribing errors?
    Q) Have you been able to find the time to receive feedback?
    Q) has there been adequate support at ward level?
Q) Has feedback been timely?
    Q) Do you think that timely feedback is important?
Q) Was the delivery of feedback on overall prescribing useful?
    P) Did it allow you to consider positive aspects of your prescribing too?
    P) is this important for learning too?
Q) Do you think that feedback should continue to be formalised?
Q) Was provision of the feedback proforma useful in any way?

Perceptions of impact of receiving feedback on themselves

Q) What has been the impact, if any, of feedback on your own prescribing?
    P) Can you think of any specific examples, positive or negative, on your own prescribing?

P) Do you think that you may make less prescribing errors as a result of feedback?

Q) Are you more aware of risks of prescribing errors as a result of feedback?

P) For example error causation or root cause analysis?

Q) How has this informed your practice?

Q) Have you used any examples of feedback for your training portfolio?

P) If yes has this made you prescribe any differently?

P) If No, then why not? Could you?

_____

Perceptions on receiving feedback from Pharmacists?

Q) Is feedback delivered consistently?

Q) What are your views on receiving feedback on prescribing errors from Pharmacists?

P) Are they suitable?

P) Did you find it useful / not useful?

Q) How was feedback delivered by your Pharmacist?

P) i.e. was it constructive / educational ?

Q) Do you receive feedback on the quality of your prescribing from any other colleagues?

If yes, **P)** Does this differ at all from feedback delivered by Pharmacists?

Q) Has formalised feedback changed had any impact on your working relationship with your Pharmacist?

P) Has the process of feedback changed how you seek advice from your Pharmacist?

P) Has it affected your rapport?

Future Delivery of error feedback

Q) Should a formalized feedback process be rolled out trustwide?

P) Why is that?

Q) Could prescribing error feedback be delivered any differently?

Q) How would you prefer to receive feedback on your prescribing?

P) Face to face?

P) e-mail?

P) Letter?

Q) Can the system of formalised feedback be improved at all?

General second / probing questions

Silence….

You said earlier…

Can you provide an example / clarify what you mean…

Can you elaborate on that….

Could you expand on that….

Ask if any questions at end and thank them for their time

Finish interview. Turn off audiotape. Advise thankyou letter will be circulated.

Appendix 4: Interview topic guide for pharmacist experiences of delivering feedback

Version 1.1: June 2015
Pharmacist focus group schedule

Venue: Any pharmacy seminar room at a convenient time for the participant pharmacist
Ensure undisturbed i.e. pagers, phones etc. turned off
Likely Duration: 20-30 minutes.

Preliminary: Greet, establish rapport and candour. Summarise study purpose again, including need for consent. Obtain written consent and allow opportunity to ask any questions before commencing the interview.
Study Purpose
Prescription errors account for the majority of all Medication errors and are considered more likely to cause patient harm. Formalised feedback on prescription errors is one proposal suggested to mitigate prescribing errors. Pharmacists are often advocated as the most appropriate individual to both intercept and deliver feedback on prescribing errors. Little is currently known on the attitudes of Pharmacists to delivering formal feedback on prescribing errors.

This study is concerned with exploring your attitudes and views to delivering feedback in a more structured and formal manner.

Advise that as all questions must be asked. Hence, it may seem that some are repeated as we progress through the schedule where you have provided an answer earlier.

Themes are in bold. Follow up prompting questions are denoted by P) and will be used to clarify responses and gain more detailed responses (as opposed to yes/no responses for example)

Turn digital recorder on and start recording.

Background information
Q) Can you state your current band and number of years you have been qualified?

General views of the process
Q) How did you find the process of delivering individualised formal feedback on prescribing errors?
        P) Did you feel adequately prepared?
Q) Is the process an improvement on the current system?
        P) How does it differ?

Q) What do you think are the key benefits of providing formal feedback on prescribing errors?

Q) Was it clear what you had to deliver feedback on?

    P) Overall?

    P) For each significant error?

Q) How did you find completing and delivering feedback using the proforma?

    P) Overall?

    P) Each error?

    P) Confident? Useful? Supportive or distracting?

Q) How do you think that doctors took / received the feedback?

    P) Relaxed? Open? Anxious or afraid?

Q) Did you encounter any barriers to the process?

Specific process themes

Q) Were you able to find the time to deliver feedback as part of your ward visits?

Q) How did you negotiate time with the doctor to deliver feedback?

Q) Where did you deliver feedback? How did you decide on this?

    P) Ward / seminar room / office etc

Q) Did you provide feedback on every significant error that you identified?

    P) If no, then why not?

Q) How soon after identifying an error did you provide feedback to the docto

Q) Do you think doctors changed their prescribing behaviour in response to your feedback?

Impact on individual Pharmacists

Q) How did you feel about delivering formal feedback on prescribing errors?

    P) Comfortable? Confident? Relaxed? Anxious? Afraid?

Q) Do you think any other staff group could / should deliver prescribing error feedback?

    P) Should all Pharmacists be doing this?

Q) What has been the impact on you?

    P) Any positive impacts?

    P) Any negative impacts?

    P) Impact of workload?

Q) Has the process of feedback changed how you work in any way?

    P) How you review prescriptions or communicate with doctors for example?

Q) Has there been any impact on your working relationship with your doctors?

Q) Is the process sustainable?

    P) Could you continue to audit prescribing every rotation?

    P) Could you continue to deliver feedback on prescribing errors to all doctors?

-

Ending Questions

Q) Should doctors continue to receive feedback on their prescribing?

Q) Should it continue in the current format or could it be delivered any differently or improved?

We wanted you to help review and evaluate systems of feedback on PE's in the hospital. We've covered various issues including…..   Is there anything that we have not discussed or would you like to revisit a particular question to add anything?

Thank them for their time. Turn off audio tape.

Advise participants that a thankyou letter will be sent out in the post.

General second / probing questions
Silence….
You said earlier…
Can you provide an example / clarify what you mean…
Can you elaborate on that….
Could you expand on that….

Appendix 5: Interview topic guide for impact of feedback on prescribing behaviour

Version 1.1: June 2015
Prescriber interview schedule

Venue: Any private room on site at STHKH at a convenient time for the participant Prescriber
Ensure undisturbed i.e. pagers, phones etc. turned off
Likely Duration: 20-30 minutes.

Preliminary: Greet, establish rapport and candour. Summarise study purpose again, including need for consent. Obtain written consent and allow opportunity to ask any questions before commencing the interview.
Study Purpose
Prescription errors account for the majority of all Medication errors and are considered more likely to cause patient harm. Feedback on prescription errors is one solution proposed to reduce prescribing errors with doctors welcoming and valuing feedback to support professional development. However, little is known on the impact of feedback on prescribing errors specifically, the impact on different types of error.

This study is concerned with exploring the causes of prescribing error and the perceived impact of receiving feedback from Pharmacists on your prescribing.

Advise that all questions must be asked. Hence, it may seem that some are repeated as we progress through the schedule where you have provided an answer earlier.

Themes are in bold. Follow up prompting questions are denoted by P) and will be used to clarify responses and gain more detailed responses (as opposed to yes/no responses for example)

Turn digital recorder on and start recording.

Background information
Q) Can you state your current grade, number of years qualified, University you trained in and how long you have worked at the hospital
Q) What education and training have you had to prepare you for prescribing?
    P) Do you feel it was adequate / prepared you for practice?

The Prescription error
Q) Error details:
    P) Medication details (dose, route, frequency etc)
    P) The type of prescribing error. (i.e. why was it an error e.g. dose, GFR, interaction, omission, allergy, course duration etc)
    P) Stage of prescription i.e. admission, during stay, transcription, discharge
Q) Did you prescribe it yourself or was it transcribed from another chart, clinical notes or were you verbally asked to prescribe it by someone else for example?
Q) Was or could there have been any impact on the patient / other staff or the organisation?

Situational factors
Q) Can you describe the situation for me when you wrote the prescription?
    P) Patient factors
    P) Location (Ward but also exact location on ward)
    P) Usual ward or other area?
    P) Day / time
    P) Workload / supervision / number of doctors in on that day
    P) Distractions? Who else was around? Supervision

Q) Did you have adequate access to relevant information resources?
    P) BNF / Guidelines / policies etc
    P) Maxims / EDMS
    P) Pharmacist available?
    P) Senior doctor available for advice?

