The effect of structured resuscitation training programmes on the retention of knowledge and skills

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

Chiara Maria Juliette Mosley RN RM Bsc Msc MPhil

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Declaration

This thesis is the result of my own work. The material contained in this thesis has not, to my knowledge, been presented, nor is being presented, for any other degree.

The research was carried out, in the main, at the Liverpool Women's Hospital Foundation Trust. Some data was obtained at other hospitals within Mersey Deanery.

Dedication

To my best friend Alison, I am sorry you were taken from this world before I had completed this research, I will never forget you.

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I would firstly like to offer my sincere thanks to my supervisors Professor Nigel Shaw and Professor Michael Weindling for their tolerance, unwavering encouragement and relentless support over the last five years. Without their guidance and understanding this research would have not been completed.

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To my parents Carole and Rick, you have been there for me through all my difficult times. I thank you for guiding and supporting me throughout my life and never doubting my ability, I hope I have made you proud.

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Abstract

Background

Structured resuscitation training (SRT) programmes for healthcare professionals have been developed to try and achieve an optimum standard of resuscitation management amongst the participants and thus improve patient care. The effectiveness of these has not been systematically investigated.

Aims

1. To systematically review the literature regarding the effectiveness of structured resuscitation programmes.
2. To investigate, in particular, aspects of the effectiveness of the Neonatal Life Support course (a SRT programme which takes place within the author's area of clinical practice).

Methods

A systematic review of the literature on structured adult, paediatric and neonatal resuscitation training was carried out using Best Evidence Medical Education (BEME) methodology.

Over a 22 month period, candidates undertaking a one day Neonatal Life Support Course at the Liverpool Women's Hospital were recruited into a follow-up study whose aim was to assess their retention of resuscitation skills over time and their confidence at performing neonatal resuscitations.

Candidates repeated the Neonatal Life Support 'airway' test at 3-5 months and, if successful, they were subsequently retested at 12-14 months. Prior to the test, candidates were asked to complete a confidence questionnaire and following the test, peer assessment review forms were distributed by their line manager to their peers as part of a multi-source feedback exercise.

Results

The systematic review revealed that knowledge and skills are significantly improved following SRT compared to pre-training levels. Where reported, confidence at performing resuscitation tasks is universally improved in participants who have undertaken SRT. It appears that knowledge can be maintained for several months after SRT. Skills generally deteriorate from at least three months after SRT. Factors which may prevent this occurring are, providing refresher or booster sessions after training and possibly identifying discrete actions to be assessed within simulation during training and at follow up. There were no studies reporting evidence of transfer of learning to clinical practice in individuals. Studies, reporting patient or organisational outcomes, revealed that the introduction of SRT within an institution has a direct positive impact on mortality and also on clinical management.

In the Neonatal Life Support follow up study, 67 candidates were tested at 3-5 months, 26 passing first time and seven failing after retest. Forty-three candidates were retested at 12-14 months, 19 passing first time and two failing after retest.

Conclusions

SRT programmes result in an improvement in knowledge and skills in those that attend them. The literature and the NLS study, reported in this thesis, suggests that deterioration in skills in a simulated scenario, and to a lesser extent knowledge, is highly likely as early as 3 months following SRT. There is no evidence available to assess whether ability in resuscitation procedures in clinical practice changes after SRT in individuals. There is a need for research to determine whether deterioration in skills after SRT, in particular the NLS as assessed by simulation correlates with deterioration of skills in clinical practice.

The introduction of SRT programmes within institutions, where no previous training existed, has a positive effect on patient outcome and leads to improvement in clinical management. However, where staff of all disciplines in a

healthcare institution are trained in resuscitation, there is a need for future research. This needs to investigate whether the learning that takes place on subsequent resuscitation courses, attended by individuals from these institutions, results in further behavioural change in the clinical area, thus further improving resuscitation management. If further work reveals little impact on patient benefit or long term knowledge and skills retention in clinical practice, there may need to be a change in how SRT programmes are delivered, together with a further assessment of their effectiveness. Within the body of this thesis effectiveness is defined as the degree to which objectives are achieved.

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Abbreviations

ACLS	Advanced Cardiac Life Support Course
AHA	American Heart Association
ALS	Advanced Life support Course
ALSO	Advanced Life Support in Obstetrics
ALERT	Acute Life threatening Events Recognition and Training
AP	Accredited Programme
APLS	Advanced Paediatric Life Support Course
ATLS	Advanced Trauma Life Support Course
BEME	Best Evidence in Medical Education
BLS	Basic Life support Course
CPR	Cardio-pulmonary Resuscitation
ET	Endotracheal Tube
ECG	Echo-cardiogram
GIC	Generic Instructor Course
ILS	Immediate Life support Course
IQR	Inter-quartile Range
MCQ	Multiple Choice Questionnaire
NHS	National Health Service
NLS	Newborn Life Support Course
NRP	Neonatal Resuscitation Programme
OSCE	Observed Structured Clinical Event

PALS	Paediatric Advanced Life Support Course
PHTLS	Pre-Hospital Trauma Life Support Course
PILS	Paediatric Intensive Life Support Course
PLS	Paediatric Life Support Course
RCT	Randomised controlled Trial
SRT	Structured Resuscitation Training
UK	United Kingdom
UVC	Umbilical Venous Catheter

Chapter 1

Introduction

1.1 Structured resuscitation training programmes

A structured resuscitation training (SRT) programme can be defined as a resuscitation training curriculum, delivered to a group of learners over a finite period of time, in a pre-defined, structured manner. SRT programmes are run globally to train health care professionals in adult, paediatric and neonatal resuscitation. Resuscitation councils have attempted to standardise such training and share common objectives, namely to optimise standards of clinical practice in resuscitation management, minimise error and decrease patient morbidity and mortality.

Upon studying these training programmes in greater depth, it is apparent that there are only slight differences in the course programmes and provision. Some training programmes are mandatory requirements for health care professionals, and are thus funded by employers as part of a professional update. Others, however, are attended voluntarily by health care professionals who want to further their clinical skills. In this situation, there are possible barriers to learning, as candidates are often charged for their attendance and the programme or course must be completed in the candidates' own time.

The Resuscitation Council UK (2010) supports SRT courses for all specialities including adults, paediatrics and neonates. These courses are standardised and take place over one day with a pass or fail outcome for the candidate. If successful, candidates are issued a certificate which is recognised across most of Europe and is valid for four years.

A central feature of these courses is the use of a multidisciplinary approach to teaching and learning to replicate the multidisciplinary team involvement which occurs in such resuscitations (Resuscitation Council UK 2010). Due to the financial constraints facing most NHS trusts, especially in training budgets, trusts are starting to develop their own in-house advanced, immediate and neonatal life support courses. Despite this resolving a problem in the short term (the training and updating of health care workers), it may, unfortunately, have

implications regarding the quality and standardisation of resuscitation provision (Resuscitation Council UK 2010).

1.2 The Advanced Life Support (ALS) course

Resuscitation techniques, including the teaching of chest compressions and cardiac arrest management, was revolutionised in the 1960's (Greig et al 1996). This applied to cardiac arrests, both in the hospital and the community. Every attempt has been made internationally to ensure that health care professionals are offered standardised resuscitation training (Kaye and Mancini 1986), as the quality of the skills in resuscitation practices affects the long term outcomes of the patient. Kaye and Mancini (1986) were at the forefront of this work, carrying out one of the earliest studies on this topic.

The ALS course provides candidates with a manual approximately four weeks prior to the course date and there is a pre-course multiple choice questionnaire (MCQ) examination which has to be completed prior to attendance. The course itself is a revision of the manual. It concentrates, in the main, upon the teaching of the practical skills in adult resuscitation and the manual ensures the availability of the knowledge to support the use of these skills. Learning may, therefore, be somewhat dependent upon the pre-course learning from the manual that the candidate achieves. This course is generally attended by doctors, nurses and resuscitation officers. There are similar, but more specific, courses available to other specialists including midwives and members of transport teams.

1.3 The Paediatric Immediate Life Support (PILS) course

This course is aimed at providing trained healthcare staff of all disciplines with the knowledge and skills to recognise and appropriately manage the seriously ill child. There is also an emphasis placed upon candidates learning to become part of the multidisciplinary team involved in the management of resuscitation of children.

The course format is similar to that of the ALS course, but the course manual is sent approximately two weeks prior to course attendance. It also runs over one day, takes place in an approved centre and is taught by registered Resuscitation Council course providers. It has practical sessions to teach the clinical skills needed for airway and ventilation management and lectures are delivered covering the knowledge required to underpin these practical skills. The assessment process is both formative and summative and certification is valid for four years.

1.4 The Newborn Life Support (NLS) course

The NLS is a relatively new phenomenon and has been designed and produced in an attempt to standardise the approach to the assessment and resuscitation of the newborn nationwide (Resuscitation Council 2010). This standardisation of such a crucial element of health care provision will in turn enable staff of varying disciplines to provide optimum standards of evidence based practice within the National Health Service (NHS), thus resulting in positive user outcomes (Leatherman and Sutherland 1998). It is, according to the Resuscitation Council UK (2010), designed for any healthcare professional, regardless of discipline or status. However, in the author's experience as an NLS director, the majority of candidates attending are registered health care professionals, as healthcare assistants, for example, are rarely supported by their employers to attend.

The format and content of the NLS has been revised in May 2011. The candidates are exposed to evidence based lectures, practical skill stations and simulations (formally called scenarios). The course itself begins with an introduction lecture; this informs the candidates of the course structure and assessment process. Further lectures are then delivered giving candidates the theory to underpin the practical sessions which follow. The candidates then attend three skill stations including airway management, external cardiac massage and the correct insertion of an umbilical venous catheter, including the appropriate use of drugs and their doses.

Course manuals are provided four weeks prior to attendance and candidates' knowledge and skills are assessed at the end of the course in the form of an MCQ examination paper and a practical assessment of airway management. An updated manual has been designed for the new course in the last twelve months and both the pre- and post-course MCQ examination papers have been re-written. Formative assessment is also carried out both during the individual skill stations and the simulation sessions throughout the day. In the past, in an attempt to aid learning, the course was also provided over two days. Due to financial and staffing implications for both candidates and instructors, this has now been discontinued. All courses are run in the same format and course centres are assessed, using standardised criteria, on a three yearly basis, by an approved assessor from the Resuscitation Council. This individual must not be based at the centre being assessed and should not be instructing on the course itself.

1.5 The Immediate Life Support (ILS) course

The ILS course runs for a full day and has been developed to provide the standardisation of the 'in-house' training undertaken by resuscitation officers. In the main it enhances skills in cardiac arrest management prior to the arrival of the multidisciplinary team. The course has a similar format to the other SRT course and runs over one day, with candidate assessment throughout the day. The lectures are, in the main, about the causes and the prevention of cardio-respiratory arrest and include the ALS algorithm on the management of cardiac arrest. There are also practical skill stations, in which candidates can develop their techniques in initial resuscitation and defibrillation of an adult.

1.6 The Generic Instructor (GIC) course

All UK instructors have to complete a three day generic instructor's course prior to becoming an accredited instructor. Following this, they must successfully complete a minimum of two instructor candidate placements at course centres, different to the one at which they undertook their provider course. This training enhances the reliability and the validity of the courses in the United Kingdom by

standardising instruction provision. All instructors must undertake recertification in their speciality training every four years. During this process, their teaching and assessing skills are assessed using strict marking criteria by both the faculty and course director.

1.7 Simulation

With the advent of revolutionised medical training programmes and a reduction in clinical hours because of the European Working Time Directive, junior doctors, despite having the knowledge to underpin their practice, often lack the experience of exposure to clinical scenarios to enhance their skills (Douglas 1990). The art of simulation training aids in creating a training technique that supports experiential and reflective learning (Russo et al 2007 and Issenberg et al 1999). All of the SRT programmes described above employ simulation in their skill stations and as part of their assessment process.

The 'Resusci Annie' mannequin was developed in 1960 and was heralded as one of the first significant events in the history of medical simulation (Laerdal 2006). Further from this, the use of patient actors to assist with skill acquisition was introduced in 1963 (Rosen 2008). Simulation in medical education prepares the practitioner to deal with real patients (Issenberg et al 2005). The evidence in the literature suggests that it allows them to acquire the necessary skills to deal with 'real-life' situations in preparation for clinical practice.

Simulation established its roots as far back as the fighter pilot 'flight simulation in world war two (Issenberg et al 1999). Simulation in medical education is quickly becoming a common part of training for all health care professionals. The development of portable simulation workshops have been publicised at educational conferences more recently (Issenberg et al 1999 and Issenberg et al 2005). Within simulation, the practitioner is faced with 'real life' situations in real time using, not only manikins, but also, life like models, synthetic wounds, and monitors displaying simulated information which can be controlled without the candidates knowledge by the facilitator, to enhance the experience. Videos

of the practitioner performing the skills are then replayed to the candidate to enable critical reflection to take place and thus learning to be enhanced.

Russo et al (2007) suggest that self reported accuracy and confidence increase following a simulator airway management course. Issenberg et al (2005) have reported that simulation facilitates learning when used under the right conditions. Simulation training development has been pursued in an attempt to assist both junior and senior doctors with the practical skills required for good clinical management of various clinical situations.

Numerous individual products are available on the market to assist with the simulation experience. These include partial task simulators for specific skills including intravenous access, catheterisation and intubation. Collectively these, and the overall simulated scenario, enhance the learning experience for the individual and prepare them for clinical practice. Hospital training departments are now running 'real life' simulations where healthcare professionals are not only faced with specific procedures to perform on manikins, but are also involved with the clinical decision making and team working required to manage more complex situations. This approach has also been addressed by the Resuscitation Council UK in their resuscitation programmes. The previously called scenario demonstrations and workshops have now been renamed simulation sessions. They utilise the same equipment but are more structured and explicit in their approach and management with respect to clinical decision making and team-working as well as to demonstrating clinical skills. These changes have been implemented within the NLS course specifically since May 2011 and are yet to be fully evaluated. It is, therefore, not yet possible to determine the effect that these developments will have on knowledge and skill acquisition or retention and transference of these to the clinical area.

Changes in health care provision must be reflected in medical education delivery (Issenberg et al 2001 and Issenberg et al 2005). A restriction in finances and time constraints means that education must be appropriately delivered to the

individual in a high quality and timely manner, to efficiently optimise the learning experience and allow for the improvement in both knowledge and skills. As learning is based on a lifelong continuum, teaching methods must support not only knowledge and skill attainment, but also its retention. Simulation offers individuals a unique learning experience for a huge range of medical procedures. High fidelity simulation manikins provide flexibility for learning, thus enhancing the learning experience.

With the advent of advanced technology, new manikins are by far superior and allow a wide range of skills to be practiced. Donoghue et al (2009) showed an improvement in cognitive performance by paediatric house staff following the use of high-fidelity simulation resuscitation training. It appeared that, not only was there an improvement in their clinical skill performance, but also in their clinical decision making. The adult SRT programmes use the high fidelity manikins (which include built in computerised systems) which can be defibrillated. The NLS course is one of the SRT programmes which currently utilises a low fidelity baby manikin to teach and assess clinical skills. New manikins to assist with high fidelity training for neonates have recently been designed but are not currently used as part of the UK Resuscitation Council NLS programme.