Q) How was you feeling at the time?
    P) i.e. physically and mentally
    P) Tired?
    P) Hungry?
    P) Angry / upset / frustrated?
    P) Stressed?
    P) Ill or unwell?

Q) What do you think was the cause of the prescription error?
    P) Knowledge, communication, resources, environment, slip or lapse?

The feedback
    Q) Who delivered the feedback and how was it delivered?
    Q) How did you feel about making the error?
    Q) How did you feel after receiving the feedback?

Q) Has the feedback had any impact on your prescribing practice?
  P) Had the error happened before?
  P) Has it happened since?
  P) Are you aware of any other prescribers who have made this error?
Q) Will feedback prevent this specific error happening again?
Q) Will it prevent similar errors from happening?
Q) Can anything else be done to prevent the error from happening?

Closing
We've covered various issues including the prescription error, possible error causation and potential impact of feedback on you as a prescriber. Is there anything else that we have not discussed or do you have any suggestions or would you like to revisit a particular question to add anything?

Thank them for their time. Turn off audio tape.
Advise participants that a thankyou letter will be sent out in the post.

General second / probing questions
Silence….
What are you thinking right now…
You said earlier…
Can you provide an example / clarify what you mean…
Can you elaborate on that….
Could you expand on that…

Appendix 6: e-mail for pharmacist interviews

Invitational e-mail to be sent to Pharmacists / Prescribers to participate in the study

Subject line: Research study assessing attitudes and opinions to delivering / receiving feedback on prescribing errors

Email content:

Dear Pharmacist / Prescriber,

Please find attached participant information sheet providing an overview of a research study to determine the attitudes and opinions of Pharmacists / Prescribers to delivering / receiving feedback on prescribing errors.

This study is being undertaken by Michael Lloyd as part of an MPhil, supervised by Dr. Simon Watmough at the University of Liverpool.

Briefly, the study is concerned in exploring your attitudes, views and opinions to the delivery / receipt of feedback on prescribing errors.

Please read the attached participant information sheet about the study and then decide if you would or would not like to participate in the research.

If you wish to participate in the study, please contact Michael Lloyd at Michael.lloyd@sthk.nhs.uk who will then be in contact to arrange a convenient date for the focus group / interview.

If you have any questions at all regarding the study please do not hesitate to contact Michael for further information.

Appendix 7: Participant information letter for pharmacist interviews

UNIVERSITY OF LIVERPOOL

Exploring experiences on delivering formal prescribing error feedback

Version Number: 1.1 1st June 2015

1.   Introduction

You are being invited to participate in a research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with others if you wish.   We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

2.   What is the purpose of the study?

Feedback is one intervention proposed to reduce prescribing errors with pharmacists advocated as best placed to facilitate and deliver feedback to doctors. We know that doctors welcome and value formalised feedback from pharmacists with both direct and indirect benefits reported. However, little is known on pharmacists' attitudes and opinions to delivering feedback in a formal and structured way.

This study is concerned with exploring the attitudes and opinions of pharmacists to delivering formal feedback on prescription errors to hospital doctors.

3.   Why have I been chosen to take part?

You are a pharmacist based at the host organisation and have been involved in delivering formal feedback to your ward based doctors.

4.   Do I have to take part?

It is entirely up to you to decide whether or not to join the study and be interviewed by the researcher. If you agree to participate, the researcher will talk to you about the research and will go through this information sheet with you. You will be asked to sign a consent form. You are free to withdraw from the study at any time.

5.   What will happen if I take part?

If you would like to participate in this study:

• You will be asked to take part in an interview that will last for approximately 20-30 minutes.

• In this interview, we will ask you about your experiences of delivering formal feedback on prescribing errors

• The interview will be carried out on the hospital premises at a time convenient for yourself. Michael Lloyd will facilitate the interview.

• The interview will be recorded on a digital recorder, and will be transcribed verbatim so that we have a written account of what you have said for subsequent analysis.

6. Expenses and / or payments

No expenses or payments will be available

7. Are there any risks in taking part?

There are no anticipated risks involved. However, it is possible that you may discuss medication errors that have occurred which may cause some distress. No harm is wished upon you and you may refuse to answer questions or discuss issues at any time, and without giving a reason. Any Pharmacist that is distressed will be allowed to the leave the study and will be referred to their supervisor for support in accordance with trust procedures.

8. Are there any benefits in taking part?

By participating in this research, you will be actively contributing to knowledge in this field. You will be helping us to improve our understanding and delivery of feedback on prescribing errors. Specifically, the impact of delivering formal feedback on pharmacists and doctor-pharmacists relationships. This may lead to improvements in patient safety and the delivery of feedback on prescribing errors.

9. What if I am unhappy or if there is a problem?

You can contact the researcher Michael Lloyd at Michael.lloyd@sthk.nhs.uk or Dr Simon Watmough at efcsw@liv.ac.uk or Professor Sarah O'Brien at Sarah.OBrien@sthelensccg.nhs.uk and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact the Research Governance Officer at ethics@liv.ac.uk. When contacting the Research Governance Officer, please provide details of the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make.

10. Will my participation be kept confidential?

• Only the researchers involved in the study will listen to the recording of your interview, or read the transcript

• The information that you provide will be kept anonymous – it will not be linked with you personally.

• After the study has been completed, the recording of your interview will be erased.

• Your details will not be disclosed to any third party.

• The information that you provide will be treated in the strictest confidence, in accordance with the Data Protection Act 1998.

• Confidentiality will be assured to all participants throughout the entirety of the study. The sole exception being when intentional malpractice or unsafe practice is identified. In these situations, details will be referred to your educational supervisor for further review.

11. What will happen to the results of the study?

• Our aim is that the results of the research will contribute to our understanding on the feedback of prescribing errors to prescribers. Specifically, the impact of delivering formalised feedback.

• We plan to publish our results in a peer reviewed journal or educational conference.

• All information will be anonymised to prevent identification of individual research participants.

• Results will also be presented locally at relevant meetings

12. What will happen if I want to stop taking part?

Participants can withdraw at anytime, without explanation. Results up to the period of withdrawal may be used, if you are happy for this to be done. Otherwise you may request that they are destroyed and no further use is made of them. If results are anonymised you should make clear that results may only be withdrawn prior to anonymisation.

13. Who can I contact if I have further questions?

Please contact Michael Lloyd between 8:30 am and 5pm, Mon-Fri, on either extension 4323, or pager 7437. Alternatively, Michael can be contacted at Michael.lloyd@sthk.nhs.uk. Alternatively you can contact Dr. Simon Watmough at efcsw@liv.ac.uk

Appendix 8: Consent form

UNIVERSITY OF LIVERPOOL

Participant Consent Form

Exploring prescribing error feedback

Please initial in the box below

1. I confirm that I have read and have understood the information sheet version number 1.1 dated 19th July 2014 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected. In addition, should I not wish to answer any particular question or questions, I am free to decline.

3. I understand that, under the Data Protection Act, I can at any time ask for access to the information I provide and I can also request the destruction of that information if I wish.

4. I understand that the interview will be recorded and transcribed, and that the interview recording will be erased on completion of the study.

5. I understand that my contribution will be anonymised. I understand that extracts from my interview may be quoted anonymously in print and online when the findings of the study are published.

6. I agree to take part in the above study.

_____   _____

Participant Name   **Date**

_____   _____

Participant signature   **Date**

Principal Investigator: **Student Researcher:**
Dr. Simon Watmough   **Michael Lloyd**
Dept. of Medical education   **Pharmacy Department**
University of Liverpool   **0151-430-1565**
efcsw@liv.ac.uk   Michael.lloyd@sthk.nhs.uk

Version Number: 1.1 19th July 2014

Appendix 9: Participant information sheets for prescriber interviews in chapter 6

Exploring Prescribing Error Feedback

Version Number: 1.1 19th July 2014

Invitation Paragraph

You are being invited to participate in part of a research study involving an interview. This is part of a larger research project involving audits, other interviews and focus groups. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with others if you wish. We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

What is the purpose of the study?
Prescription errors account for the majority of all Medication errors and are considered more likely to cause patient harm. Various solutions have been advocated to reduce prescribing errors including electronic prescribing, greater reporting of errors and a focus on education and training. However, trainees have expressed concerns over their preparedness to prescribe and report that they would welcome feedback on their prescribing.

Formalised feedback is one proposal to mitigate prescribing errors with prescribers suggesting errors would not be repeated if they knew about them. Little is known on the attitudes and experiences of Prescribers to receiving feedback on prescribing errors.

This study is concerned with exploring the impact of formalized prescribing errors feedback on prescribers.

Why have I been chosen to take part?
You are one of the current prescribers on the pilot ward.

Do I have to take part?
It is entirely up to you to decide whether or not to join the study and be interviewed by the researcher. If you agree to participate, the researcher will talk to you about the research and will go through this information sheet with you. You will be asked to sign a consent form. You are free to withdraw from the study at any time.

What will happen if I take part?

If you would like to participate in this study:

- You will be asked to take part in a short interview with the researcher which will last approximately 20 to 30 minutes.
- In this interview, the researcher will ask you about your experiences of receiving feedback on prescribing errors
- The interview will be carried out on the hospital premises at a time convenient to you.
- The interview will be recorded on a digital recorder, so that we can analyse what you have said. The recording will be transcribed verbatim so that we have a written account of what you have said for analysis.

Expenses and / or payments

No expenses or payments will are available

Are there any risks in taking part?

No harm is intended to you. Whilst the study is focused on attitudes to receiving feedback, it is possible that you may discuss prescribing errors affecting real patients. You do not have to discuss any issues that you do not want to, and without explanation. You should also be aware that the researcher will be operating within their codes of professional practice and so confidentiality cannot be assured at all times. Where intentional malpractice or unsafe practice is identified this will be referred to your clinical / educational supervisor for further review.

Are there any benefits in taking part?

By participating in this research, you will be contributing to knowledge in this field. You will be helping us to improve our understanding of and delivery of feedback on prescribing errors. This may lead to improvements in patient safety and the delivery of feedback on prescribing errors.

What if I am unhappy or if there is a problem?

You can contact the researcher Michael Lloyd at Michael.lloyd@sthk.nhs.uk or Dr Simon Watmough at efcsw@liv.ac.uk or professor Sarah O'Brien at sarah.o'brien@sthk.nhs.uk and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact the Research Governance Officer at ethics@liv.ac.uk. When contacting the Research Governance Officer, please provide details of the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make.

Will my participation be kept confidential?

- Only the researchers involved in the study will listen to the recording of your interview, or read the transcript
- The information that you provide will be kept anonymous – it will not be linked with you personally.
- After the study has been completed, the recording of your interview will be erased.
- Your details will not be disclosed to any third party.

- The information that you provide will be treated in the strictest confidence, in accordance with the Data Protection Act 1998.
- Confidentiality will be assured to all participants throughout the entirety of the study. The sole exception being when intentional malpractice or unsafe practice is identified. In these situations, details will be referred to your educational supervisor for further review.

What will happen to the results of the study?
- Our aim is that the results of the research will contribute to our understanding on the feedback of prescribing errors to prescribers. Specifically, the impact of receiving formalised feedback.
- We plan to publish our results in a peer reviewed journal or educational conference.
- All information will be anonymised to prevent identification of individual research participants.
- Results will also be presented locally at relevant meetings

What will happen if I want to stop taking part?

Participants can withdraw at anytime, without explanation. Results up to the period of withdrawal may be used, if you are happy for this to be done. Otherwise you may request that they are destroyed and no further use is made of them. .If results are anonymised you should make clear that results may only be withdrawn prior to anonymisation.

Who can I contact if I have further questions?
Please contact Michael Lloyd between 8:30 am and 5pm, Mon-Fri, on either extension 4323, or pager 7437. Alternatively, Michael can be contacted at Michael.lloyd@sthk.nhs.uk.   Alternatively you can contact Dr. Simon Watmough at efcsw@liv.ac.uk

Appendix 10: Participant information sheets for prescriber interviews in chapter 9

UNIVERSITY OF LIVERPOOL

Exploring the impact of prescribing error feedback on specific prescription error types

Version Number: 1.1 1st June 2015
Introduction
You are being invited to participate in a research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with others if you wish. We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

What is the purpose of the study?
Prescribing errors account for the majority of all medication errors and are considered more likely to cause patient harm. Feedback on errors has been proposed to improve prescribing whist it is also valued and welcomed by prescribers to inform their professional development.

However, little is known on the impact of feedback on prescriber behaviour and specifically, if feedback changes prescribing practice or if its influence is dependent on the error causation. Understanding these problems further will help to support design and delivery of more robust and tailored feedback processes.

Hence, this study is concerned with exploring the impact of feedback on specific types of prescription errors.

Why have I been chosen to take part?
You are a doctor based at the host organisation and have been involved in receiving individualised, formal feedback on a prescription error from your ward based pharmacist.

Do I have to take part?

It is entirely up to you to decide whether or not to join the study and be interviewed by the researcher. If you agree to participate, the researcher will talk to you about the research and will go through this information sheet with you. You will be asked to sign a consent form. You are free to withdraw from the study at any time.

What will happen if I take part?

If you would like to participate in this study:

•   You will be asked to take part in an interview that will last for approximately 20-30 minutes.

•   In this interview, we will ask you about the causes of a specific prescription error that you have received feedback on in the past 96 hours and the impact if any, that the feedback has had on your prescribing.

•   The interview will be carried out on the hospital premises at a time and venue convenient for yourself. Michael Lloyd will facilitate the interview.

•   The interview will be recorded on a digital recorder, and will be transcribed verbatim so that we have a written account of what you have said for subsequent analysis.

Expenses and / or payments

No expenses or payments will be available

Are there any risks in taking part?

There are no anticipated risks involved, all data will be anonymised and confidentiality maintained (see point 10 below). However, you will be discussing a prescription error that has occurred which may cause some distress. No harm is wished upon you and you may refuse to answer questions or discuss issues at any time, and without giving a reason. Any doctor that appears distressed will be allowed to the leave the study and will be referred to relevant support in accordance with trust procedures.

Are there any benefits in taking part?

By participating in this research, you will be actively contributing to knowledge in this field. You will be helping us to improve our understanding and delivery of feedback on prescribing errors. Specifically, the impact of prescribing error feedback on certain types of errors. This may lead to improvements in patient safety and the delivery of feedback on prescribing errors.

What if I am unhappy or if there is a problem?

You can contact the researcher Michael Lloyd at Michael.lloyd@sthk.nhs.uk or Dr Simon Watmough at efcsw@liv.ac.uk or Professor Sarah O'Brien at Sarah.OBrien@sthelensccg.nhs.uk and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact the Research Governance Officer at ethics@liv.ac.uk. When contacting the Research Governance Officer, please provide details of

the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make.

Will my participation be kept confidential?

•   Only the researchers involved in the study will listen to the recording of your interview, or read the transcript

•   The information that you provide will be kept anonymous – it will not be linked with you personally.

•   After the study has been completed, the recording of your interview will be erased.

•   Your details will not be disclosed to any third party.

•   The information that you provide will be treated in the strictest confidence, in accordance with the Data Protection Act 1998.

•   Confidentiality will be assured to all participants throughout the entirety of the study. The sole exception being when intentional malpractice or unsafe practice is identified. In these situations, details will be referred to your educational supervisor for further review.

What will happen to the results of the study?

•   Our aim is that the results of the research will contribute to our understanding on the feedback of prescribing errors to prescribers. Specifically, the influence of feedback on certain types of error causation.

•   We plan to publish our results in a peer reviewed journal or educational conference.

•   All information will be anonymised to prevent identification of individual research participants.

•   Results will also be presented locally at relevant meetings

What will happen if I want to stop taking part?

Participants can withdraw at anytime, without explanation. Results up to the period of withdrawal may be used, if you are happy for this to be done. Otherwise you may request that they are destroyed and no further use is made of them. Results may only be withdrawn prior to anonymisation of the data.

Who can I contact if I have further questions?

Please contact Michael Lloyd between 8:30 am and 5pm, Mon-Fri, on either extension 4323, or pager 7437. Alternatively, Michael can be contacted at Michael.lloyd@sthk.nhs.uk.   Alternatively you can contact Dr. Simon Watmough at efcsw@liv.ac.uk

Appendix 11: e-mail for prescriber interviews in chapter 6

Invitational e-mail to be sent to Pharmacists / Prescribers to participate in the study

Subject line: Research study assessing attitudes and opinions to delivering / receiving feedback on prescribing errors

Email content:

Dear Pharmacist / Prescriber,

Please find attached participant information sheet providing an overview of a research study to determine the attitudes and opinions of Pharmacists / Prescribers to delivering / receiving feedback on prescribing errors.