The literature suggests that high fidelity simulation, with clear aims and learning outcomes for the individual are the optimum (Issenberg et al 2005) for effective learning. This necessitates the use of advanced clinical equipment to simulate the experience. Currently, the majority of SRT programmes within the UK are limited in their use of such equipment. High fidelity manikins and other advanced learning devices are currently being developed. These will subsequently need to become part of training programmes and used as standard within all disciplines. Coupled with this is the need for the educators involved with such training to be offered updates in new teaching practices and new methods of assessment during simulation using high-fidelity simulators.

1.8 Motivation to learn

Much has been written on the topic of motivation (Nicklin and Kenworthy 1996). Whilst studying adult learning, with specific respect to SRT programmes, it is crucial to return to the roots of the 'teacher training' the educational faculty receive. Although primarily directed by The Resuscitation Council UK to utilise the four stage technique within the practical sessions, faculty are expected to adapt accordingly and use other techniques to meet the diverse learning needs and motivations of the individual.

Professional disciplines require practitioners to regularly develop and update their practice, 'in-service' training assists with the facilitation of this. As the commitment to lifelong learning becomes the foundation of our professional practice so does the relevance of assessment of learning, which has, not always, been at the forefront of our minds (Brown and Glasner 1999). Bee and Bee (1999) stress the need for the educators to have a clear aim of the learning needs of the individual and the proposed outcome, for effective learning to ensue.

Undoubtedly adult learners expect to be treated with some degree of respect and dignity (Resuscitation Council UK 2010 and Fuszard 1995). This and other well respected theories of learning are highlighted during their generic instructor course. The facilitation of teaching to those who are less or unmotivated to learn becomes a greater challenge to the teacher.

Attendance on a provider course may be part of the learners' career plan, therefore resulting in high levels of motivation and an eagerness to achieve high standards. Their managers may, however, have instructed them to attend which may have been associated with some reluctance on the learner's part, which thus may have formed a potential barrier to learning.

Although fear of failure and anxiety may be present for an individual during the learning experience, the anxiety can actually drive the learning experience and

the motivation to learn resulting in a positive outcome. It can, however, be detrimental to the overall learning if the candidate concentrates only upon the outcome rather than the learning opportunity available to them (Brown, Bull and Pendlebury 1997). In practice, as many candidates are mandatorily required to attend the SRT programmes, they often concentrate upon the final assessment process rather than the learning experience available to them.

The motivation to successfully complete a training programme may not also assist with the retention of knowledge or skills over a longer period of time as the drive was for successful completion not retention. Unless professionals are either updated or re-assessed in the clinical setting on a regular basis, there is a potential for the knowledge and skills acquired to decay early, suggesting that the learning was purely superficial and/or strategic to achieve an outcome and thus of less long term benefit.

Motivation to learn is essential if an educational intervention is to be successful. Curzon (1997, p.227) has described motivation as "a person's aroused desire for participation in a learning process". Reece and Walker (2000) describe motivation as a key factor in successful learning. A detailed understanding of learning styles and theories of learning enables the faculty on an SRT programme to meet the challenge of the unmotivated individual and enhance the learning process. Motivation in humans is according to the Resuscitation Council UK (2010) governed by the requirement to satisfy basic needs.

Maslow (1970) described the principles of motivation as a five-tier hierarchy. These have been split into two categories; primary and secondary needs. Each of the five must be satisfied in turn, before the next stage is approached and the final level of self actualisation is fulfilled. In relation to SRT programmes, the physiological and security needs (primary needs), relate to the physical needs of those attending the training. Whilst on any of the resuscitation programmes, candidates must be provided with adequate accommodation and acceptable food and rest, and they must also in turn feel a sense of security in the midst of a

potentially alien environment. Individuals lacking this security may not actively participate in the group activities during the simulation sessions which may affect the learning experience.

There are two forms of motivation, namely intrinsic and extrinsic. Intrinsic motivation comes from; the candidates desire to learn, meeting others and gaining confidence in the process. Extrinsic motivation suggests that there are external factors influencing the reason for engaging in an educational process, such as attendance at a SRT course, and may be less effective than intrinsic motivation. Despite being quite different, extrinsic and intrinsic motivation factors often co-exist and ultimately may complement each other. Course instructors must assist learners to draw on factors providing extrinsic motivation to increase the intrinsic motivation and thus the potential to learn more effectively.

The secondary needs of Maslow (1970), namely belonging, self esteem and self actualisation, also need addressing when planning the provision of an SRT course. The candidates must feel a sense of belonging within the group. This may be more difficult to achieve for those who are less experienced or lack knowledge and these candidates must be encouraged to seek guidance and support from their mentors. It is essential during session planning of an SRT programme, that the course director ensures an eclectic mix of individuals to encourage the candidates to draw on the experiences of others.

Self-actualisation is the highest part of Maslow's hierarchy and relates, in the main, to personal growth and the realisation of one's ability. It is an ideal, rarely achieved by many and highly unlikely to be achieved during a one day resuscitation course. Although, upon completion, candidates may feel that they have benefitted from the course, and learnt from the individual sessions, it is not until they receive the final summative assessment results that they could even attempt to begin the process of self fulfilment. The actual concept of self actualisation could be achieved following the repeated use of the skills in the

clinical setting. The potential for overall fulfilment and the factors relating to the basic needs must be taken into account within the planning and delivery of the SRT course itself. This is not only in an attempt to achieve a high pass rate, but also to ensure that the candidates feel that their attendance has been useful.

1.9 Knowledge and skill acquisition

As the provision of early and appropriate resuscitation in clinical emergencies, such as cardiac arrest, may improve patient outcome (White et al 1998), appropriate teaching in this area is paramount. Learning can be defined as changes in knowledge, understanding and skills (Brown, Bull and Pendlebury 1997). Tight (2002) documents that although adults have considerable experience of education, for some this will have been largely confined to childhood. Some argue that prior knowledge and exposure appears to be a key principle in effective lifelong learning (Marton, Hounsell and Entwistle 1997). All candidates attending SRT programmes have some prior knowledge of resuscitation in their speciality and the issuing of the course manual assists with the development of their knowledge prior to the course.

The aim of a SRT course is to facilitate the acquisition of the knowledge and skills which together, can, in the future, be used by the participant to provide optimal resuscitation for the patient group relevant to the course. On SRT programmes, the learning takes place in a standardised environment, with a prescriptive syllabus and teaching delivery, for example as described for the NLS earlier.

The degree of knowledge and skill acquisition following SRT may vary (Wynne 1986). Most individuals can successfully learn on and pass resuscitation courses, as evidenced by assessment using a multiple choice questionnaire and a practical test using simulation. Although these modes of assessment seem to be appropriate for testing knowledge and skills (Collins 2006), it is not known whether passing these assessments necessarily results in consistent transfer of the knowledge and skills to the clinical area thus enhancing resuscitation.

Part of the aim of this thesis is to perform a comprehensive systematic review of the evidence reporting learning, resulting from SRT programmes and to determine the extent of the learning that takes place.

1.10 Knowledge and skills retention

Miller (1990) suggests that, despite significant advances in testing and the innovative equipment available to support this, assessment does not always truly reflect how practitioners will deal with similar situations in real patients. In an attempt to improve this, he provides a pyramid framework for clinical assessment which encompasses actions, performance, competence and knowledge, the base of the pyramid structure being knowledge. There can be no doubt that it is the assessment of knowledge which is fundamental to the training and education of health professionals and must, therefore, be carried out in an appropriate manner.

Adult learners attend the SRT study days with an extensive pre-existing knowledge and advanced clinical skills and expertise. They set their own learning objectives and have an awareness of their learning needs. Despite, in the main, being highly motivated and keen to successfully complete the training programme, poor learner motivation may be a contributory factor for candidates being unsuccessful at achieving the necessary skills and knowledge. Not only is it important to attain skills and knowledge, but it is equally important to retain these and for the candidate to be able to apply and transfer their learning consistently to the clinical area.

Various approaches to learning were first reported in the literature in the mid 1970's. Prosser and Trigwell (1999) argue that learning and teaching are fundamentally related. The focus of effective teaching must be the on the learning needs of the individual and not the actions of the teacher. They refer to two types of leaning; deep and surface. Students who adopt deep learning approaches are more likely to have higher quality learning outcomes with retention of information. Teachers are encouraged to continually change the

teaching methods they utilise to maintain a sense of excitement. The Resuscitation Council UK regularly review the delivery of the NLS course in an attempt to ensure it is delivered in the most optimum manner for deep learning to take place.

Theories of learning provide frameworks for studying the process associated with learning (Nicklin and Kenworthy 1996). Theories of learning have been applied to SRT courses to try and enhance learning and retention of skills and knowledge. The concept of andragogy encompasses the idea of how adults learn, placing a greater emphasis on what the learner is doing (Reece and Walker 2000), as opposed to pedagogy, which, as it highlights the teacher dominating and leading the session completely, is used more in the teaching of children.

Adults, according to Knowles (1984), have reached a stage of independence by adulthood and are, therefore, successfully able to undertake self-directed study. Prior to their attendance on the ALS, APLS and NLS, learners are encouraged to read and digest the manuals to assist with their learning experience on the day of the training. A failure to do so may ultimately affect their overall outcome and retention of knowledge.

The behaviourists approach to learning is based upon repeated practice, where students learn mainly through association. It places great emphasis upon the importance of rewards. The SRT courses are designed to ultimately give candidates the skills to effectively resuscitate a patient. The optimum method of achieving this, for all grades of staff, has been through a behaviourist approach of repetitive practice on the SRT course in order to enhance retention of skills. A contrasting theory, the humanistic approach, takes a person-centred view of learning (Welsh and Swan 2002).

Undoubtedly, for learning to be effective, even if only for short term retention, learning should be tailored to meet the leaning needs of the individual. Bee and Bee (1999) support this and describe the importance of having clear aims of the

learning needs and the proposed outcome to ensure effective learning results. All UK based SRT programmes offer the learner pre-set learning objectives and the facilitators are encouraged to highlight them during the teaching sessions and to ensure that these are appropriate for each individual.

Another theory emphasises the educator act as the facilitator (Dunn 2000). This theory also stems from a belief that human beings have a natural eagerness to learn, thus learners become more empowered to take responsibility for their own learning. On the UK SRT courses, candidates are requested to share their knowledge and experiences with their peers during the various teaching sessions. Discussing these real-life experiences, in the context of an SRT course, may facilitate retention.

Burns (1995), reports that the majority of 'competency based training' is based upon the theory of negative reinforcement to strengthen behaviour. Reinforcement theory was developed by the behaviourist school of psychology. It works on the premise that the learner will repeat the desired behaviour, if positive reinforcement follows the behaviour. This is used by the faculty repeatedly throughout all registered resuscitation courses. Candidates are frequently praised and given positive feedback during the mentor tutorials if there is evidence of learning taking place. They are also given the opportunity to practice any resuscitation manoeuvres they do not feel confident in, to assist with the final assessment. This approach may also aid retention of knowledge and skills.

The methods utilised for the assessment of both knowledge and skills on SRT courses are MCQ's or short answer questions for the former and simulation for the latter. In simulations, for candidates to be successful, they must utilise their knowledge of algorithms and resuscitation techniques. Despite it being important to try and avoid the deterioration of such a crucial part of clinical practice, and the above assessment methods being widely used immediately after SRT programmes, there is no published evidence available to support the most appropriate method of assessment to use to assess retention of both

knowledge and skills some time after an SRT. Some departments use live or simulated resuscitation 'drills' in the clinical area to facilitate maintenance of resuscitation skills (Blakely 2007) and some utilise routine videoing of resuscitations followed by debriefing (Weston et al 1992). No studies have, however, reported formal assessments using these techniques some time after SRT.

Another aim of this thesis is to perform a comprehensive systematic review of the evidence reporting retention of knowledge and skills after SRT and to determine what assessments have been used to do so. As a result, it may be possible to recommend at what intervals repeated training should occur and how this should be assessed.

1.11 Organisational change and patient outcome

It can be argued that an improvement in patient outcome is the most important result with regards to the successful education of health care professionals. As a result of training there may also be an associated change in service provision aimed at improving patient outcome. Owing to the possibility of only small changes occurring in patient outcome as a result of educational interventions, the identification and assessment of these may involve large numbers of patients over a long period of time. Many organisations could carry out an audit of the possible effects as part of the audit cycle reassessment, but a true research study may be avoided as it might be perceived too difficult to perform with respect to gaining ethical approval and recruiting patients.

A further aim of this thesis is to perform a comprehensive systematic review of the evidence reporting changes in patient outcome and change in organisational practice after SRT and to determine what methods have been used to do so.

1.12 The assessment process with particular reference to the NLS course

The testing of practical skills is crucial to assesses if someone is a competent practitioner. This must be appropriate to the learning which has taken place.

Assessing skills in clinical practice is quite different to assessing the theoretical components within a training programme and raises different issues. Technology and oral communication are two components which need to be considered. To assess competence in practice, Brown and Dove (1990) stipulate the need to use experiential approaches for the testing of skills with the utilisation of a 'hands on approach'. Within the body of this thesis competence is defined as the ability to perform a skill to a specific standard under specific conditions. Clinical skills testing for resuscitation programmes within the U.K. take place in a simulated setting on a designated day and not in the clinical area. Once completed, candidates are not routinely re-examined within the clinical setting at a later date.

Assessments have been described as tools which allow the student to demonstrate that learning has taken place (Nicklin and Kenworthy 1996). Assessment has been defined in the literature in a number of ways. Chambers and Wall (2000) describe it as the process and instruments which are used to measure the achievements of the learners. This is, in general, achieved following completion of a learning programme. Reece and Walker (2000) have suggested that assessment is more the provision of information which is generally through testing and is the process by which information about how much the students know is obtained. This is supported by Petty (1998), who adds that it also assists in measuring both the breadth and depth of learning.

McAllister et al (1997 p.215) has more specifically described summative assessment as an "appraisal of various aspects of students' clinical performance". As it thus serves many purposes including, grading, contribution to the effectiveness of future courses and the provision of goals for learners (Petty 1998), it has been included as the final part of the Resuscitation Councils SRT courses.

Werner and DeSimone (2008) suggest that pre and post training assessment allows the trainer to see how the learner has changed following completion of

the study. Candidates completing the NLS are tested pre and post course but, as they are allowed to have their manual at hand and complete the pre course MCQ at their leisure, prior to attendance, it is difficult to assess the degree of learning that has taken place from their post course MCQ scores.

Throughout these courses candidates are assessed formatively. Chambers and Wall (2000) suggest that, through the exposure to such assessments, the development of the learner is facilitated. On the courses, assessments take place during each of the practical skill stations and also during the simulation demonstrations. This helps to prepare the candidates for the final summative assessments by enhancing their skills and encouraging the utilisation of peer support. Chambers and Wall (2000) have also suggested that assessments have a more positive outcome if they are fully based upon the learning objectives set at the beginning of the course. As the NLS currently does not define specific learning outcomes, this could potentially affect the overall outcome for the candidates.

Assessment of learning involves a degree of measurement, either numerically or involving a coding or grading system. A judgement must, therefore, be made in order to measure something. This includes the measurement of clinical skills and knowledge (Jarvis, Holford and Griffin 1988). In the past, assessment has been criticised as being inaccurate and unreliable as it usually refers to immediate learning rather than knowledge retention (Petty 1998) and yet it continues to be widely used throughout most educational facilities to measure students' clinical skills and knowledge. The assessment process strategy ensures competency in the resuscitation procedure in a simulated environment immediately after the SRT. It does not, however, ensure the retention of the acquired knowledge and skills over time.