This study is being undertaken by Michael Lloyd as part of an MPhil, supervised by Dr. Simon Watmough at the University of Liverpool.

Briefly, the study is concerned in exploring your attitudes, views and opinions to the delivery / receipt of feedback on prescribing errors.

Please read the attached participant information sheet about the study and then decide if you would or would not like to participate in the research.

If you wish to participate in the study, please contact Michael Lloyd at Michael.lloyd@sthk.nhs.uk who will then be in contact to arrange a convenient date for the focus group / interview.

If you have any questions at all regarding the study please do not hesitate to contact Michael for further information.

Appendix 12: e-mail for prescriber interviews in chapter 9

Subject line: Research study assessing impact of feedback on prescribing

Email content:

Dear 'Dr. Name',

Please find attached a participant information sheet providing an overview of a research study exploring the impact of feedback on prescribing behaviour.

As you have recently received feedback on your prescribing you are eligible to participate.

This study is being undertaken by Michael Lloyd as part of an PhD, supervised by Dr. Simon Watmough at the University of Liverpool.

Please read the attached participant information sheet about the study and then decide if you would or would not like to participate in the research.

If you wish to participate in the study, please contact Michael Lloyd at Michael.lloyd@sthk.nhs.uk who will then be in contact to arrange a convenient date for the interview.

If you have any questions at all regarding the study please do not hesitate to contact Michael for further information.

Appendix 13: Invitational e-mail for focus group participation

Subject line: Research study exploring attitudes of pharmacists towards delivering prescribing error feedback

Email content:

Dear Pharmacist,

Please find attached a participant information sheet providing an overview of a research study.   Briefly, the study is concerned in exploring your attitudes, views and opinions towards delivering prescribing error feedback.

This study is being undertaken by Michael Lloyd as part of an MPhil, supervised by Dr. Simon Watmough at the University of Liverpool.

Please read the attached participant information sheet about the study and then decide if you would or would not like to participate in the research.

If you wish to participate in the study, please contact Michael Lloyd at Michael.lloyd@sthk.nhs.uk who will then be in contact to arrange a convenient date for the focus group.

If you have any questions at all regarding the study please do not hesitate to contact Michael for further information.

Appendix 14: Participant information letter for pharmacists focus groups

Version Number: 1.1 19th July 2014

Introduction

You are being invited to participate in part of a research study involving focus groups. This is part of a larger research project involving audits, interviews and other focus groups. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with others if you wish.   We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

What is the purpose of the study?

Prescription errors account for the majority of all Medication errors and are considered more likely to cause patient harm. Various solutions have been advocated to reduce prescribing errors including electronic prescribing, greater reporting of errors and a focus on education and training although prescription errors still occur.

Formalised feedback is one proposal to mitigate prescribing errors with prescribers suggesting errors would not be repeated if they knew about them. Pharmacists are often considered best placed to deliver prescribing error feedback. Little is known on the attitudes of Pharmacists to delivering prescribing error feedback.

This study is concerned with exploring the attitudes and opinions of Pharmacists to delivering feedback on Prescription errors.

Why have I been chosen to take part?

You are a Pharmacist based at the host organisation.

Do I have to take part?

It is entirely up to you to decide whether or not to join the study and be interviewed by the researcher. If you agree to participate, the researcher will talk to you about the research and will go through this information sheet with you. You will be asked to sign a consent form. You are free to withdraw from the study at any time.

What will happen if I take part?

If you would like to participate in this study:

- You will be asked to take part in a focus group with 6-8 other Pharmacists and the researcher which will last approximately 60 minutes.
- In this interview, we will ask you about your experiences of delivering feedback on prescribing errors
- The focus group will be carried out on the hospital premises at a time convenient for the group and facilitated by the researcher Michael Lloyd.
- The focus group discussion will be recorded on a digital recorder, so that we can analyse what you have said. The recording will be transcribed verbatim so that we have a written account of what you have said for analysis.

Expenses and / or payments

No expenses or payments will be available

Are there any risks in taking part?

There are no anticipated risks involved. However, it is possible that you may discuss medication errors that have occurred. These may causes some discomfort and embarrassment in front of your colleagues. No harm is wished upon you and you may refuse to answer questions or discuss issues at any time, and without giving a reason. Any Pharmacist that appears distressed will be allowed to the leave the study and will be referred to their supervisor for support in accordance with trust procedures.

Are there any benefits in taking part?

By participating in this research, you will be actively contributing to knowledge in this field. You will be helping us to improve our understanding and delivery of feedback on prescribing errors. Specifically, the impact of delivering any feedback on the Pharmacists. This may lead to improvements in patient safety and the delivery of feedback on prescribing errors.

What if I am unhappy or if there is a problem?

You can contact the researcher Michael Lloyd at Michael.lloyd@sthk.nhs.uk or Dr Simon Watmough at efcsw@liv.ac.uk or professor Sarah O'Brien at sarah.o'brien@sthk.nhs.uk and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact the Research Governance Officer at ethics@liv.ac.uk. When contacting the Research Governance Officer, please provide details of the

name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make.

Will my participation be kept confidential?

- Only the researchers involved in the study will listen to the recording of your interview, or read the transcript
- The information that you provide will be kept anonymous – it will not be linked with you personally.
- After the study has been completed, the recording of your interview will be erased.
- Your details will not be disclosed to any third party.
- The information that you provide will be treated in the strictest confidence, in accordance with the Data Protection Act 1998.
- Confidentiality will be assured to all participants throughout the entirety of the study. The sole exception being when intentional malpractice or unsafe practice is identified. In these situations, details will be referred to your educational supervisor for further review.

What will happen to the results of the study?

- Our aim is that the results of the research will contribute to our understanding on the feedback of prescribing errors to prescribers. Specifically, the impact of delivering formalised feedback.
- We plan to publish our results in a peer reviewed journal or educational conference.
- All information will be anonymised to prevent identification of individual research participants.
- Results will also be presented locally at relevant meetings

What will happen if I want to stop taking part?

Participants can withdraw at anytime, without explanation. Results up to the period of withdrawal may be used, if you are happy for this to be done. Otherwise you may request that they are destroyed and no further use is made of them. .If results are anonymised you should make clear that results may only be withdrawn prior to anonymisation.

Who can I contact if I have further questions?

Please contact Michael Lloyd between 8:30 am and 5pm, Mon-Fri, on either extension 4323, or pager 7437. Alternatively, Michael can be contacted at Michael.lloyd@sthk.nhs.uk. Alternatively you can contact Dr. Simon Watmough at efcsw@liv.ac.uk

Appendix 15: Focus group topic guide

Venue: Pharmacy seminar room at a convenient time for pharmacists
Ensure undisturbed i.e. pagers, phones etc. turned off
Likely Duration: 30-60 minutes.

Preliminary: Greet, establish rapport and candour. Summarise study purpose again, including need for consent. Obtain written consent and allow opportunity to ask any questions before commencing the interview.
Study Purpose
Prescription errors account for the majority of all medication errors and are considered more likely to cause patient harm. Various solutions have been advocated to reduce prescribing errors including electronic prescribing, greater reporting of errors and a focus on education and training. Formalised feedback on prescription errors is one proposal to mitigate prescribing errors. Pharmacists are often advocated as the most appropriate individual to both intercept and deliver feedback on prescribing errors. Little is currently known on the attitudes of Pharmacists to delivering feedback on prescribing errors.

This study is concerned with exploring the attitudes, views and opinions of Hospital Pharmacist on delivering feedback on prescribing errors.

Advise that as all questions must be asked. Hence, it may seem that some are repeated as we progress through the schedule where you have provided an answer earlier.

Themes are in **bold.** Follow up prompting questions are denoted by **P)** and will be used to clarify responses and gain more detailed responses (as opposed to yes/no responses for example)

Background information
Can you state your current band and number of years you have been qualified

Theme: Perceptions of delivering Prescribing Error Feedback

Introduction
Do you think that prescribers should receive feedback on PE's?
        P: Why?
What system currently exists in the Hospital for identifying prescription errors?
        P: Does it work well? Who identifies PE's?
Are there any problems with the current system?
How often do you identify PE's?
        P: i.e. daily? weekly?
Do you provide feedback on PE's?
        P: How often?
Do you record PE's that you identify in the clinical notes?
        P: If not then why?
Do you complete DATIX reports for PE's?