To increase the accuracy of assessing learning ability, utilising two methods of assessment can be regarded as more beneficial (Mandernach et al 2005). At the end of the NLS course the candidates must complete both an MCQ paper and a

practical 'airway test'. Both of these tests are based on the information and skills that have been taught throughout the day. The MCQ comprises fifty questions which relate to the lectures delivered at the beginning of the course and carries an eighty percent pass mark. Thirty minutes is allowed for completion of this questionnaire and it is invigilated by one member of the faculty. Candidates are free to leave the testing room when they feel that they have completed the paper. The same questions have been utilised for a number of years and have not been updated recently. The questions were written by a supporting panel of health professionals from the UK Resuscitation Council. It is not possible to re-sit the paper on the day. Candidates who are unsuccessful are, however, asked to return at a later date to attempt the examination again.

The high stakes nature of summative assessments mandates that they are valid, reliable and varied (Manderncach 2005). Reece and Walker (2000), suggest that the practical test, including the 'Airway test', has a high validity with medium reliability. Validity, in terms of assessment, refers to how well the test measures what it is supposed to (Chambers and Wall 2000 and Reece and Walker 2000). Thus, it is possible ascertain whether the candidate is able to carry out the correct approach to assessment and resuscitation of the newborn appropriately, upon completion of the NLS course. This premise is supported by Reece and Walker (2000), who have added, that an appropriate assessment should also allow the instructor to ascertain whether the candidate has both the knowledge and the ability that are required for safe practice.

Reece and Walker (2000), also suggest that the reliability of a test refers to the extent or degree to which the test constantly measures what it is supposed to measure. Smee (2003) supports this and suggests that the results will be similar if the test is re-administered, depending upon how reliable the test is. Reliability is, however, affected by certain variables including the length of the test and the examiner's demeanour. With specific reference to the NLS course, to assist with the reliability of the airway test, the instructors are frequently observed by the course director during the testing station. The more experienced members of

the faculty examine any unsuccessful candidates highlighted throughout the course as potentially performing poorly.

There are two instructors present at the test on the NLS course at all times, one of which may be an instructor candidate. Each instructor marks the candidate using a 'tick box' marking structure. Having completed the test, the candidates are requested to vacate the room for the instructors to decide on a pass or a retest (if it was the candidates' first attempt). If they require a retest, they are offered full feedback on areas for improvement. They are then tested by two different instructors and are given the opportunity prior to this to practice with a member of the faculty until they feel both competent and confident to continue.

To ensure high levels of reliability, it would be essential for the candidates to obtain the same result each time. As the learner is offered detailed feedback prior to the retest, it is more likely that they will be successful during the retest as there has already been further exposure to the test scenario. Criterion referenced assessment assess the learners by comparing them with pre-determined criteria (Robertson and Rosenthal 1997). The airway summative assessment process is clear and well defined and the marking criterion is straight forward and leaves little scope for personal opinion. Candidates must achieve all of the 'tick boxes' to be given a pass. The clarity of the 'tick box' system assists the faculty with the overall assessment process.

Summative assessments are also a means of holding the teachers accountable for the students learning. With reference to the NLS course, all course data must be sent to the Resuscitation Council UK directly, with a course directors report, immediately following the day. This includes the students' evaluation forms, completed as mandatory, the MCQ papers and the airway testing sheets. All data is then collated and the faculty is sent a course summary one to two months following the course.

A report on students' views on summative assessment recorded that some learners felt that someone, by whom they had received teaching from, should be involved in their assessment (Robertson and Rosenthal 1997). The Resuscitation Council UK have addressed this and the candidates are taught by all members of the faculty throughout the day so they are familiar with their testers in the airway test.

Lifelong learning, including knowledge and skill retention, depends upon a number of common variables associated with the learning experience for the individual. These include: the frequency of the training; the availability of booster sessions prior to reassessment; the frequency of the assessments; the individuals' exposure to utilising their knowledge and skills in clinical practice coupled with their motivation to learn. The assessment of knowledge and skills acquisition is present in all of the Resuscitation Councils SRT programmes. This assessment is based only upon the acquisition of knowledge and skills immediately post-training and does not form part of a continuing assessment process. The majority of SRT is recommended to be repeated on an official SRT programme on a four yearly basis (where there is a structured formal assessment which could result in a pass or fail). In between these courses, it strongly depends upon the individual, their clinical profession and their work place as to the frequency of booster sessions and updates they receive.

There is little published data to support how frequently resuscitation updates should be provided. Also, little analysis as to how this might affect long term knowledge and skill retention. In the main, updates are offered to nursing and midwifery staff annually on an in-house basis and four yearly on an official SRT programme. Doctors are often exposed to training on a six monthly basis as part of their induction programmes to new work places, they too are encouraged to re-certify every four years. Some units now use 'skills and drills' simulations in the work place as part of booster sessions. These enable health professionals to work in their own capacities within the multidisciplinary team. This not only assists with team building as a whole but also enables individual development.

There appears to be very little evidence within the literature which recommends the assessment of candidates in between SRT programmes. Curran et al (2004) and Kovacs et al (2000) both used booster sessions in between the original training and the later assessments of knowledge and skills. In the majority of cases this was shown to be not significant in influencing knowledge retention and, although it might aid in immediate learning, it did not influence the retention of this learning over time.

Video analysis, specifically used as part of the assessment process, may provide a more long term aid in assisting the individual in learning and thus prolong knowledge and skills retention (Quan et al 2001 and Nadel et al 2000). It could even be used as an assessment tool later on after an SRT in the clinical area. It provides the individual with a structured feedback mechanism and has the ability to highlight both positive and negative areas in their clinical delivery. For some individuals this would be regarded as a threatening process and would have negative implications on the learning experience. In contrast, for others it might increase their motivation to learn and act as a positive influence for learning. Fear of failure and anxiety can drive the learning experience and the motivation to learn but can also be detrimental to the overall learning, particularly if the candidate concentrates only upon the outcome rather than the learning opportunity available to them (Brown, Bull and Pendlebury 1997).

As part of the overall process of teaching and learning clinical skills, it is vital that the faculty providing the education are also monitored and assessed. Peer observation is a useful tool in the assessing of teaching practices to ensure that appropriate methods are being utilised (Shortland 2004). In the United Kingdom SRT programmes, course directors are encouraged to observe their faculty members throughout the day. Peer observation forms are available for completion, and time is given at the end of the course for giving feedback to faculty members. All members of the faculty must re-certify on a four yearly

basis. This process is carried out formally requiring a course report on the individual to be sent to the Resuscitation Council.

1.13 Multi source feedback and peer assessment

Multi source feedback is now becoming widely used throughout many workplaces. Large corporations introduced this method of assessment as early as 1987 and this has, more recently, become more popular. In the past it has been a way of assessing individuals but, more recently, has been used to assess group performance. According to Ward (2006,p.xi), the aim of 360 degree feedback is to obtain "performance information on an individual from those with whom they interact most" examples of this would be their line manager and other members of their team. Ward (2006, p.4) defines it as "the systematic collection and feedback of performance data on an individual or group derived from a number of the stakeholders in their performance".

There is no doubt as to the importance of assessment, especially within clinical practice. It can be the driving force for the motivation to learn and improve. If done properly it can provide the learner with the foundation upon which they can build and develop. Both peer and self assessment are increasingly used within higher education and have become a standard part of nursing and medical assessment. Despite this, the process is often misunderstood, as peer assessment is not an actual method of assessment, rather a source of assessment and must, therefore, be used appropriately. Brown, Bull and Pendlebury (1997) have highlighted that skilful feedback is a central aspect of the multi source feedback assessment process. It is thus paramount that it is done effectively. It includes the collection of data from questionnaires, completed by patients, peers and co-workers of the individual and usually, one to one discussion of the anonymised summarised results with the individual who is receiving the feedback.

This process of the measurement of clinical skills and knowledge (Jarvis, Holford and Griffin 1988) can include peer assessment which can be an indirect way of

assessing competence in the absence of direct observation by a formally appointed assessor. It thus lends itself very well to the assessment of resuscitation skills. Peer assessment also provides the opportunity to learn from peer review and feedback (Welsh and Swann 2002). Whilst it can be a very effective method of assessment, especially in the clinical area, it must be used with caution if the results will affect any high stakes outcome such as a final grade. Brown, Bull and Pendlebury (1997) support this and also suggest that, although employing peer assessment does indicate that it can be a useful tool to promote critical thinking, care must be taken not to assess the individual falsely too high. To work effectively, all parties must be on board and have awareness, not only of the processes involved, but also of the potential benefits and learning outcomes.

Data is collected in a systematic manner usually with the use of interviews or questionnaires. Anyone who directly works with the individual can be part of the assessment. Peer review is generally undertaken by someone of the same level, who works with the individual being assessed. This is different to team reviews, which are completed by workers of varying levels. The review is generally based upon a questionnaire. Having processed the results, and anonymised them, these are fed back to the individual. Once the individual has reflected upon the review, a structured action plan is developed. Following a period of hopefully changed behaviour (if required) the process is repeated -hence the 360 degree title of a cyclical event.

As peer review relies upon colleagues assessing each other's clinical competence, there is always potential for problems to arise. If individuals rate themselves to be much higher than their assessors do, this can cause conflict and poor working relationships and even resentment of each other (although responses should be anonymised).

There appears to be very little evidence to suggest that peer assessment may assist with retention of skills over time. Literature has suggested it is a useful

part of the assessment process (Hammersley-Fletcher and Orsmond 2005), but has not expanded upon its long term influence.

Peer observation has been cited as a way in which learning and teaching can be improved (Hammersley-Fletcher and Orsmond 2005). It is a useful and effective method of assessing individuals if done in a confidential and non-judgemental manner. The observer should act to provide feedback to the individual to facilitate reflection of their practice and give constructive suggestions for possible improvement. Peer observation can cause both the observer, and who they are the observing, to feel vulnerable as it is not easy to either take or give criticism from a peer, especially if they are to work closely with them in the future (Hamersley-Fletcher and Orsmond 2005).

Peer assessment of knowledge and skills has been included into educational courses to improve the process of learning. Brown and Glasner (1999) describe the process as students assessing students and subsequently providing feedback for their colleagues. Sensitivity is required from the individual delivering the feedback (Ward 2006). This is usually the first line manager or mentor. The participant may react badly or even feel threatened by this process, especially if the feedback is poor. Despite this being, in the main, a confidential process, if the team is small, conflict within a team may evolve. It could be suggested that if the learner knows that they will be regularly exposed to peer review and assessment they will strive to retain their knowledge and skills in-between reviews.

1.14 Confidence

A small number of studies have been carried out which include the assessment or perception of confidence both prior to and following the attendance on an SRT. Confidence is usually assessed through the use of a questionnaire, either sent to the candidate's home for them to reflect upon, or immediately following completion. The Resuscitation Council in the United Kingdom requires all

candidates to fill in an assessment of the training itself but do not assess candidates confidence in resuscitation practices.

Self assessment is not a process that can be carried out in an unbiased manner and the result may not be the same as peer assessment or the candidate's competence. There appears to be little research which assesses confidence and its association with whether or not candidates have passed or failed the SRT programme. It would not be unexpected to find that successful (competent) candidates felt more confident and had good peer assessment following training, although whether the latter predict retention of competencies over time is not known.

1.15 Overview and rationale

Thousands of pounds are spent globally, on an annual basis, by health services specifically for resuscitation training and numerous working hours allocated for training purposes. This is in an attempt to successfully train health care professionals to perform adequate resuscitation within all disciplines in order to optimise patient management and reduce mortality and morbidity rates. Little literature is available which suggests a recommended time scale for retraining.

Hospitals within the United Kingdom are expected to facilitate resuscitation for their staff on an accredited programme on a four yearly basis, with a yearly in-house booster in-between. It is not clear, however, if this is the optimum time scale for retraining as skills may deteriorate earlier post-training. There is no guidance available as to the optimal length of training programmes or the assessment procedures to be used to minimise this deterioration.

Successful learning also requires a behavioural change within the candidate. Learning depends upon the individual and retention of both knowledge and skills are dependent upon the individuals learning styles and ability to retain a taught skill. Much training does not take this into account as programmes are

standardised to teach large groups of health care professionals of various grades and disciplines with a standard assessment process.

With the above in mind, it is important to understand the effect of structured resuscitation training in all specialities, both in the short and long term, for the individual and in relation to patient outcome. In particular, the author was interested to understand the effect of structured resuscitation training in her own speciality of neonatology.

Chapter 2

Methods

2.1 Research Overview

This thesis investigates and reports two major aspects of structured resuscitation programmes.

Firstly, a systematic review of the literature on this topic dating back to 1972 was performed. The objective of this review was to determine and describe the evidence for knowledge and skills acquisition after resuscitation training and retention of these skills over time. The studies of adult, neonatal and paediatric resuscitation training which were considered for the review had concentrated specifically on resuscitation training programmes that had been delivered in a structured fashion.

The specific primary aims of the review were to determine whether structured resuscitation training:-

- Results in the acquisition of clinical skills and knowledge and retention of these attributes over time.
- Results in transfer of learning to clinical practice.
- Affects service care provision.
- Affects the clinical welfare of patients.

Secondary aim was to:-

- Establish whether the characteristics of the training provided determine the type of impact that occurs.

Secondly, a longitudinal cohort study was performed. The aim of this was to investigate whether airway management and non invasive ventilator skills were retained after successful completion of the NLS course and also to explore the relationship between the retention of skills and both the resuscitation provider's confidence and their peer's view of their competence at performing these skills. As approval for the BEME review was not granted until the prospective study had already commenced, both pieces of work were carried out in parallel. The BEME

review increased my insight into both the importance of robust data collection and provision of clearly published results.

2.2 Systematic Review Methodology

2.2.1 Best Evidence Medical Education (BEME)

The BEME collaboration (http://www.bemecollaboration.org) has pioneered systematic reviews in medical education and recommends a specific process for carrying out systematic reviews. It was, therefore, decided that it was most appropriate to carry out the review under the auspices of, and using the terms of reference of the BEME group. The process undertaken for the review related to this thesis is described below.

2.2.2 Review Group Formation

A systematic review group was formed by myself (CM) comprising of staff from different disciplines working at the Liverpool Women's Hospital Foundation Trust. It consisted of three consultant neonatologists (NS and CD and CY), myself (CM), an advanced neonatal nurse practitioner and a hospital librarian (SM). All group members attended a one day training course on how to conduct a BEME review. After this, individual supporting roles were defined within the group for the neonatologists and the librarian and a timeline set for conduction of the study was made. I (CM) was entirely responsible for obtaining articles and the final analysis of the review. The nature of a BEME review is such that the analysis of results of published studies needs to be corroborated with others to ensure consistency in quality of reported outcomes. Other members of the group provided this function.

2.2.3 Search Strategies

A search strategy was developed by CM. The following databases were searched: Medline, CINHAL, Pub Med and the Cochrane Database of systematic reviews by SM. The search itself was confined to the English language literature. This avoided translation errors and reduced the potential time delay this may

have entailed. Updates were undertaken on two occasions over the two years of conducting the review to allow for the inclusion of new publications. See Table 2.1 for keywords and phrases used in the search.