P: Are you expected to complete DATIX reports for PE's?

Do you think that DATIX reports should be completed for PE's?

P: Does this happen now?

Does the severity of the PE influence how you deal with it?

P: In what way?

Why do you think delivery of PE feedback might be inconsistent?

Transition

What do you think are the benefits of delivering feedback on PE's?

Who do you think is the best person to provide feedback on PE's?

P: i.e. Pharmacist, doctor, nurse or someone else

Is it the role of a Pharmacist to deliver feedback on PE's?

Is the speed of feedback important?

P: Is timely feedback needed?

Can you provide any examples where you have delivered PE feedback?

P: How was it delivered? How did you feel about it?

When you identify a PE, what do you do?

P: Do you feedback to the prescriber? Amend the error yourself?

How do you deliver feedback, if any, on prescribing errors?

P: i.e. face to face, written, e-mail etc

What factors make you decide whether you feedback or not on a PE?

P: i.e. PE severity, rapport with prescriber, time pressures?

Can you think of any barriers to delivering feedback on PE's?

Do you feel comfortable delivering feedback on PE's?

P: Do you feel confident? Prepared? If unsure / afraid then why?

What impact if any does providing feedback have on you?

P: Workload? Commitments? Rapport with prescriber?

What impact if any does providing feedback have on your working relationship with the prescriber?

Ending Questions

In an ideal world, how do you feel that PE feedback should be delivered?

What can be done to improve the current system?

We wanted you to help review and evaluate systems of feedback on PE's in the hospital. We've covered various issues including….. Is there anything that we have missed or anyone would like to add before we conclude the meeting?

Thank them for their time. Turn off audio tape.

Advise participants that a thankyou letter will be sent out in the post.

General second / probing questions

Silence….

You said earlier…

Can you provide an example / clarify what you mean…

Can you elaborate on that….

Could you expand on that….

Appendix 16: Prescribing error data collection tool

Prescribing Error Intervention Audit Form

(Please use one form per patient / prescriber reviewed)

Ward _____   Prescriber Name: _____

Prescription type: **a)** Electronic Prescription ☐   **b)** Handwritten prescription ☐

Prescription Stage: **a)** During Stay **c)** Discharge ☐

Prescriber Grade: FY1 / FY2 / Specialty / Staff grade / Consultant / NMP

Total number of new items on the prescription: _____

Was the prescription error free? Yes☐   No☐

	Prescribing error description (Include drug name and route)	Error code (see over)	Error severity (PL, SE, SIG or M)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Prescribing error severity

1. Potentially lethal error = **P**
2. Serious error = **SE**
3. Significant error = **SIG**
4. Minor error = **M**

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Appendix 17: Prescribing error severity

Potentially lethal error	An error is defined as potentially lethal if it could have one or more of the following consequences: • The serum level resulting from such a dose is likely to be in the severe toxicity range based on common dosage guidelines, e.g. serum theophylline concentrations greater than 30 micrograms per ml. More than 10 times the dose of chemotherapy agent for example • The drug being administered has a high potential to cause cardiopulmonary arrest in the dose ordered. • The drug being administered has a high potential to cause a life threatening adverse reaction, such as anaphylaxis, in light of the patient's medical history. • The dose of a potentially life saving drug is too low for a patient having the disease being treated • The dose of a drug with a very low therapeutic index such as digoxin is too high (ten times the normal dose)
Serious Error	An error is defined as serious if it could have one or more of the following results: • The route of drug administration ordered is inappropriate, with the potential of causing the patient to suffer a severe toxic reaction. • The dose of the drug prescribed is too low for a patient with serious disease who is in acute distress • The dose of a drug with a low therapeutic index is too high (four to ten times the normal dose) • The dose of the drug would result in serum drug levels in the toxic range, e.g. theophylline levels 20-30 micrograms per mL. • The drug orders could exacerbate the patient's condition, e.g. drug-drug interaction or drug-disease interaction. • The name of the drug is misspelled or illegible creating a risk that the wrong drug might be dispensed (i.e. amiloride instead of amlodipine) including errors in decimal points or units if the error could lead to the dose being given • High dosage (ten times) normal of a drug without a low therapeutic index
Significant error	An error is defined as significant if it could have one or

	more of the following results:
	- The dose of the drug with low therapeutic index is too high (half – four times the normal dose) - The dose of the drug is too low for a patient with the condition being treated - The wrong laboratory studies to monitor a specific side effect of a drug are ordered e.g. CBC and reticulocyte counts are ordered to monitor gentamicin toxicity - The wrong route of administration for the condition being treated is ordered e.g. the inadvertent change from IV to oral therapy for the treatment of meningitis - Errors ordering fluids are made e.g. specific additives needed for complete therapy are omitted or incompatible fluids are ordered - Errors of omission whereby patient's regular medication is not prescribed either on admission, during a rewrite and on discharge
Minor error	An error is defined as minor if it could have one or more of the following results: - Duplicate therapy was prescribed without potential for increased adverse effects - The wrong route was ordered without potential for toxic reactions or therapeutic failure - The order lacked specific drug, dose, dosage strength, frequency, route or frequency information - Illegible, ambiguous or non-standard abbreviations - An errant order was written that was unlikely to be carried out given the nature of the drug, dosage forms, route ordered, missing - information etc Examples include, simvastatin prescribed in the morning rather than at night. Bisoprolol – two puffs four times a day.

Appendix 18: Prescribing error types

Error category	Includes	Excludes
1. Dosing errors	Overdose, underdose, dose rate/mismatch	Excludes overdoses caused by duplication eg, Paracetamol with co-codamol
2. Writing	Strength/dose missing	

errors	Product/ formulation not specified, Incorrect formulation, No signature, Start date incorrect/missing, CD requirements incorrect/missing, dose units missing	
3. **Allergy status**	Significant allergy, Includes allergy status not completed, or where a drug has been prescribed despite an allergy to that drug/class	
4. **Duration of treatment**	Continuation for longer than needed, Includes no stop/review date for antibiotics, steroids etc, Premature discontinuation, Includes drugs stopped without appropriate reducing course	
5. **Drug Interactions**		Excludes 2 items prescribed from same class eg, omeprazole with lansoprazole (duplication)
6. **Omissions**	Omission on admission, Omission on Discharge, Drug not prescribed but indicated	
7. **Excessive / unnecessary prescribing**	Duplication: Includes a second agent prescribed which contains an ingredient already being taken; 2 drugs prescribed from the same class/with same clinical effect eg, Lansoprazole + Omeprazole. Unintentional Rx: Drug prescribed was not that desired. Includes prescription of a discontinued drug, excluding discontinuation due to ADR, or course is too long	
8. **Clinical safety**	No max dose. Clinical Contraindication. Continuation after ADR. No dosage alteration after levels out of range	Excludes prescriptions with no frequency (administration times missing/incorrect)

9. Lack of clear directions	Administration times incorrect/ missing Incorrect route Intravenous instructions incorrect/missing Route missing Daily dose divided incorrectly	
10. Miscellaneous	No indication: Includes PRN medications, where lack of indication on prescription could prevent administration. Excludes failure to write an indication when prescribing antibiotic. Illegible drug details, non-standard abbreviations, patient details incorrect/missing, warfarin fixed dose prescribed	

Appendix 19: Prescribing scenarios for pharmacist training

1. Inpatient Prescription:
Patient admitted with a mild LRTI, CURB$_{65}$ = 1, commenced on amoxicillin. Also commenced on amlodipine for hypertension. On simvastatin 40mg po on.