Searched		Searched		
RESUSCITATION		(CLINICAL ADJ COMPETENCE).MH		
RESUSCITATION#.W..DE.		CLINICAL ADJ SKILLS		
CARDIOPULMONARY ADJ RESUSCITATION		RETAIN OR RETAINED OR RETENTION		
CARDIOPULMONARY-RESUSCITATION#.DE.	**AND**	RETENTION-PSYCHOLOGY.MH.	**AND**	TRAIN$ OR COURS$ OR PROGRAM$
ADVANCED ADJ LIFE ADJ SUPPORT OR BASIC ADJ LIFE ADJ SUPPORT		EDUCATION-MEDICAL.MH.		
		MEDICAL ADJ EDUCATION		
		MEASURE OR MEASUREMENT		
		COGNITION.MH.		
		COMPUTER-SIMULATION.MH.		
		COMPUTER-ASSISTED-INSTRUCTION.MH.		
		PRETEST OR POSTTEST		
		TIME-FACTORS.MH.		

Table 2.1 Search Strategy

2.2.4 Article inclusion

All articles that described a SRT programme (resuscitation training delivered to a group of learners, over a finite period of time in a pre-defined, structured manner) were identified. References were initially filtered on their title alone and those that clearly had no relevance to the review were discarded. The abstracts of the remaining articles (where the article was of relevance or where there was uncertainty from just reading the title) were then distributed throughout the group. Members of the group then decided on whether, upon reading the abstract, the article was likely to fulfil the inclusion criteria, and if it did, allocated a provisional Kirkpatrick level (Figure 2.1).

The Kirkpatrick system in Figure 2.1 was modified from Kirkpatrick's (1994) model of outcomes at four levels. Articles were allocated a Kirkpatrick level according to the outcomes described – some articles described outcomes relating to more than one level in which case they were included in the analysis for each outcome level.

Kirkpatrick Level 1 Reaction to learning experience

Evidence of learners' views on the overall learning experience and its inter-professional nature including the training programme, rather than any specific learning outcomes.

Kirkpatrick Level 2a Modification of attitudes and perceptions

Evidence of documented changes in reciprocal attitudes or perceptions between participant groups and possible changes in perception or attitude towards the value and/or use of team approaches to caring for a specific client group.

Kirkpatrick Level 2b Acquisition of knowledge and skills

Evidence of knowledge and skills acquisition immediately following completion of a SRT programme.

Kirkpatrick Level 2c Acquisition of knowledge and skills over time

Evidence of the retention of knowledge and/or skills over a period of time after the SRT programme.

Kirkpatrick Level 3 Behavioural change

Evidence of transfer of learning to clinical practice.

Kirkpatrick Level 4a Change in organisational practice

Evidence of changes within the organisational practice and delivery of care after the SRT.

Kirkpatrick Level 4b Benefits to patients/clients, families and communities

Evidence of documented impacts in the health or well being of patients/clients, families and communities after the SRT.

Figure 2.1 Possible levels of outcome of articles

(Modified from Kirkpatrick, 1994)

All abstracts were subsequently reviewed by CM in order to confirm that the provisional Kirkpatrick level was correct and that the article should be provisionally included in the review or otherwise. If there was disparity between the coder's Kirkpatrick level, and/or disagreement whether the article should be provisionally included, further discussion took place between CM and the coder in order to agree these issues by consensus. To ensure up to date articles were included in the review, an update of the full search was performed twice over the two years of conducting the review. New reference titles identified were subjected to the same process as described above.

The full article of each included study was then requested. When received, each article was categorised according to discipline (adult, paediatric and neonatal) and assigned a unique reference number. Each article was read by CM and the provisional Kirkpatrick level allocated was again reviewed and confirmed or changed accordingly. The full text of all the articles identified for provisional inclusion were then distributed to a second reviewer in the group for confirmation of Kirkpatrick level and final decision regarding inclusion. Any discrepancies were discussed and final agreement of both the level and the articles inclusion or exclusion was reached by consensus.

2.2.5 Quality assessment and final inclusion of articles

Initially an attempt was made to analyse the quality of each article, based upon the research methodology used and the clarity of overall results presented. Articles were assessed by CM and scored in relation to two different quality assessments (Appendix 1 and 2). The vast majority of studies were cohort studies and it became evident that neither assessment helped to define appropriate articles for inclusion. It was therefore decided to include articles using all research designs and a number of quality criteria for inclusion were produced and agreed by the rest of the group as follows:

- The reported resuscitation training had to have been delivered in a pre-defined structured manner over a finite period of time.

- The participants had to be health care practitioners (including pre and post registration, undergraduate and postgraduate).
- Participants had to be assessed in some manner at the end of the training and the result of this assessment had to be stated.
- If participants were assessed some time after the training, the immediate post-training assessment result also had to be stated.
- Where there was an improvement in outcome for patients and/or their healthcare organisation the magnitude of the effect had to be stated.

Articles were assessed by CM and also by NS and any discrepancies were discussed and final agreement of the articles inclusion or exclusion was reached by consensus. Some articles reported outcomes at more than one Kirkpatrick level. The bibliographies of all articles to be included in the review (once received) were also searched to capture any further relevant articles.

The search process yielded 3781 article titles. Of these, 425 abstracts were then reviewed and 196 full articles were requested. Of these 105 were included as there were 11 duplicate publications identified and 80 did not completely fulfil the quality inclusion criteria (Fig 2.2).

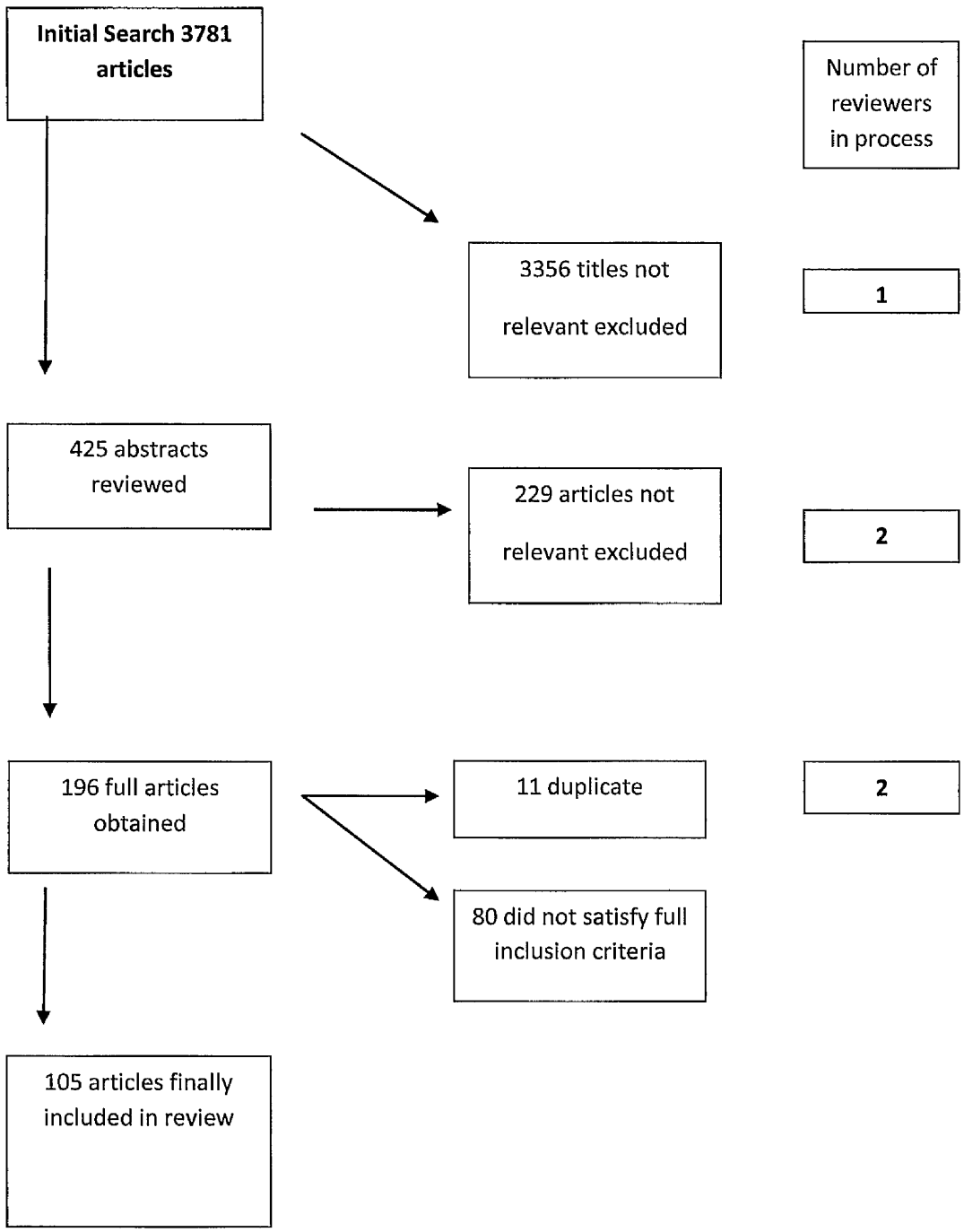

Figure 2.2 Flow chart of the process for final inclusion of papers in the review

2.2.6 Coding and analysis

An initial coding sheet was designed by the group and produced in an Access Data Base electronic format. To pilot this, five of the selected articles were coded by CM and corroborated independently by CD and the sheet was redesigned to exclude any ambiguities. Following this, twenty articles were coded in the same way by CM, then CD. Ambiguities however remained, due to, it was felt, the large number of fields present in the electronic format. A simplified (paper) coding sheet was therefore initially used (Appendix 3). Data from this was then transferred to the electronic database.

Forty articles were subsequently coded by CM and then independently by NS and the results were periodically reviewed to ensure that they were in agreement prior to them being inputted into the electronic format. Very few differences in coding occurred - these were discussed and agreement by consensus reached.

For ease of reference, the relevant results were displayed on a final coding sheet in tabular form for each Kirkpatrick group in each discipline using a Microsoft word document (Appendix 4). Heterogeneity of research designs, educational interventions and outcome measures precluded data synthesis using meta-analysis. Qualitative data synthesis of research methods and outcomes were used involving the identification of common outcome themes. The narrative that emerged describes the key themes and overall outcomes within groups of studies. This was discussed with the review team who fed-back possible modifications to, or corroborated, the final narrative findings. Discussions with Professor Marilyn Hammick, (BEME consultant), confirmed that this approach was acceptable and was consistent with other BEME reviews.

2.3 Skill retention study methodology

2.3.1 Ethics approval

Ethical approval was granted prior to the commencement of this part of the study by The Liverpool Paediatric Research Ethics Committee. (A copy of the proposal and approval letter can be found in Appendix 5).

2.3.2 Recruitment

Recruitment of the participants for the study took place on NLS courses occurring at Liverpool Women's Hospital between May 2007 and March 2009. An information sheet, detailing the background to the study, the data collection process, along with a consent form and demographics questionnaire, was issued to candidates in their welcome pack upon registration at the NLS (Appendix 6 and 7). The study was then described to candidates in the introductory session of the course. Candidates were recruited during the first coffee break after the lectures on the course when there was an opportunity to discuss things in more detail and to answer individual questions about the study if required.

Recruitment was carried out by two consultants, both registered NLS instructors, in an attempt to not potentially bias the recruitment process and avoid coercion. The author, who was well known by the majority of the candidates in attendance, abstained from this process. At recruitment, written consent was obtained to take part in the study and the participant's demographic data was collected. Candidates who wished to consent, but worked outside a fifty mile radius of the course centre were not eligible for inclusion, owing to the difficult logistics and time constraints of visiting them at their base hospital, in order to follow them up. Details of all of the candidates who had consented, including their job title, grade, workplace and contact details were recorded on an excel spreadsheet for ease of analysis.

2.3.3 The study process

Approximately two months following the NLS course, the line manager of each eligible candidate was contacted and appointments made for re-testing the candidate, using the same airway test that they had been given at the end of the NLS course. The appointment date was scheduled between three and five months after completion of the NLS course.

Managers were requested not to inform the candidate and their colleagues of the appointment to prevent any possible preparation for the test. One week

prior to the arranged testing date, the candidates' managers were contacted again to confirm the appointment. This allowed confirmation that the candidate would not be absent due to long-term sickness, last minute holidays or change of shift and also confirmation that the candidate was not aware of the date of the visit. To prevent the possibility of preparing for the retest, candidates themselves were not informed of the retest day and appropriate cover was made for them by their line manager to leave the unit for half an hour for the retesting to take place. It was requested that this was not put on the duty rota, nor were their colleagues informed, to reduce the possibility of them preparing for the test and to maintain the element of surprise.

All equipment, excluding the resuscitaire, was taken to each re-test. This included two newborn manikins, a stethoscope, three guedel airways, a laryngoscope and three different sized ET tubes, two towels, two sizes of Bennett's face masks, suction catheters, two newborn hats and 'Neopuff' connecting tubing. It was ensured, prior to the visit, that each hospital had access to a resuscitaire which was in a secluded area, often on the delivery suite.

Upon arrival at the candidates' place of work, prior to the testing, line managers were offered briefing of what was about to take place. All of the equipment was then set out in the same way as for the airway test on the NLS course on the resuscitaire. Following this, and once there was someone available to cover for the candidate, the candidate was called into the prepared assessment room. It was at this point that the candidate was informed of the imminent test and they were then asked to complete a demographic data sheet (Appendix 8). They were also requested to complete a 'self assessment of confidence' scoring chart on which they had to mark on a Likert scale their confidence in being able to carry out all the items in the NLS airway test (Appendix 9). This was based upon the questions asked during the 'airway test'. This was looked at informally for readability by members of the nursing and medical team on the Neonatal unit. Using a Likert scale is considered an acceptable method of assessing self-efficacy (Maurer and Pierce 1998).

The NLS 'airway test' (Appendix 10) was then carried out in the same manner as on the NLS course without any prompting or help from the instructors. As on the NLS course, each retest needed two NLS instructors. To ensure uniformity, the test was always run by the same instructor (myself, CM), it was only the assistant that altered, who was a registered NLS instructor. In order to achieve this, a small bank of NLS instructors was compiled prior to the study to support with retesting. Candidates who were successful on their first attempt were congratulated and informed that the same process would take place again at approximately 12-14 months after their initial NLS course. They were asked to give new line manager contact details if they knew that they would be changing their place of work within this time.

As practiced on the NLS course, if the candidate was unsuccessful in the airway test, or they were struggling to complete the test, the test was stopped and the candidate was asked to wait outside the room to allow for discussion. If the candidate was unsuccessful, they were offered a mini 'booster' training session. This included a brief summary of the reasons for failure and a demonstration of all airway manoeuvres required for the NLS airway test. Immediately after the booster session, a further airway test was carried out using the same testing process. Following the test, the candidate was asked to wait outside the room in order to confirm a pass or fail. If, at this point, they were unsuccessful for a second time, they were then withdrawn from future testing.

After the test all, of the candidates were given a pack containing ten peer review forms which had questions relating to airway management (Appendix 11). The candidate was asked to distribute these to peers who would be able to comment on their skill at airway management. Once completed, their peers were asked to return the forms to myself in a pre-paid stamped addressed envelope. Candidates were also asked the date of their last resuscitation training in case they had had any intervening training since the NLS course.

After the first few tests had been completed, it became apparent that the number of peer review forms returned in the stamped addressed envelopes was low. As a result of this, it was decided that subsequently the forms would be given out and collected by the line manager and then sent back using the pre-paid envelopes. Also the number of forms and envelopes issued for each candidate was increased to 20 to try and increase the number of returns.

Line managers of those who had successfully completed the first retest on the first or second attempt were contacted at approximately eleven months after the NLS course. The same process of preparation and testing was undertaken. At the second retesting, candidates were again offered two attempts at completing the airway test and were tested by two NLS instructors. The author (CM) remained the lead for each retest.

Candidates who were successful on the first attempt were congratulated and their line managers were issued with 20 peer review assessment forms and stamped addressed envelopes for completion by peers as previously described. If candidates were unsuccessful on their first attempt they were offered the same mini 'booster' session as detailed previously. This included a brief summary of the reasons for failure and a demonstration of all airway manoeuvres required for the NLS airway test. Retesting took place immediately following this. Once completed, they were thanked for their support in this study. All data for all tests and all demographic data was then input onto an excel spread sheet.

2.3.4 Sample size

Having tested 15 of the recruited candidates, the author met with a statistician to discuss and finalise sample sizes. An overall pass rate of 86% was assumed on the data collected at that time. It was calculated that, if the sample size was 50 (completed both retests), a two-sided 95% confidence interval for a single proportion (using the large sample normal approximation) would extend 10% from the observed proportion for an expected proportion of 86%. Therefore, if a

pass rate of 86% was observed, then the confidence interval would change from 76% to 96% which was considered adequate for this study. If, however, the sample size was 40 (completed both retests), a two-sided 95% confidence interval for a single proportion (using the large sample normal approximation) would extend to 10.8% from the observed proportion for an expected proportion of 86%. Forty first and second retests were, therefore, considered the minimum number that could be accepted for this study. Study recruitment was therefore projected to continue until at least 40 retests had been obtained.

Chapter 3

Best Evidence in Medical Education Results

3.1 Systematic review

The findings will be presented for each of Kirkpatrick levels 2, 3, and 4 subdivided into adult, paediatric and neonatal resuscitation data. This allows the reader to view data that exists for their own discipline. A description of the studies for each level and each discipline, linked to the tables displaying the full relevant data for each level, is followed by a description of the themes which emerged from the data for each Kirkpatrick level. Data relating to Kirkpatrick level 1 (satisfaction with the SRT) have not been analysed or reported here as it is not felt to be relevant to the impact of SRT programmes on learning by the participants, maintenance of skills and knowledge or improvements in clinical care.

3.2 Studies reporting outcomes at Kirkpatrick level 2A and 2B modification of attitudes and perceptions (2A) and acquisition of knowledge and skills (2B)

3.2.1 Neonates (Table 3.1)

There were three studies in this category (Cavaleiro, Guimaraes and Calheiros 2009, Ergenekon et al 2000 and Trevisanuto et al 2007). The nature of the SRT offered was a mixture of lectures and simulation and one study reported an accredited training programme. All three studies tested knowledge at the end of the training by MCQ and all three demonstrated statistically significantly improved knowledge at the end of training (p more significant than <0.01 in all cases). None reported testing skills at the end of training, however, one assessed confidence (Kirkpatrick level 2A) in resuscitation revealing an improvement (Ergenekon et al 2000). One sub-group of students in one study (Cavaleiro, Guimaraes and Calheiros 2009) using self-study alone showed no improvement in knowledge compared to those receiving a lecture.

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence assessed (if so how)	Significant improvement in confidence at the end of the training
Cavaleiro et al 2009	No	50 min Lecture then self study or simulation (RCT)	Yes – after lecture and again after self study /simulation	MCQ	Yes after lecture (p<0.0001) No after self study/ simulation	No	N/A	N/A	No	N/A
Ergenekon et al 2000	No	8 hours Lectures Simulation	Yes	MCQ	Yes (mean score pre-course 9.5 vs post course 14.2) (P=0.001)	No	N/A	N/A	Yes, assessed in evaluation form at the end of the course	72% felt more confident at the end
Trevisanuto et al 2007	Yes NRP	2 courses 2 day Lectures Simulation	Yes	MCQ	Yes-Both courses (52% to 85% and 64% to 94%) P=<0.01	No	N/A	N/A	No	N/A

MCQ- multiple choice questionnaire, NRP- Neonatal Resuscitation Programme, N/A - Not applicable, RCT – Randomised Controlled Trial.

Table 3.1 Kirkpatrick 2A and 2B Neonates

3.2.2 Paediatrics (Table 3.2)

There were five articles in this category. The nature of the SRT, where stated, included lectures and simulation (three reporting an accredited training programme). Three studies tested knowledge at the end of training (two with an MCQ and one with written case scenarios) (Gerard, Scalzo, and Laffey, 2006, Quan et al 2001, Waisman 2002). In one there was a statistically significant improvement in knowledge (Waisman 2002) and in one there was no change (Quan et al 2001). In the third study knowledge change was not stated (Gerard, Scalzo, and Laffey, 2006). Three studies reported testing skills at the end via simulation with or without video, two (Donoghue et al 2009, Quan et al 2001) reporting statistically significant improvement in skills (one not reporting outcomes (Gerard, Scalzo, and Laffey, 2006). Three studies (Dobson et al 2003, Gerard, Scalzo, and Laffey, 2006 and Quan et al 2001) assessed confidence (Kirkpatrick 2A) by questionnaire and reported statistically significant improvements in confidence score after training. A sub-group of participants in one study who received high fidelity simulation training had improved skills on testing compared to a low fidelity training group (Donoghue et al 2009).

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Dobson et al 2003	No	6 hours Lectures/ simulation	No	Not tested	Not tested	No	Not tested	Not tested	Yes – Likert scale	Yes in all 13 areas tested (p=<0.002)
Donoghue et al 2009	No	simulation – Hi fidelity vs. low (RCT)	No	Not tested	Not tested	Yes	Simulation with two different manikins	Both groups improved scores but P value not stated (High fidelity group improved more than low fidelity) (P= 0.007)	No	N/A
Gerard et al 2006	Yes PALS	Web based course vs. traditional PALS	Yes	MCQ	Not stated	Yes	Video of performance	Not stated	Yes	Scores improved from 3.77 TO 4.28 in one group and 3.57 to 4.24 in other group (p value not stated but 95% confidence intervals indicate significant)

N/A - Not applicable, PALS- Paediatric Advanced Life Support, RCT – Randomised Controlled Tria

Table 3.2 Kirkpatrick 2A and 2B Paediatrics

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Quan et al 2001	Yes PALS	2 days Not stated	Yes	Written case scenarios	No	Yes	Video simulation	Yes P=<0.05 and <0.01 depending upon skill	Yes questionnaire	Mean confidence score increased from 1.9 to 6.2 (p value not stated but 95% confidence intervals indicate significant)
Waisman et al 2002	Yes PALS	Not stated	Yes	MCQ	Yes – proportion passing exam increased from 62% to 84% (P=<0.001)	No	N/A	N/A	No	N/A

MCQ- multiple choice questionnaire, N/A- not applicable, PALS- Paediatric Advanced Life Support

Table 3.2 Kirkpatrick 2A and 2B Paediatrics continued

3.2.3 Adults (Table 3.3)

There were 23 articles in this category. The nature of the SRT in most cases included simulation with mannequins combined with lectures (14 used an accredited training programme). Eleven studies reported testing knowledge at the end of training (10 with an MCQ and one with short answer questions), (Aboutanos et al 2007, Ali Cohen and Renznck 1995, Ali et al 1996, Ali et al 1998, Azcona et al 2002, Dauphin-McKenzie et al 2007, Girdley et al 1993, Hoadley 2009, Jenson et al 2009, Owen et al 2006, Tippet 2004). All of these studies reported statistically significant improved exam scores at the end compared to before training. Eighteen studies reported testing skills at the end of training using simulation mannequins (Aboutanos et al 2007, Ali et al 1995, Ali et al 1996, Ali et al 1998, Bilger et al 1997, Cimrin et al 2005, Azcona et al 2002, Dunning et al 2006, Greig et al 1996, Devita et al 2005, Hoadley 2009, Jenson et al 2009, Mayo et al 2004, Monsieurs et al, 2005 Marshall et al 2001, Owen et al 2006, Rosenthal et al 2006, Wayne et al 2005). In three the testing took the form of an OSCE and in one only telephone skills conveying the severity of the collapse requiring resuscitation to other professionals were tested. Seven studies reported statistically significant improvements in post-course skill scores compared to those pre-course (Ali et al 1996, Ali et al 1998, Cimrin et al 2005, Dunning et al 2006, Devita et al 2005, Marshall et al 2001, Rosenthal et al 2006). In addition four studies reported skill improvement but with no P value reported to indicate whether this was statistically significant (Azcona et al 2002, Greig et al 1996, Jenson et al 2009, Owen et al 2006), and six studies reported improved scores in skills in a group receiving the training compared to a control group who did not (four of these were randomised controlled trials), (Ali Cohen and Renznck et al 1995, Ali et al 1996, Ali et al 1998, Bilger et al 1997, Mayo et al 2004, Wayne et al 2005). Three studies did not report the levels of skill before and after the training despite reporting testing it (Aboutanos et al 2007, Hoadley 2009, Monsieurs et al, 2005).

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Aboutanos et al 2007	No	Lectures simulation	Yes	MCQ	Score increased from 72% to 79% (P=0.032)	Yes	OSCE	Not known – no pre-course score	No	N/A
Ali et al 1995	Yes ATLS	Not stated (RCT of course vs. not course)	Yes	MCQ	Improved compared to control group (p<0.01)	Yes	OSCE	Improved compared to control group (P<0.01)	No	N/A
Ali et al 1996	Yes ATLS	Not stated (RCT of course vs. not course)	Yes	MCQ	Improved compared to control group and pre-course scores (no P value)	Yes	OSCE	Improved compared to control group and pre-course scores (P<0.05)	No	N/A
Ali et al 1998	No PHTLS	Not stated	yes	MCQ	Improved compared to control group and pre-course scores (P<0.05)	Yes	Simulation	Improved compared to control group and pre-course scores (P<0.05)	No	N/A

ATLS- Advanced Trauma Life Support, MCQ- multiple choice questionnaire, N/A- not applicable, PHTLS- Pre Hospital Life Support, RCT – randomised controlled trial, OSCE- Objective Structured Clinical Examination

Table 3.3 Kirkpatrick 2A and 2B Adults

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Azcona et al 2002	Yes ATLS	Not stated	Yes	MCQ	Improved from 0% to 100% pass	Yes	Simulation	Improved from 5/16 to 16/16 passed	No	N/A
Bilger et al 1997	Yes AHA	Model telephone simulation (RCT – phone vs. no phone)	No	N/A	N/A	Yes	Use of phone	Improved in group taught with model phone ($p<0.01$)	No	N/A
Cimrin et al 2005	No	Lectures simulation	No	N/A	N/A	Yes	Simulation	Improved from score of 11.2 pre-course to 15.6 post-course ($P<0.001$)	No	N/A

AHA- American Heart Association, ATLS- Advanced Trauma Life Support, MCQ- multiple choice questionnaire, N/A- not applicable, RCT – randomised controlled trial.

Table 3.3 Kirkpatrick 2A and 2B Adults continued

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Dauphin-McKenzie et al 2007	Yes ALSO	2 days Lectures Simulation	Yes	MCQ	Improved from mean score of 55% pre-course to mean 86% post-course ($p<0.01$)	No	N/A	N/A	Yes questionnaires	8 of 9 felt more confident
Dunning et al 2006	No	Lectures simulation	No	N/A	N/A	Yes	Simulation	Improved times in most tasks (all $p<0.05$)	No	N/A
Featherstone et al 2005	Yes ALERT	Not stated	No	N/A	N/A	No	N/A	N/A	Yes questionnaires	Confidence improved in many areas ($P<0.01$)
Girdley et al 1993	Yes ATLS	Lectures Simulation	Yes	MCQ	Improved from mean score of 28.3% pre-course to mean 34.5% post-course $p=0.0001$	No	N/A	N/A	No	N/A

ALERT- Acute Life threatening Events Recognition and Training, ALSO- Advanced Life Support in Obstetrics, ATLS- Advanced Trauma Life Support, MCQ- multiple choice questionnaire, N/A- not applicable.

Table 3.3 Kirkpatrick 2A and 2B Adults continued

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Greig et al 1996	Yes BLS	Not stated	No	N/A	N/A	Yes	Simulation	Yes (6 weeks later) – p value not stated	No	No
Devita et al 2005	No	Lectures, simulation, debriefing	No	N/A	N/A	Yes – as a team	Simulation	Improved survival and task completion after training (p<0.002)	No	N/A
Hoadley 2009	Yes ACLS	Lectures Simulation	Yes	MCQ	Improved score from mean pre-course of 80% to post course mean of 89% (p<0.001)	Yes	Simulation	N/K	Yes	N/K

ACLS- Advanced Cardiac Life Suport, BLS- Basic Life Support, MCQ- multiple choice questionnaire, N/A- not applicable, N/K- not known.

Table 3.3 Kirkpatrick 2A and 2B Adults continued

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Jenson et al 2009	Yes ALS	Lectures simulation RCT	Yes	MCQ	Improved scores of means of 73 and 70% pre course to 85 and 83 % post course (no p value reported)	Yes	simulation	Yes (combined score with MCQ)	No	N/A
Mayo et al 2004	No	2 groups – one received training the other not Simulation	No	N/A	N/A	Yes	simulation	Improved in most areas in group receiving training ($p<0.001$)	No	N/A
Monsieurs et al 2005	No	Not stated RCT 2 different bagging systems	No	N/A	N/A	Yes	simulation	Not stated – automatic bagging system better than manual. ($P=0.0001$)	No	N/A

ALS- Advanced Life Support, MCQ- multiple choice questionnaire, RCT- Randomised Controlled Trial, N/A- not applicable.

Table 3.3 Kirkpatrick 2A and 2B Adults continued

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Marshall et al 2001	Yes ATLS	Not stated	No	Not sated	N/A	Yes	Simulation	Skills improved in all areas post course (P<0.002)	Yes- survey	Increased from mean score of 5.8 to 8.1 (P<0.01)
Murphy and Fitzsimmons 2004	Yes ILS	Not stated	No	N/A	N/A	No	N/A	N/A	Yes - qualitative	Improved (qualitative data)
Owen et al 2006	No	Simulation	Yes	MCQ	Yes P=0.001	Yes	Simulation	Improved (p value not stated))	Yes- questionnaire	P=<0.001
Rosenthal et al 2006	No	Simulation	No	N/A	N/A	Yes	Simulation	Improved in nearly all areas (at 6 weeks after)from pre-course score (p<0.0001)	No	N/A

ATLS- Advanced Trauma Life Support, ILS- Immediate Life Support, MCQ- multiple choice questionnaire, N/A- not applicable.

Table 3.3 Kirkpatrick 2A and 2B Adults continued

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Tippet 2004	Yes ATLS	Not stated	Yes	Short answers	Improved from mean 61% to mean 83% (p=0.006)	No	N/A	N/A	No	N/A
Wayne et al 2005	No	Simulation RCT	No	N/A	N/A	Yes	Simulation	Improved scores – 38% higher than controls with no training (p<0.0001)	No	N/A

ATLS- Advanced Trauma Life Support, RCT- Randomised Controlled Trial, N/A- not applicable.