Drug Allergies / Sensitivities If no allergies / sensitivities - write NKDA.
This section MUST be completed before medication is given. Confirm drug AND type of reaction

NKDA.
RAMIPRIL

Confirmed by: _____ Date: 13/7/15

First Name: This
Surname: Patient
Hospital number: 98765432
Date of birth: 11/9/1962
Address: this place

Weight .... kg | Height .... m | Body Surface Area ....
Tick if applies ✔ Renal Impairment ◯ | Liver Impairment ◯ | Pregnant ◯ Breast Feeding ◯

Medication	Time													
Drug Name **ENOXAPARIN** (not to be given unless signed and dated)	0800													
Dose / Route SC / Start date	1200													
Pharmacy / Stop date/sig.	1400													
Other instructions: Check platelets every 2-3 days from day 5	1800													
and potassium once weekly	2200													
Prescriber's signature														
Drug Name Simvastatin	0800													
Dose 40mg / Route PO / Start date 13/7/15	1200													
Pharmacy / Stop date/sig.	1400													
Other instructions	1800													
	2200													
Prescriber's signature														
Drug Name Amlodipine	0800													
Dose 5mg / Route po / Start date 13/7/15	1200													
Pharmacy / Stop date/sig.	1400													
Other instructions	1800													
	2200													
Prescriber's signature														
Drug Name Amoxicillin	0800													
Dose 500mg / Route po / Start date 13/7/15	1200													
Pharmacy / Stop date/sig.	1400													
Other instructions	1800													
	2200													
Prescriber's signature														
Drug Name	0800													
Dose / Route / Start date	1200													

2. Inpatient Prescription:

Epileptic patient (stable) on valproate. Admitted with confusion, UTI
diagnosed resistant to trimethoprim, sensitive to ciprofloxacin and cephalexin

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In-Patient Medication Administration Chart

St Helens and Knowsley Teaching Hospitals — NHS Trust

Drug Allergies / Sensitivities If no allergies / sensitivities - write NKDA.
This section MUST be completed before medication is given. Confirm drug AND type of reaction

NKDA

Confirmed by: [signature] Date: 13/7/15

First Name: Amy
Surname: Patient
Attach Addressograph Here
Hospital number: 12345678X
Date of birth: 12 / 8 / 62
Address: Any Town.

Weight .... kg   Height .... m   Body Surface Area .... m²
Tick if applies ✔ Renal Impairment ◯ Liver Impairment ◯ Pregnant ◯ Breast Feeding ◯

Medication	Time
Drug Name ENOXAPARIN (not to be given unless signed and dated) Dose 40mg Route SC Start date 13/7/15 Pharmacy Stop date/sig. Other Instructions Check platelets every 2-3 days from day 5 and potassium once weekly Prescriber's signature	0800 1200 1400 1800 2200
Drug Name Sodium Valproate MR Dose 500mg Route PO Start date 13/7/15 Pharmacy Stop date/sig. Other Instructions "EPILIM CHRONO" Prescriber's signature	0800 1200 1400 1800 2200
Drug Name Paracetamol Dose 1g. Route PO Start date 13/7/15 Pharmacy Stop date/sig. Other Instructions 4-6° PRN. Prescriber's signature	0800 1200 1400 1800 2200
Drug Name Codeine Dose 30-60mg Route PO Start date Pharmacy Stop date/sig. Other Instructions 4-6° PRN Prescriber's signature	0800 1200 1400 1800 2200
Drug Name Ciprofloxacin Dose 500mg Route PO Start date 13/7/15 Pharmacy Stop date/sig. Other Instructions 7/7 only. Prescriber's signature	0800 1200 1400 1800 2200
Pharmacy Review	

Please re-write chart

3. Inpatient prescription
Diabetic patient admitted.

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In-Patient Medication Administration Chart

St Helens and Knowsley Teaching Hospitals NHS
NHS Trust

Drug Allergies / Sensitivities If no allergies / sensitivities - write NKDA.
This section MUST be completed before medication is given. Confirm drug AND type of reaction

NKDA

Confirmed by: _(signature)_ Date: 15/7/15

First Name: Other
Surname: Patient
Hospital number: 100908078
Date of birth: 4/4/1975
Address: Other area

Attach Patient Photograph Here

Weight .... kg	Height .... m	Body Surface Area .... m²
Tick if applies ✔ Renal Impairment ◯	Liver Impairment ◯	Pregnant ◯ Breast Feeding ◯

Medication	Time
Drug Name **ENOXAPARIN** (not to be given unless signed and dated)	0800
Dose 40mg / Route SC / Start date	1200
Pharmacy / Stop date/sig.	1400 ✔
Other instructions Check platelets every 2-3 days from day 5 and potassium once weekly	1800
Prescriber's signature _(signature)_	2200
Drug Name NovoMix Flexpen	0800 ✔
Dose 16IU / Route S/cut / Start date 15/7/15	1200
Pharmacy / Stop date/sig.	1400
Other instructions 15 mins pre meals.	1800 ✔
Prescriber's signature _(signature)_	2200
Drug Name Ramipril	0800
Dose 5mg. / Route po / Start date 15/7/15	1200
Pharmacy / Stop date/sig.	1400
Other instructions	1800
Prescriber's signature _(signature)_	2200
Drug Name	0800
Dose / Route / Start date	1200
Pharmacy / Stop date/sig.	1400
Other instructions	1800

re-write chart

4. Inpatient prescription
Patient prescribed treatment dose Clexane for suspected PE. Reduced GFR (25mL/min).

In-Patient Medication Administration Chart

St Helens and Knowsley Teaching Hospitals NHS
NHS Trust

Drug Allergies / Sensitivities If no allergies / sensitivities - write NKDA.
This section MUST be completed before medication is given. Confirm drug AND type of reaction

NKDA

Confirmed by: Date:

First Name: Any
Surname: Patient
Attach Addressograph Here
Hospital number: 12345678A
Date of birth: 10 6 71
Address: This place

Weight ...... 80 ...... kg   Height .... m   Body Surface Area .... m²

Tick if applies ✔ Renal Impairment ◯   Liver Impairment ◯   Pregnant ◯ Breast Feeding ◯

Medication	Time	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
Drug Name ENOXAPARIN (not to be given unless signed and dated)	0800													
Dose 120mg Route SC Start date	1200													
Pharmacy Stop date/sig.	1400													
Other instructions Check platelets every 2-3 days from day 5 and potassium once weekly	1800													
Prescriber's signature	2200													
Drug Name Paracetamol	0800													
Dose 1 g Route PO Start date	1200													
Pharmacy Stop date/sig.	1400													
Other instructions 4-6hrly PRN	1800													
Prescriber's signature	2200													
Drug Name	0800													
Dose Route Start date	1200													
Pharmacy Stop date/sig.	1400													

write chart

5. Discharge prescription
No items omitted

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MEDICAL DISCHARGE SUMMARY

St Helens and Knowsley Teaching Hospitals **NHS**
NHS Trust

Copies: Yellow – Pharmacy   White – GP   Pink – Case notes   Blue – Patient

Warrington Road, Prescot, Merseyside, L35 5DR
Tel: 0151 426 1600

WARD : ONE   CONSULTANT : OTHER

Patient Details		GP Details (Name & Address)
Name	OTHER PATIENT.	
Address	OTHER PLACE.	
		Date of Admission : 15/7/15
		Date of Discharge : 18/7/15
Date of Birth and Hospital Number	15 / 11 / 1972	Discharged to : Home

Diagnosis/Problem with indication of severity

Clinical Details include relevant investigations, complications, treatment, progress, medication stopped and why

Medication on Discharge   Allergies/sensitivities : NKDA   Weight (in kg) if applicable :

Item , Dose , Frequency , Dosage Form	New Item (✓)	GP please review (✓)	Notes e.g. indication for new items	Pharmacy Use Only Quantity / Notes
Morphine Sulphate solution 10mg/5ml 5mg po PRN.			(Morphine Sulphate caps).	
Zomorph 20mg po BD.			(Morphine Sulphate caps).	
Paracetamol 1g po qds			(regular).	
Senna 7.5mg ii po ON PRN				
Lactulose 15ml po BD PRN.				

Complete if multiple sheets : Total number of sheets including any CD prescription sheet(s) ....   CD prescription(s) attached Y / N

	Sent from Ward	Received	Clinical check	Labelled	Dispensed	Final Check	Received on Ward	Additional
NAME								
DATE TIME								

Advice on discharge / Follow up information

SIGNED: _____   PRINT NAME AND TITLE : ANY DOCTOR   BLEEP: 1234   DATE: 18/7/15

6. Discharge prescription

Exacerbation of COPD. Multiple recent courses of steroids, no maintenance dose (but needs reducing regimen). NKDA

Drug Chart:

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Tiotropium 18mcg inh od
Furosemide 40mg po om
Salbutamol evo 100mcg 2puffs inh prn
Seretide 250/25 evohaler 2 puffs inh bd
Amoxicillin 500mg po tds 7/7 (3/7 remaining)
Prednisolone 30mg poo m 7/7 (3/7 remaining then reduce by 5mg every three days to zero)
Aminophylline MR 225mg po bd

MEDICAL DISCHARGE SUMMARY — St Helens and Knowsley Teaching Hospitals NHS

Copies: Yellow – Pharmacy   White – GP   Pink – Case notes   Blue – Patient

WARD: ANY   CONSULTANT: OTHER

Warrington Road, Prescot, Merseyside, L35 5DR
Tel: 0151 426 1600

Patient Details		GP Details (Name & Address)	
Name	ANY PATIENT.		
Address	ANY PLACE.		
		Date of Admission : 15/7/15	
		Date of Discharge : 19/7/15	
Date of Birth and Hospital Number	17/4/1943	Discharged to : HOME	

Diagnosis/Problem with indication of severity

Clinical Details include relevant investigations, complications, treatment, progress, medication stopped and why

Medication on Discharge   Allergies/sensitivities : NKDA .   Weight (in kg) if applicable :

Item , Dose , Frequency , Dosage Form	New Item (✓)	GP please review (✓)	Notes e.g. Indication for new items	Pharmacy Use Only Quantity / Notes
Tiotropium 18microg po od				
Salbutamol TT INH PRN.				
Seretide TT INH BD.				
Amoxicillin 500mg po TDS	3/7			
Prednisolone 30mg po om	3/7			
Amitriptylline 225mg po BD.				

Complete if multiple sheets : Total number of sheets including any CD prescription sheet(s) ....   CD prescription(s) attached Y / N

	Sent from Ward	Received	Clinical check	Labelled	Dispensed	Final Check	Received on Ward	Additional
NAME								
DATE TIME								

Advice on discharge / Follow up information

SIGNED: _____   PRINT NAME AND TITLE: ANY DOCTOR   BLEEP: 1234   DATE: 18/7/15

7. Inpatient prescription
Diabetic patient admitted with a LRTI CURB$_{65}$=4. Treated empirically as per local policy.

In-Patient Medication Administration Chart

St Helens and Knowsley Teaching Hospitals **NHS** NHS Trust

Penicillin – anaphylaxis

Confirmed by: *[signature]* Date: 3/2/15

First Name: Ann
Surname: Pa... *Attach Addressograph Here*
Hospital number: TL345678A
Date of birth: 22/3/1960
Address: Ann Place

Weight .... kg Height .... m Body Surface Area .... m²
Tick if applies ✓ Renal Impairment ◯ Liver Impairment ◯ Pregnant ◯ Breast Feeding ◯

Medication	Time														
ENOXAPARIN (not to be given unless signed and dated) Dose 40mg Route SC Start date Pharmacy Stop date/sig. Other instructions: Check platelets every 2-3 days from day 5 and potassium once weekly Prescriber's signature	0800 1200 1400 18 2200														
Augmentin Dose 1.2g Route IV Start date 3/2/15 Pharmacy Stop date/sig. Other instructions: R/w in 48hrs Prescriber's signature	0600 1200 1400 1800 22														
Clarithromycin Dose 500mg Route IV Start date 3/2/15 Pharmacy Stop date/sig. Other instructions: R/w in 48hrs Prescriber's signature	0600 1200 1400 1800 2200														
Metformin Dose 500mg Route po Start date 3/2/15 Pharmacy Stop date/sig. Other instructions: Prescriber's signature	0800 1200 1400 1800 2200														
Gliclazide Dose 80mg Route po Start date 15/2/15 Pharmacy Stop date/sig. Other instructions: Prescriber's signature	0800 1200 1400 1800 2200														

Please re-write chart

Medication	Time	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
Drug Name Simvastatin (U) Dose 40mg Route po Start date Pharmacy Stop date/sig. Other instructions: Prescriber's signature	0800 1200 1400 1800													
Drug Name U C N Dose Route Start date Pharmacy Stop date/sig. Other instructions:	0800 1200 1400 1800 2200													

...e chart

8. Inpatient prescription
Parkinson's patient, admitted with a fall. eVTE completed, needs clexane.

In-Patient Medication Administration Chart

St Helens and Knowsley Teaching Hospitals **NHS**
NHS Trust

Drug Allergies / Sensitivities If no allergies / sensitivities - write NKDA.
This section MUST be completed before medication is given. Confirm drug AND type of reaction

NKDA.

Confirmed by: _____ Date: 15/7/15

First Name: Any Patient.
Surname:
Attach Addressograph Here
Hospital number: 123456789 X
Date of birth: 12/11/47
Address: Any Where

Weight .... kg	Height .... m	Body Surface Area .... m²

| Tick if applies ✔ | Renal Impairment ◯ | Liver Impairment ◯ | Pregnant ◯ | Breast Feeding ◯ |

Medication	Time	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
Drug Name ENOXAPARIN (not to be given unless signed and dated)	0800														
Dose / Route SC / Start date	1200														
Pharmacy / Stop date/sig.	1400														
Other instructions: Check platelets every 2-3 days from day 5 and potassium once weekly	1800														
Prescriber's signature	2200														
Drug Name Paracetamol	0800														
Dose 1 g. / Route PO / Start date 13/9/15	1200														
Pharmacy / Stop date/sig.	1400														
Other instructions 4-6hrly PRN MAX 6DS	1800														
Prescriber's signature	2200														
Drug Name Codeine	0800														
Dose 30-60mg / Route PO / Start date 13/9/15	1200														
Pharmacy / Stop date/sig.	1400														
Other instructions PRN.	1800														
Prescriber's signature	2200														
Drug Name Co-Careldopa	0800														
Dose 100/25 / Route PO / Start date 13/9/15	1000														
Pharmacy / Stop date/sig.	1600														
Other instructions 8am 12pm 4pm 8pm	1800														
Prescriber's signature	2000														
Drug Name Co-Careldopa MR	0800														
Dose 100/25 / Route PO / Start date 13/9/15	1200														
Pharmacy / Stop date/sig.	1400														
Other instructions	1800														
Prescriber's signature	2200														

Pharmacy Review

Medication	Time	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
Drug Name Metoclopramide	0800														
Dose 10mg. / Route IV/IM/PO / Start date 13/9/15	1200														
Pharmacy / Stop date/sig.	1400														
Other instructions PRN	1800														
Prescriber's signature	2200														
Drug Name	0800														
Dose / Route / Start date	1200														

Please re-write chart

9. Inpatient Prescription

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Admitted with mild LRTI. Known MRSA positive. Nil DHx.

In-Patient Medication Administration Chart

St Helens and Knowsley Teaching Hospitals **NHS**
NHS Trust

Drug Allergies / Sensitivities If no allergies / sensitivities - write NKDA.
This section MUST be completed before medication is given. Confirm drug AND type of reaction

ICM

NKDA

Confirmed by ~~~~ Date: 15/10/15

First Name Any
Surname [Attach Addressograph Here]
Hospital number 1098965432 A .
Date of birth 27/3/1969
Address Any Place

Weight .... kg   Height .... m   Body Surface Area .... m²

Tick if applies ✔ Renal Impairment ◯   Liver Impairment ◯   Pregnant ◯ Breast Feeding ◯

Medication	Time	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
Drug Name **ENOXAPARIN** (not to be given unless signed and dated)	0800													
Dose 40mg Route SC Start/date 13/10/15	1200													
Pharmacy Stop date/sig.	1400													
Other instructions Check platelets every 2-3 days from day 5 and potassium once weekly	1800													
	2200													
Prescriber's signature														
Drug Name Amoxicillin U C N	0800													
Dose 500mg Route po Start date	1200													
Pharmacy Stop date/sig.	1400													
Other instructions 7/7	1800													
	2200													
Prescriber's signature														
Drug Name U C N	0800													
Dose Route Start date	1200													
Pharmacy Stop date/sig.	1400													
Other instructions	1800													

write chart

10. Inpatient Prescription

NIDDM patient admitted, has own medications with them. U&E's and BMs NAD.