Table 3.3 Kirkpatrick 2A and 2B Adults continued

3.2.4 Summary of findings from Kirkpatrick 2A and 2B

The overwhelming message from these studies is that both knowledge and skills are significantly improved following SRT compared to pre-training levels. This has been confirmed both when individuals are tested pre- and post- training and also, in the context of randomised controlled trials, when groups of participants who have been trained are compared with control groups who have not. The assessment of knowledge and skills levels and changes in these were reported using scoring systems which were unique to each study in most cases thus precluding meta-analysis. There is a suggestion from one study that high fidelity simulation, compared to low fidelity, may be more effective in improving skills (Donoghue et al 2009), and that attending a training session compared to self-study might be more effective in improving knowledge (Cavaleiro Guimaraes and Calheiros 2009). There were no clear differences in outcomes between accredited and non accredited training programmes. Where reported, confidence at performing resuscitation tasks is universally improved in participants who have undertaken SRT. There is no evidence available to indicate whether the improvement in knowledge and/or skills after SRT results in improved clinical performance immediately after SRT.

3.3 Studies reporting outcomes at Kirkpatrick 2C (retention of knowledge and skills over a period of time after SRT)

3.3.1 Neonates (Table 3.4)

There were eight studies in this category. In those studies that stated the nature of the training, all used simulation with mannequins and most used lectures (four described accredited programmes). The number of participants followed up after SRT in the studies ranged from 6 to 166. The period of follow up ranged from 6 weeks to 12 months. All studies reported knowledge retesting at follow-up with an MCQ and 5 reported skill testing using mannequins. Four studies reported a decrease in knowledge (Curran et al 2004, Duran et al 2008,

Kaczorowski et al 1999, Trevisanuto et al 2005) and four reported that knowledge did not change at follow up (Dunn et al 1992, Levitt et al1996, Skidmore and Urquhart 2001, West 2000), (only two of these however reported no statistically significant difference). There did not appear to be any difference with respect to the nature of the training between those studies where knowledge decreased and those where it was maintained. In all but one study which tested skills (Curran et al 2004, Dunn et al 1992, Kaczorowski et al 1999, Skidmore and Urquhart 2001, West 2000), a significant decrease in skills at follow up testing occurred. The study where skills were maintained was small (six participants) and skills were tested only 6 weeks after the training (West 2000).

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	P	Skill change	Notes	P
					K	S						
Curran et al 2004	No	Computer manikin	60 (D)	4 and 8 months (one group with booster)	Yes MCQ	Yes Simulation	D then NC	RCT - Decreased knowledge at 4 months in both groups then remained same at 8 months	<0.0001 then Not SIGNIF	D	RCT- Both groups at 8 months	<0.0001
Dunn et al 1992	No	1 day Lectures Demo	166 (N)	6 months	Yes MCQ	Yes Simulation	NC	Mean MCQ score from 91% to 85%	Not SIGNIF	D	All passed after training - All failed at follow-up	N/K
Duran et al 2008	Yes NRP	Lectures Simulation	42 (D)	6 and 12 months	Yes MCQ	No	D	Mean MCQ score from 94.5% to 59.2% after 6 months and 93.2% to 58.3% after 12 months	N/K	N/A		N/A
Kaczorowski et al 1999	Yes NRP	Video Practical	44 (D)	6-8 months	Yes MCQ	Yes Simulation	D	RCT - All passed after training –at Follow-up 26 (56%) passed in control group and 2 other groups who had booster	N/K	D	All passed after training - all failed at follow-up	N/K

AP - Accredited programme, Knowledge change: D – Decreased, I – Increased, NC - No change, P- P Value, MCQ-Multiple-Choice Questionnaires, Not SIGNIF- not significant, , N/A-Not applicable, N/K-Not known, NRP-Neonatal Resuscitation Programme, RCT- Randomised Controlled Trial

Table 3.4 Kirkpatrick 2C Neonates.

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	P	Skill change	Notes	P
					K	S						
Levitt et al 1996	Yes NRP	N/K	10 (D)	6-9 months	Yes MCQ	No	NC	Mean MCQ score from 86.4% to 75.4%	Not SIGNIF	N/A		N/A
Skidmore + Urquhart 2001	No	Lectures Simulation	62 (D and N)	6 months 12 months	Yes MCQ	Yes Simulation	NC		N/K	D	After 6 months (but not back to pre-training score)	N/K
Trevisanuto et al 2005	Yes NRP	2 days Lectures Simulation	25 (D)	6 months	Yes MCQ	No	D	Mean MCQ score from 94.1% to 62.7%	<0.0001	N/A	N/A	N/A
West 2000	No	2 hours N/K	6 (N)	6 weeks	Yes MCQ	Yes Simulation	NC		N/K	NC		N/K

AP - Accredited programme, Knowledge change: D – Decreased, I – Increased, NC - No change, P- P Value, MCQ-Multiple-Choice Questionnaires, Not SIGNIF- not significant, , N/A-Not applicable, N/K-Not known, NRP-Neonatal Resuscitation Programme.

Table 3.4 Kirkpatrick 2C Neonates continued

3.3.2 Paediatric (Table 3.5)

There were five articles in this category (two reporting accredited training programmes). The nature of training was variable: in two studies this was unknown, in one it was self-study and in others it was lectures and simulation with mannequins. The period of follow up testing ranged from two to 21 months. All studies reported knowledge testing (three with an MCQ), three demonstrating a decrease in knowledge at follow up (Spaite et al 2000, Su et al 2000, Wolfram et al 2003) and one demonstrating no change (Durojaiye and O'Meara 2002), (assessment was by telephone questionnaire and no p value was reported). Two reported testing skills at follow up, but did not report any assessment data (Nadel et al 2000, Su et al 2000).

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested K	S	Knowledge change	Notes	P	Skill change	Notes	P
Durojaiye and O'Meara 2002	Yes PLS	N/K	23 (D)	2 weeks and 2 and 4 months	Yes phone questions	No	NC		N/K	N/A		N/A
Nadel et al 2000	No	8 hours Lectures Simulation video - Then booster in one group	57 (D)	Approx 12 months	Yes MCQ	Yes Simulation video	N/K	Did not report change in knowledge but group who received booster did better than control group	N/K	N/K	Did not report change in skills over time but group who received booster did better than control group	N/K
Spaite et al 2000	No	Self-study	11 (O)	4 months	Yes 'test'	No	D	Mean score in test fell from 13.04 to 11.59	<0.01	N/A		N/A
Su et al 2000	No	16 hours Lectures, Simulation. Sub-groups had simulation or knowledge exam at 6 months	43 (O)	12 months	Yes MCQ	Yes Simulation	D	Scores in reduced between 19.7% to 22.3% at follow-up – no difference between groups randomised to have test at 6 months and controls	<0.05	N/K		N/K

AP-Accredited programme, Knowledge and Skill change: D – Decreased, I – Increased,MCQ- Multiple Choice Questionnaire, N/A- not applicable, NC- no change, N/K- not known, P- P value, PLS- paediatric Life Support.

Table 3.5 Kirkpatrick 2C Paediatrics

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	P	Skill change	Notes	P
					K	S						
Wolfram et al 2003	Yes PALS	N/K	99 (O)	Mean 21 months	Yes MCQ	No	D	25% passed exam at follow-up	N/K	N/A		N/A

AP-Accredited programme, Knowledge and Skill change: D – Decreased, NC - No change, MCQ, Multiple-Choice Questionnaires, N/A-Not applicable, N/K-Not known, P- P Value, PALS Paediatric Advanced Life Support.

Table 3.5 Kirkpatrick 2C Paediatrics continued

3.3.3 Adults (Table 3.6)

There were 39 articles in this category. The nature of the training was varied and included lectures, simulation with mannequins and videos (in 18 this was part of an accredited programme). The training was delivered over a period of time ranging from 15 minutes to two and a half days. The period between the training and testing at follow up ranged from one to 60 months. Twenty-seven studies reported testing knowledge at a later date (20 with an MCQ, the others with a variety of written assessments). Sixteen of these reported significant deterioration in knowledge at follow up testing (Ali, Howard and Williams 2002, Ali et al 1996, Azcona et al 2002, Blumenfeld et al 1998, Boonmak et al 2004, Broomfield 1996, Curry and Gas 1987, Curry and Gas 1983, Fossel et al 1983, Leith 1997, O'Steen, Kee and Minick 1996, Semeraro, Signore and Cerchiari 2006, Stross 1983, Tippett 2004, Wenzel et al 1997, Young and King 2000) and seven reported no deterioration in knowledge at follow up testing (Aboutanos et al 2007, Coleman et al 1991, Cooper, Johnston and Priscott 2007, Hammond et al 2000, Holden Monaghan and Cassidy 1996, O'Donnell and Skinner 1993, Stross 1983). With respect to the nature of the training, those groups who received a refresher or booster session (in two randomised trials) maintained knowledge better than those who did not (O'Donnell and Skinner 1993, Stross 1983). There were no other clear differences between those retaining and those deteriorating in their knowledge with respect to the nature of their training. Twenty-eight studies reported a deterioration in skills at follow up testing (Ali, Howard and Williams 2002, Ali et al 1996, Beckers et al 2007, Bradley et al 1988, Broomfield 1996, Cooper, Johnston and Priscott 2007, Curry and Gas 1987, Curry and Gas 1983, Erickson et al 1996, Fabius et al 1994, Fossel et al 1983, Hammond et al 2000, Heidenreich et al 2004, Holden Monaghan and Cassidy 1996 , Kovacs et al 2000, Leith 1997, Mancini and Kaye 1985, McKee et al 1994, O'Steen, Kee and Minick 1996, Plank and Steinke 1989, Semeraro, Signore and Cerchiari 2006 , Smith, Gilcresast and Pierce 2008, Spooner et al 2007, Stross 1983, Ten Eyck 1993, Wenzel et al 1997, Yakel 1989, Young and King 2000) whereas only nine reported maintenance of skills at follow up (Ander, Hanson and pitts2004,

Boonmak et al 2004, Coleman, Dracup and Moser 1991, De Regge et al 2005, Heidenreich et al 2004, Kovacs et al 2000, McKee et al 1994, O'Donnell and Skinner 1993, Wayne et al 2006). In the studies where skills were maintained, two (Boonmak et al 2004 and Coleman et al) reported re-testing only a short time period after the SRT (three months), three studies (Ander, Hanson and Pitts 2004, De Regge et al 2005 and Hiedenreich et al 2004) reported maintenance of isolated discrete skills within a resuscitation scenario (other skills having deteriorated) and three (Kovacs et al 2000, O'Donnell and Skinner 1993, and Wayne et al 2006) had, as part of their SRT, repeated testing and refresher sessions (all in the context of randomised trials).

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested K	S	Knowledge change	Notes	P	Skill change	Notes	P
Aboutanos et al 2007	No	Lectures simulation	12 (D)	2 years	Yes MCQ	No	I	Mean score increased from 65% to 77%	<0.05	N/A		N/A
Ali et al 2002	Yes ATLS	Lecture Simulation	144 (D)	6 months, 2,4,6,8 years	Yes MCQ	Yes OSCE Simulation	D	High and low trauma-exposed groups reduced scores from 83.9% to 74.8% and 81.9% to 74.6% respectively at 6 months. After this no group passed MCQ	N/K	D		N/K
Ali et al 1996	Yes ATLS	N/K	60 (D)	6 months, 2,4,6 years	Yes MCQ	Yes OSCE	D	Scores after ATLS 85.3 – 87.7% in four groups. At 6 months = 77.8% (50%) pass, at 2 years 70.6% (0 passes), at 4 years 69.4% (0 passes), at 6 years (68.9% (0 passes)	N/K	D	Score after ATLS 16.6. Score at 6 months = 16.8, at 2 years = 13.9, at 4 years 12.0, at 6 years 11.9	N/K
Ander et al 2004	No	4 hour lectures 2 hours and Simulation	40 (D)	6 and 12 months	No	Yes Simulation	N/A		N/A	I	2 out of 3 skills improved at follow-up	N/K
Azcona et al 2002	Yes ATLS	Not stated	59 (D)	Less than 2 years (38) and more than 2 years (21)	Yews MCQ	No	D	8/38 and 2/21 passed at follow-up	N/K	N/A		N/A
Beckers et al 2007	No	15 minute lecture	59 (S)	6 months	No	Yes Simulation	N/A		N/A	D	Time to first shock elongated from mean of 56.5 seconds post-training to 59.9 seconds at follow-up (but not back to pre-training level)	<0.01

AP-Accredited programme, ATLS- Advanced Trauma Life Support, CPR Cardio-pulmonary Resuscitation, ILS- Immediate Life Support, Knowledge and Skill change D – Decreased, I – Increased, , MCQ-Multiple-Choice Questionnaires, N/A-Not applicable, NC - No change, N/K-Not known, OSCE- observed structures clinical event, P- P Value

Table 3.6 Kirkpatrick 2C Adults

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested K	Components of ability tested S	Knowledge change	Notes	P	Skill change	Notes	P
Blumenfeld et al 1998	Yes ATLS	N/K	220 (D)	3 to 60 months	Yes MCQ	No	D	Mean score 84% post-course and 66% at follow-up. 50% participants scored above 80% by 180 weeks	N/K	N/A		N/A
Boonmak et al 2004	No	1 hour lecture, 1 hour Simulation	30 (N)	3 months	Yes MCQ	Yes Simulation	D	Mean score fell from 75.4% to 60.5% at follow-up (back to pre-training levels)	N/K	N/C	(Mean skill score after training 79.7, at follow-up 75.7)	Not SIGN IF
Bradley et al 1988	No	10 hour and 4 hour lectures and Simulation	51 (O)	18 months (after 6 month test at follow-up)	Yes MCQ And written	Yes Simulation	?D	RCT Proportion of failures may have increased in both groups at follow-up – no formal analysis	N/K	?D	Proportion of failures may have increased at follow-up – no formal analysis	N/K
Broomfield 1996	Yes ENB	3 hours Lectures Simulation	19 (N)	10 weeks	Yes MCQ	Yes Simulation	D	Mean score 23.9 post-course and 19.4 at follow-up (higher than pre-training)	<0.0001	D	Mean score 7.2 post-course and 5.1 at follow-up (higher than pre-training)	<0.001
Coleman et al 1991	No	4 hours of either lectures, discussion, handouts and simulation or e-learning	49 (S)	3 months	Yes MCQ	Yes Simulation	NC	Maintained scores in both groups	Not SIGNIF	NC	Maintained scores in both groups	Not SIGN IF
Cooper et al 2007	Yes ILS	1 day Lectures Simulation	29 (D,N,O)	6 months	Yes MCQ	Yes Simulation	N/C	Mean score 82% post course and 80% at follow-up	Not SIGNIF	D	Mean score 99% post-course and 85% at follow-up (higher than pre-training)	0.02

AP-Accredited programme, ATLS- Advanced Trauma Life Support, ILS- Immediate Life Support, Knowledge and Skill change D – Decreased, I – Increased, ENB- English National Board, MCQ-Multiple-Choice Questionnaires, N/A-Not applicable, NC - No change, N/K-Not known, Not SIGNIF- not significant, P- P Value

Table 3.6 Kirkpatrick 2C Adults continued

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	P	Skill change	Notes	P
					K	S						
Curry and Gas 1987	No	N/K	85 (D an N)	6 and 12 months	Yes MCQ	Yes Simulation	D	Doctors mean score 89.6% post-course, 84% at 6 months and 83.4% at 12 months Nurses mean score 92.3% post-course, 82% at 6 months and 79.4% at 12 months (Both back to pre-training levels)	N/K	D	Both for doctors and nurses – numerical data not reported (Both back to pre-training levels)	N/K
Curry and Gas 1983	Yes CPR	N/K	12(N)13(D) 12(N)6(D)	6months 12 months	Yes MCQ	Yes Simulation	D	D and N had decreased after 6 months – back to pre-training levels by 12 months	<0.05	D	D skills decreased after 6 months, N by 12 months – both back to pre-training by 12 months	<0.01
De-Regge et al 2005	No	Simulation	2 groups of 16 (N)	3 and 6 months	No	Yes Simulation	N/A		N/A	N/C	2 groups with different resuscitation bags - Efficiency of ventilation stayed the same in both	Not SIGNIF
Erickson et al 1996	No	30 minute lectures and Simulation	11 (D,N,O)	2 months	No	In clinical area	N/A		N/A	D	Airway and trauma skills decreased at follow-up (to pre-training levels)	N/K
Fabius et al 1994	No	Computer demo and Simulation	54 (N,O)	6 months	No		N/A		N/A	?D	RCT – two groups – 1 person in each group 'passed' at follow-up compared to 6 and 34 respectively immediately post-training	N/K

CPR Cardio-pulmonary Resuscitation, Knowledge and Skill change D – Decreased, I – Increased, MCQ-Multiple-Choice Questionnaires, N/A-Not applicable, NC - No change, N/K-Not known, Not SIGNIF- not significant, P- P Value.

Table 3.6 Kirkpatrick 2C Adults continued

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested K	Components of ability tested S	Knowledge change	Notes	P	Skill change	Notes	P
Fossel et al 1983	No	Simulation	41 (S)	1 year and 2 years	Yes MCQ	Yes Simulation	D	Score lower at 1 and 2 years compared to those followed up at 2-3 weeks after training	<0.001	D	CPR performance lower at 1 and 2 years compared to those followed at 2-3 weeks after training	<0.05
Hammond et al 2000	Yes ALS	2 days Lectures Simulation	40 (N)	18 months	Yes MCQ	Yes Simulation	N/C	Mean score 81.7% post course, 83.8% at follow-up	Not SIGNIF	D	75% percent passed at follow-up	N/K
Heidenreich et al 2004	Yes AHA	25 minutes Instruction Video Simulation	28 (S)	6 and 18 months	No	Yes Simulation	N/A		N/A	D and N/C	In standard CPR – reduction percentage correct chest compressions from 54 to 35 then 32. In uninterrupted chest compressions stayed the same	<0.02
Holden et al 1996	No	N/K	55 (N)	6 months	Yes MCQ	Yes Simulation	N/C	Number achieving more than 50% correct answers did not deteriorate	N/K	D	21 (38%) passed skills test at 6 months	N/K
Jensen et al 2009	Yes ALS	Lectures Simulation	2 groups (immediately and 6 months after qualification)	6 months	Yes composite	Yes composite with MCQ	N/K		N/A	N/K	Mean scores reduced from 85% and 83% post course to 82% and 78% at follow-up	N/K

AP-Accredited programme, AHA- American Heart Association, ALS- Advanced Life Support, Knowledge and Skill change D – Decreased, I – Increased, MCQ-Multiple-Choice Questionnaires, N/A-Not applicable, NC - No change, N/K-Not known, Not SIGNIF- not significant, P- P Value.

Table 3.6 Kirkpatrick 2C Adults continued

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	P	Skill change	Notes	P
					K	S						
Kovacs et al 2000	No	1 hour lecture, 5 hours simulation and half an hour/week for 3 weeks	84 (S)	16,25,40 weeks	No	Yes Simulation	N/A		N/A	N/C And D	RCT – groups with practice and feedback maintained skills. Control group and group receiving feedback alone deteriorated by 16 weeks (Mean score 45.2 to 34 and 45.2 to 35.4 respectively)	<0.05 in D groups
Leith 1997	No	'Defibrillation training'	10 and 10 (N)	6 and 12 months	Yes write exam	Yes Simulation	D	Mean score reduced from 89% post course to 76% at 6 months and 70% at 12 months	N/K	D	Pass rate of practical test decreased from 70% to 0% at 6 and 12 months	N/K
Mancini and Kaye 1985	Yes AHA	N/K	33 (D)	mean 8 and 22 months	Yes Assessment and action	Yes Simulation	?D	Less than 100% of candidates responded correctly in all aspects except for assessing unresponsiveness (presume all needed to be correct immediately post-training)	N/K	?D	Less than 100% of candidates performed correctly in all aspects except for ventilating (presume all needed to be correct immediately post-training)	N/K
McKee et al 1994	No	Lectures Simulation	50 (N)	1 week, 1, 3 and 6 months	No	Yes Simulation	N/A		N/A	D and N/C	Delay to defibrillation increased – resuscitation score deteriorated then improved to post training score at 6 months	<0.05 and Not SIGNIF

AP-Accredited programme, AHA- American Heart Association, Knowledge and Skill change D – Decreased, I – Increased, MCQ-Multiple-Choice Questionnaires, N/A-Not applicable, NC - No change, N/K-Not known, Not SIGNIF- not significant, P- P Value.

Table 3.6 Kirkpatrick 2C Adults continued

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested K	S	Knowledge change	Notes	P	Skill change	Notes	P
O'Donnell and Skinner 1993	No	20 min lecture and Simulation	44 K 60 S	6 months	Yes Questionnaire	Yes Simulation	N/C and D	N/C in the 2 groups with refresher sessions and D in group with no refresher prior to follow-up	Not SIGNIF and <0.05	I	Group with monthly refresher sessions improved in 'pass rate' for performing cardiac massage from 39 to 69%	<0.05
O'Steen et al 1996	Yes ACLS	N/K	40 (N)	Mean 344 days (0-1034)	Yes MCQ	Yes Simulation	D	After 12 months – no further deterioration after	<0.05	D	After 12 months – no further deterioration after	<0.05
Plank and Steinke 1989	No	2 hours Lecture and simulation vs video	36(N)	6-8 weeks	Yes MCQ	Yes simulation	N/K	Pass score not stated	N/A	D	26 failed at follow-up	Not stated
Semeraro et al 2006	Yes ALS	Lectures Simulation	47 (D)	6 months	Yes MCQ	Yes Simulation	D	Mean score 85.9% post-course and 79.5% at follow-up	<0.001	D	All passed post-course and 30 passed at follow-up	<0.001
Smith et al 2008	Yes ACLS BLS	N/K	133 (N)	3,6,9,12 months	Yes MCQ	Yes Simulation	N/K	Results not reported	N/K	D	4 groups – all deteriorated – some to pre-training	N/K
Spooner et al 2007	Yes BLS	8 hours Lectures simulation	66 (S) RCT standard vs. feedback manikin	6 weeks	No	Yes simulation	N/A		N/A	D	Fail rate increased from 16% and 25% to 10% and 38% respectively	N/K
Stross 1983	Yes ACLS	N/K	132 (D)	1 year	Yes ECG recognition and mock arrest	Yes Simulation	N/C and D	RCT. All 3 groups maintained ECG recognition but deteriorated in mock arrest – the 2 groups receiving booster sessions performed better at follow-up	N/K	D	39% performed successful ventilation and 47% external cardiac massage compared to all having passed ACLS course	N/K

AP-Accredited programme, ACLS- Advanced Cardiac Life Support, ALS- Advanced Life Support, ECG- echocardiogram,, Knowledge and Skill change D – Decreased, I – Increased, MCQ-Multiple-Choice Questionnaires, N/A-Not applicable, NC - No change, N/K-Not known, Not SIGNIF- not significant, P- P Value.

Table 3.6 Kirkpatrick 2C Adults continued

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested K	S	Knowledge change	Notes	P	Skill change	Notes	P
Ten Eyck 1993	No	4 hours lectures and Simulation	48 (O)	6 months	No	Yes simulation	N/A		N/A	D	5 failed resuscitations and others did not perform other required aspects of simulation	N/K
Tippett 2004	Yes ATNC	21/2 days Lectures simulation	14 (N)	3 months	Yes Short answers	No	D	Mean score 83% post course and 73% at follow-up (back to pre-course levels)	<0.05	N/A		N/A
Wayne et al 2006	No	4 x 2 hours teaching and HI fidelity Simulation	38 (D)	6 and 14 months	No	Yes Simulation	N/A		N/A	N/C	In context of RCT previously over 6 months which involved 3 lots of testing	Not SIGNIF
Wenzel et al 1997	No	2 hours Instruction Simulation	113 (S)	6 months	Yes MCQ	Yes Simulation	D	Mean score 6.4 post-course and 6.2 at follow-up	<0.05	D	5 out of 9 skills deteriorated significantly	<0.0001
Yakel 1989	Yes 2 BLS courses	45 minutes or 8 hours Lectures Simulation	81 then 86 (N)	4 months and 8 months	No	Yes Simulation	N/A		N/A	D	Mean score 55 post-course and 38 at 4 months. Improved to 42 at 8 months (p<0.001) – 4 month test acted as booster (remedial training given). Longer course did better at follow-up (p<0.05)	N/K
Young and King 2000	No	N/K	10 (N)	6 and 12 weeks	Yes Oral questions	Yes Simulation	D	5 failed at 6 weeks, 5 failed at 12 weeks	N/K	D	5 failed at 6 weeks, 6 failed at 12 weeks	N/K

AP-Accredited programme, ATNC- Advanced Trauma Nursing Course, BLS- Basic Life Support, Knowledge and Skill change D – Decreased, MCQ-Multiple-Choice Questionnaires, N/A-Not applicable, NC - No change, N/K-Not known, Not SIGNIF- not significant, P- P Value.

Table 3.6 Kirkpatrick 2C Adults continued

3.3.4 Summary of findings from Kirkpatrick 2C

It appears that knowledge can be maintained for several months after SRT, however, there is no specific aspect of training that can be identified which facilitates this. There were no clear differences in outcomes between accredited and non accredited training programmes. Skills generally deteriorate from at least three months after SRT. Factors which may prevent this occurring are, providing refresher or booster sessions after training and possibly identifying discrete actions to be assessed within simulation during training and at follow up. Skills were all assessed at follow-up using simulation in mannequins and not in real clinical situations, making it impossible to know whether the deterioration or maintenance of skills identified was being reflected in clinical practice. Any association with behavioural change and a change in clinical performance in participants in those studies where their retention of skills and/or knowledge was reported is, therefore, unknown. In the context of this review, Kirkpatrick level 2c, therefore, relates to retention of knowledge and skills and their application in a simulated environment. There is a need for work to be carried out to explore any association between behavioural change as evidenced by a simulated environment and behavioural change in a 'real-life' setting. To our knowledge, investigating and identifying behavioural change in individuals in such a setting has not been systematically investigated.

3.4 Studies reporting outcomes at Kirkpatrick 3 (evidence of transfer of learning to clinical practice)

There were no studies in this category.

3.5 Studies reporting outcomes at Kirkpatrick 4 (evidence of benefit to patients, families and communities after SRT)

3.5.1 Neonates (Table 3.7)

There were seven studies in this category all following accredited programmes which included lectures and simulation training. These studies reported outcomes following the introduction of SRT programmes within individual

institutions, often over a period of years. Four studies reported a significant impact on patient outcome, (Duran et al 2008, Patel et al 2001, Patel and Piotrowski 2002, Zhu et al 1997) three reporting an improved resuscitation (Apgar) score in babies and one reporting a reduction in neonatal mortality (Zhu et al 1997). Two studies reported improvement in clinical management with respect to the organisation of clinical resuscitations and interventions during resuscitation (improvement in delivery room preparation and assessment of the baby (Ryan et al 1999) and reduction in hypothermia and inappropriate use of the drug naloxone (Singh et al 2006).

Author	Accredited programme	Nature of the training	Period studied	Significant impact on patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Boo 2009	Yes NRP	Lectures Simulation	5 years pre-training and 8 years post-training	Not stated	Numerical decline in perinatal and neonatal mortality but no P values	? Less mortality	Not stated	Not stated
Duran et al 2008	Yes NRP	Not stated	Over 3 year period including pre and post implementation of training	Yes	After training: significant increase in 1 minute Apgar score (5.43-6.5 - P=0.01) Babies with ischemic changes on CT reduced from 91% to 62% (P=0.02) Reduction in inpatient stay from 12 to 6.1 days P=<0.05	No statistically significant difference	Not stated	Not stated
Patel et al 2001	Yes NRP	Not stated	Before training (1985-1988), during transition (1989-1990) and after training (1991-1995)	yes	Fewer babies with low 1 and 5 min Apgar scores post-training P=<0.001	Not stated	Not stated	Not stated
Patel and Piotrowski 2002	Yes NRP	Not stated	Before NRP- 1985-1988, after 1991-1995.	Yes	Higher 1 minute Apgar score (7-10) (24% pre versus 31% post NRP - P=0.001) and higher 5 minute (53% versus 65% - p<0.001). More changed from low 1 minute to high 5 minute after NRP (39% to 49% - p<0.001)	Not stated	Not stated	Not stated

NRP- Neonatal Resuscitation Programme, P- P Value.

Table 3.7 Kirkpatrick 4 Neonates

Author	Accredited programme	Nature of the training	Period studied	Significant improvement in patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Ryan et al 1999	Yes NRP	Lectures Simulation	51 deliveries before and 51 deliveries after the training (1994-5)	Not stated	Not stated	Not stated	Yes	Improvement in delivery room preparation (P=0.01), management (P=0.01) assessment (P=0.02) and interventions (p=0.02)
Singh et al 2006	Yes NLS	Lectures Simulation	Data collected pre-course in 1990-1994 and post-course in 1997 and 2003.	Not stated	Not stated	Not stated	Yes for par of findings	Inappropriate use of naloxone fell from 75% to 10 % (P=0.0001). Total use of naloxone fell from 13% to 0.5%, incidence of hypothermia fell from 9% to 2.3% (both not statistically significant)
Zhu et al 1997	Yes NRP	Not stated	Pre-training 1992, post-training 1993 to 1995	Yes	3x reduction in neonatal mortality (9.9 to 3.4 per 1000) P<0.001	Yes		

NLS – Neonatal life support, NRP- Neonatal Resuscitation Programme, P- P value.

Table 3.7 Kirkpatrick 4 Neonates continued

3.5.2 Paediatrics (Table 3.8)

There were two studies in this category. Neither followed an accredited training programme. One involved weekly simulation scenarios and one involved supervised practice. Neither of these studies reported any impact on patient outcome. One study reported an improvement in clinical management (Losek, Szewczuga and Glaeser 1994) and one reported deterioration in clinical management (Lo et al 2009). The latter study had weekly simulation scenarios as part of the training.

Author	Accredited programme	Nature of the training	Period studied	Significant impact on patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Lo et al 2009	No	Simulation Weekly scenarios	23 weekly training sessions of approximately 30 minutes	Not documented	N/A	Not documented	No	Median time for chest re-opening significantly longer- P=0.002. Longer to give medication P= 0.002
Losek et al 1994	No (PALS for emergency medicine in State)	Lectures as before but with additional supervised practice from 1986	Patients 0-18 years from January 1990 to December 1991 compared with data from January 1983 to June 1985	Not documented	N/A	Not documented	Yes	<18 month old improved intubation P=0.000008 and vascular access P= 0.000003 Older child improved vascular access p<0.05

N/A- not applicable, PALS- Paediatric Life Support, P- P value.