DHx (patient has PODs and repeat list): Simvastatin 40mg po on, Levothyroxine 50mcg po od, sodium valproate EC 500mg po bd, Metformin 500mg po om,

Appendix 20: University of Liverpool ethical approval letter
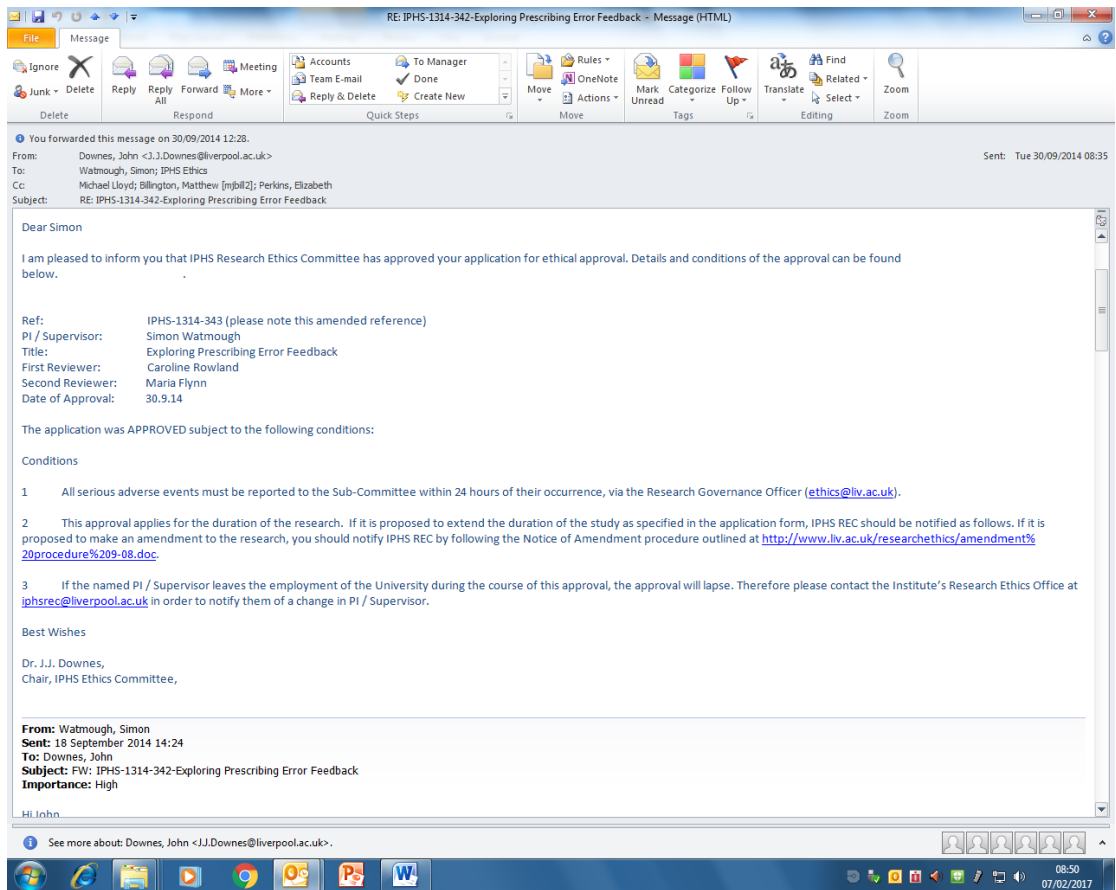
Appendix 21: STHKH research approval letter

St Helens and Knowsley Teaching Hospitals **NHS**

NHS Trust

Direct Line: 0151 430 1218

Mr Michael Lloyd
St Helens & Knowsley Teaching Hospitals NHS Trust
Pharmacy Department
Whiston Hospital
Warrington Road
Prescot
L35 5DR

Whiston Hospital
Warrington Road
Prescot
Merseyside
L35 5DR

Tel: 0151 426 1600
Website: www.sthk.nhs.uk

Dear Mr Michael Lloyd

R&D Ref No	RBN 899	REC Ref	not required
Title	Exploring the Impact of Prescribing Error Feedback		

I am pleased to inform you that the RDI Review of the above research study is now complete. Please accept this letter as formal RDI Approval and sponsorship.

Approval and sponsorship is granted on the understanding that the study will be performed to the standards outlined in the Research Governance Framework which can be found on the internet at www.dh.gov.uk.

It is a condition of this approval and sponsorship that the attached Terms of Approval are agreed, signed and returned to the RD&I Department before the study commences.

For insurance purposes NHS indemnity will apply.

Please note that this approval and sponsorship applies to STHK only, if you wish to add additional sites to this study please contact me as soon as possible.

I would like to take this opportunity to wish you every success with your research study.

Please do not hesitate to contact me if you have any queries.

Yours sincerely

J. Anders

Mrs Jeanette Anders
RD&I Manager

Date signed: 20/08/2014

Research Development & Innovation Department,
LG1 Nightingale House, Whiston Hospital
Email: research@sthk.nhs.uk
Telephone: 0151 430 2334

UNIVERSITY OF **LIVERPOOL**
SHKA81 (09/11)

University Clinical Education Centre

Liverpool John Moores University

Appendix 22: Initial thematic framework for pharmacist focus groups

Delivery of Feedback	Inconsistent
	Formal vs. Informal
	Communication of error
	Incident Reporting
	Correction vs. Feedback
Impact of Feedback	Patient Safety
	Time saving
	Information seeking behaviour
	Feedback Seeking behaviour
Prescription Error	Error Severity
	Error repetition
	Timely Feedback
Work environment	Time pressures
	Location
	Contacting prescriber
	Blame vs. No-blame culture
	Pharmacy Service
	Out of hours
	Prescription stage
Feedback Facilitator	Staff Group
	Confidence
	Job Satisfaction
	Expert Knowledge
	Emotional Intelligence
	Interpretation of error
Working relationships	Rapport
	Team integration
	Hierarchy
	Fear / anxiety
Education and Training	Independent Learning
	Constructive feedback
	Reflective Practice
	Positive vs. Negative
Future Recommendations	Electronic prescribing
	Prescriber Training (induction, shared learning)
	Clinical Governance
	Ward based
	Shared vs. individual learning
	Facilitator Training

Appendix 23: Initial thematic framework for prescriber interviews

Theme	Code
Feedback process	Importance of feedback
	Formal vs Informal
	Error Severity
	Prescriber Grade
	Correction vs Feedback
	Proforma
	Timely
	Non-intrusive
Work environment	Time pressures
	Location
	Pharmacy Service / Cover
	Open Culture
	Prescriber Identification
Feedback facilitator	Recognised Role / Objective
	Rapport
	Social Context
	Patient context
	Difference of opinion
	Hierarchy
Education and Training	Educational Process
	Positive vs. Negative
	Constructive feedback (/ memory recall)
	Personal Development / Independent Learning
	Reflection
	Portfolio
	Educational Process
	Positive vs. Negative
Prescriber impact	Error Awareness
	Discretionary Effort
	Information Seeking Behaviour
	Feedback Seeking Behaviour
	Emotional Impact
	Job Satisfaction
	Time saving
	Error Awareness
System improvement	Shared Learning
	Trust-wide process
	Evidence of error
	Learning Aids
	Induction

Appendix 24: Initial thematic framework for pharmacist interviews

Theme	Code
1. Process Overview	Directive *vs.* facilitative feedback
	Setting
	Feedback content
	Barriers
	Sustainability
2. Working relationship	Rapport
	Hierarchy
	Team integration
	Trust in prescriber
3. Benefits of feedback	Consistency in practice
	Role awareness
	Medicine optimisation
	Working relationship
	Educational
	Reciprocal learning
4. Feedback facilitator	Feedback apprehension
	Facilitator training
	Job satisfaction
	Facilitator credibility
	Raised understanding of error
5. Prescriber impact	Prescriber response
	Information seeking behaviour
	Feedback seeking behaviour
	Goal motivating behaviour
	Prescriber apprehension
	Prescribing behaviour
6. Prescribing error	Error severity
	Timely feedback
	Supporting evidence
	Stage of prescription
	Error type
	Error interpretation
7. Process improvement	Prescribing error procedure
	Formal vs informal
	Shared learning
	Incident report
	Facilitator feedback
	Protected time

Appendix 25: Initial thematic framework for prescriber error interviews

Theme / primary code	Code / secondary code
1. Affective behaviour	Assertive behaviour
	Reflective practice
	Self-awareness
	Self-regulation
	Emotional impact
	Task prioritisation
2. Learning outcome	Improved knowledge
	Error awareness
	Self-detection of errors
	Raised situational awareness
	Prescribing practice
3. Prescribing process / behaviour	Information seeking behaviour
	Careful prescribing
	Systematic prescribing
	Prescribing location
4. Error recurrence	Transferrable learning
	Cognitive anchor
	Facilitator variability
5. Further learning needs	Local induction
	Prescribing education