Table 3.8 Kirkpatrick 4 Paediatrics

3.5.3 Adults (Table 3.9)

There were 13 articles in this category. Programmes, where stated, included lectures and simulation (only two did not follow an accredited programme). The majority of studies compared outcomes following the introduction of training into an institution, however three studies (Dane et al 2000, Moretti et al 2007, and Woodall et al 2007) compared outcomes between groups of individuals who had received training with those who did not within the same institution. Seven studies reported a significant improvement in patient outcome, all of them showing a statistically significant reduction in mortality as well as in some improvement in other patient outcomes (Arreola et al 2004, Camp, Parish and Andrews 1997, Dane et al 2000, Moretti et al 2007, Spearpoint, Gruber and Brett 2009, Van Olden et al 2004a, Woodall et al 2007). Six studies reported a significant improvement in clinical management (less errors occurring or improved management at specific tasks) (Arreola et al 2004, Camp, Parish and Andrews 1997, Makker, Gray and Evers 1995, Van Olden et al 2004b, Vestrup Stomorken and Wood 1988, Woodall et al 2007).

Author	Accredited programme	Nature of the training	Period studied	Significant improvement in patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Arreola et al 2004	Yes PHTLS, BLS and ALS (some in house)	Not stated	3 ambulance services October – December 1994, pre-training and January – June 1995 post-training. January –September 2000 pre-training and October 2000 – June 2001 post training	Yes	Not stated	Improvement in survival in those patients transported in 1 intervention centre (p=0.04)	Yes	Improved airway management in the 2 intervention centres (P<0.001) Improved spinal immobilisation in 1 intervention centre P<0.001 Some improved iv fluid administration in 2 intervention centres (p<0.001)
Camp et al 1997	ACLS	Not stated	1980 to 1984 pre-training and from 1985 to 1990 post – training	Yes	Increased 'death events' reversed by intervention increased from 2% to 11% (p<0.001)post-training	Yes	Yes	Increased intervention at 'death events' post training (from 5% to 37% - p<0.001)
Curry and Gas 1987	No	Not stated	1981 -1985 – one hospital received training – the other not	No		No	No	No difference in death rates between trained and untrained staff
Dane et al 2000	Yes ACLS	Not stated	1996 and 1997 Compared resuscitation outcome of nurses ACLS trained with those not	Yes	4x more likely to survive when treated by trained nurses (38% to 10%) P=0.02	Yes	Not stated	Not stated
Makker et al 1995	Yes ACLS	Not stated	1991 – 225 cardiac arrests	No		No	Yes	Certified doctors made less errors in first semester after training (5.9%) compared with second semester (14.7%) (p=0.05)
Moretti et al 2007	Yes ACLS	2 day course Lectures Simulation	January 1998 to March 2001 Compared resuscitation outcome of personnel ACLS trained with those not	Yes	Increase in return of spontaneous circulation with trained versus non-trained (49/113 versus 16/59 P=0.04)	Better survival in ACLS trained group: at 30 days (27% versus 6% - P=0.02) and 1 year (22% versus 0% P=0.002)	Not stated	Not stated

ACLS-Advanced Cardiac Life Support, ILS-Immediate Life Support, BLS- Basic Life Support, PHTLS- Pre-Hospital Trauma Life Support Course, P- P value.

Table 3.9 Kirkpatrick 4 Adults

Author	Accredited programme	Nature of the training	Period studied	Significant improvement in patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Murphy and Fitzsimmons 2004	Yes ILS	Not stated	1999 – 2000 and 2001 – 2002	Not stated	Not stated	Not stated	No	No difference in personnel who inserted mask or defibrillated
Seidlein and Bridges 1993	No	6 hours simulation	6 month period Aug 1987 to January 1987 compared to 1985	No		No	No	
Spearpoint et al 2009	Yes ILS	1 day Lectures simulation	January 2002 to December 2007 – training ongoing during this period	Yes	Increase in survival to return of spontaneous circulation P=<0.005	Reduced deaths at cardiac arrest over time period (p<0.0002) Survival to discharge after emergency call increased to 39% (2007) from 28% (2004) P< 0.005	Not stated	Not stated
Van Olden et al 2004a	Yes ATLS	Not stated	May 1996 to September 1997 pre-course and December 1997 to April 1999 post-course	Yes	Significant reduction in mortality 24.2% to 0% in first 60 minutes following resuscitation	Yes	Not stated	Not stated
Van Olden et al 2004b	Yes ATLS	Not stated	Compared period pre-training (June 1996-November 1997) to post-training (January 1998 to July 1999)	Not stated	Not stated	Not stated	Yes	10 (out of 14) procedures were performed better post-training and management scores increased from 4.2 pre-training to 5.8 post-training (P<0.0001)

ATLS- Advanced Trauma Life Support, ILS-Immediate Life Support, P- P value.

Table 3.9 Kirkpatrick 4 Adults continued

Author	Accredited programme	Nature of the training	Period studied	Significant improvement in patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Vestrup et al 1988	Yes ATLS	Not stated	Compared periods of pre-training (April 1983 to March 1984) to post training (April 1985 to 1986)	Not stated	Not stated	Not significantly different	Yes	Significant increase in rectal examinations for trauma patients P=0.03
Woodall et al 2007	Yes ACLS	Lectures clinical placement	January 2000 to December 2002 Compared resuscitation outcome of paramedics ACLS trained with those not	Yes	Pulse on admission more likely in ACLS trained (21%) compared to non-trained (8.5%)P= 0.0001	Yes Increased survival to discharge in ACLS trained (6.7%) versus non-trained (4.66%) P=0.03	Yes	Quicker mean time to first shock in ACLS trained (9.44 minutes) vs non-trained (10.07 minutes)

ACLS-Advanced Cardiac Life Support, ATLS- Advanced Trauma Life Support, P- P Value.

Table 3.9 Kirkpatrick 4 Adults continued

3.5.4 Summary of findings from Kirkpatrick 4

Most of the studies reporting outcomes at Kirkpatrick 4 level were carried out over many years – with a period prior to SRT being introduced (typically 2-3 years) being compared with one after its introduction. From these there is overwhelming evidence from the reported studies that the introduction of SRT within an institution has a direct positive impact on mortality and also on clinical management. The majority of SRT that were delivered were accredited programmes which include a mixture of lectures and simulation. There were no clear differences in outcomes between accredited and non accredited training programmes.

Chapter 4

NLS Study Results

4.1 Results of the NLS Skill Retention Study

Recruitment commenced on the 3rd of May 2007 at a registered United Kingdom NLS course centre (Liverpool Women's Hospital) and continued until the 19th March 2009. This included a total of 13 NLS courses. In total 294 candidates attended the courses over this time. Out of these, 173 candidates consented to take part in the study. Due to incomplete consent forms, or living outside of the pre-designated testing area (50 miles radius from Liverpool Women's Hospital), only 167 of these were eligible for retesting at a later date. Candidates comprised midwives, including labour ward managers, neonatal nurses, one resuscitation officer, and doctors (ranging from foundation doctor to consultant). A breakdown of these showed that 39 (23%) were midwives, 73 (44%) were nurses, one (<1%) was a resuscitation officer and the remaining 54 (32%) were doctors. Table 4.1 details the NLS courses included in the study and the numbers of each discipline recruited for each course.

Table 4.1 Course details

Date of Course	Number of Attendees	Number Consented	Total number recruited and eligible	Total number of midwives	number of midwives recruited	Total number of doctors	number of doctors recruited	Total number of nurses	number of nurses recruited	Total number of resuscitation officers	Number of resuscitation officers recruited	Reasons for Not using	Number actually seen	Number followed up
03/05/2007	22	12	12	1	0	14	6	7	6	0	0	lived outside area	4	3
17/09/2007	24	15	13	3	3	4	2	17	8	0	0	lived outside area	9	6
29/10/2007	22	14	15	3	2	6	5	13	8	0	0	lived outside area	5	2
12/11/2007	23	14	15	2	2	4	3	17	10	0	0	lived outside area	10	8
28/01/2008	22	19	17	7	5	7	7	5	4	1	1	Lived outside area	8	5
18/02/2008	22	19	13	2	4	9	4	11	5	0	0	lived outside area	3	1
17/03/2008	23	7	7	8	2	5	2	10	3	0	0	lived outside area	0	0
12/05/2008	23	12	13	4	3	4	2	15	8	0	0	lived outside area	4	2
16/06/2008	22	6	6	7	3	5	2	10	1	0	0	lived outside area	3	3
14/07/2008	22	12	12	5	2	9	7	8	3	0	0	lived outside area	5	3
22/09/2008	23	14	14	10	9	7	3	6	2	0	0	lived outside area	5	5
29/01/2009	22	14	17	1	1	9	8	12	8	0	0	lived outside area	6	5
19/03/2009	24	15	13	3	3	6	3	15	7	0	0	lived outside area	5	0
Totals	294	173	167	56	39	89	54	146	73	1	1	N/A	67	43

Of the 167 candidates eligible, 67 (40%) were tested at 3-5 months after the course. Out of these candidates, 38 (57%) had undertaken the NLS previously. For 29 (43%) of the candidates, this was their first attempt at the NLS course. Out of the 67 candidates tested, 16 (24%) were midwives, 33 (49%) were nurses, one (<1%) was a resuscitation officer and the remaining 17 (25%) were doctors. The reasons for this smaller number of actual recruits tested from the 166 who consented were; living outside the testing area, incorrectly completed consent data forms, sickness, maternity leave and last minute change of shift. Two candidates withdrew from the study within a week of attending the NLS course due to retirement prior to the retest date. A significant drop-out was anticipated and therefore the projected sample size was achieved.

The median testing time from the NLS course to the first retest at 3-5 months was 108 days (range 64 to 145 days). The median number of days from the NLS to the second retest at 12-14 months was 342 (range 234 to 450 days). The median number of days from retest one (3-5 months post-NLS) to retest two (12-14 months post-NLS) was 263 days (range 143-349 days).

Out of the 67 candidates tested at 3-5 months, 26 (39%) passed the airway test on their first attempt. Of the 41 candidates re-tested, 34 (51%) passed on retest and seven (10%) failed. There were numerous reasons for failure on the first attempt noted during the airway test (some candidates having more than one reason). These were: not assessing the heart rate at the correct times, not changing the wet towel, not asking for chest movement, incorrect timing of chest compressions, incorrect insertion of the Guedel airway, choosing the incorrect mask size, not covering the baby and intubation without resuscitation. No candidates failed for incorrect jaw- thrust technique. A breakdown of these is shown in Table 4.2. In the seven that failed overall this was due to a combination of one or more of: not assessing heart rate (5), not asking for chest movement (3), incorrect timing of chest compressions (1) and incorrect insertion of the Guedel airway (1). No candidate failed to demonstrate adequate jaw thrust at 3-5 months.

Of the 67 tested 3-5 months post NLS, 43 (64%) were retested again at 12-14 months. The reasons for not retesting the other 24 candidates at 12-14 months are shown in Table 4.3. Out of the 43 candidates tested, 19 (44%) passed on their first attempt. Of the 24 re-tested 22 (51%) passed on retest and two (5%) failed (both for not assessing heart rate following inflation breaths). The main reasons for failure on the retest at the first attempt at 12-14 months are shown in Table 4.4. (Some candidates had more than one reason). No candidate failed to demonstrate adequate jaw thrust at 12-14 months.

Reasons	Total	Percentage (of n=41)
Not assessing heart rate	21	51
Not changing wet towel	12	29
Not asking if there was chest movement	11	27
Incorrect timing of chest compressions	9	22
Incorrect insertion of Guedel airway	9	22
Not assessing colour and tone	2	5
Choosing incorrect mask size	1	2

Table 4.2 Reasons for failure on retest at 3-5 months (n=41)

Reasons for not retesting	Total (n=24)
Failure of first retest	7
Change of job location	7
Maternity leave	4
Unable to contact	2
Changed shift on retest day	2
Sickness on day of retest	2

Table 4.3 Reasons for not retesting at 12-14 months (n=24)

Reasons for failure of retest at 12-14 months	Total (n)	Percentage (of n=24)
Not assessing heart rate	11	46
Incorrect insertion of Guedel airway	12	50
Not changing wet towel	11	46
Not asking if there was chest movement	7	29
Incorrect timing of chest compressions	4	17
Not assessing tone	4	17

Table 4.4 Reasons for first failure on retest at 12-14 months (n=24)

Out of the total number of candidates tested on two occasions (n=43), 11 (26%) passed on their first attempt on both occasions. A total of five (12%) passed on their first attempt at 3-5 months and on their second attempt at 12-14 months. Seven (16%) passed on their second attempt at 3-5 months and on their first attempt at 12-14 months. Only two (5%) passed on their first attempt at 3-5 months and failed at 12-14 months.

Out of the total 43 candidates tested at 3-5 months and 12-14 months, 18 (42%) passed on retest on both occasions. A total of 14 (33%) of these failed for the same reason on both tests. However, nine (21%) also had other accompanying reasons for which they failed.

When candidates were asked how many resuscitations they undertook on average per month, 24 (36%) stated that they attended less than one resuscitation per month, 24 (36%) one to five per month and 19 (28%) attended more than five per month. Fifty-one (76%) of the 67 candidates retested were given in-house resuscitation updates on an annual basis.

The demographic data, collected from each candidate prior to the retest at both 3-5 months and 12-14 months was analysed using Fisher's Exact Test, to examine possible associations between certain variables and whether candidates passed on their first attempt on retesting at both 3-5 months and at 12-14 months (A copy of the form can be found in Appendix 8).

At 3-5 months, 67 demographic data forms were fully completed. At 12 -14 months, 38 forms were fully completed and returned out of as possible 43. For those passing on the first attempt at 12-14 months (n=19), 15 forms were completed for the frequency of resuscitation training and 16 for the number of resuscitations attended per month.

The possible association between the number of resuscitations candidates were exposed to per month and whether they passed on their first attempt at

resuscitation at 3-5 months was explored (Table 4.5). More candidates (nine out of 19 (47%) passed when they had been exposed to more than five resuscitations per month compared to nine out of 24 (38%) candidates who had been exposed to less than one per month. This trend is not, however, statistically significant (P=0.669).

At 12-14 months the data set is smaller (Table 4.6). The data, however, suggests that if candidates are exposed to more than five resuscitations per month, they are more likely to pass on their first re-test attempt at this time. Six out of seven (86%) candidates exposed to more than five resuscitations per month passed compared to five out of 18 (28%) candidates, who were exposed to less than one resuscitation per month. This association is statistically significant (P=0.029).

The frequency of resuscitation updates candidates attended and whether they passed on their first attempt at resuscitation at 3-5 months was also considered (Table 4.7). The data suggests that if candidates are offered resuscitation training at six monthly intervals, they are more likely to pass the retest on their first attempt, than if they are offered training less frequently. This is statistically significant (P=0.022).

This may also be true for the retest at 12-14 months (Table 4.8), although the data set for this is smaller and the difference is not statistically significant (P=0.416).

Number of resuscitations per month	Number of candidates who passed first time at 3-5 months (n)	Total (n)	Percentage
<1	9	24	38
1-5	8	24	33
>5	9	19	47
Total	26	67	39

Table 4.5 Number of candidates passing on their first attempt at 3-5 months after the NLS according to number of resuscitations candidates are exposed to each month

Number of resuscitations per month	Number of candidates who passed first time at 12-14 months (n)	Total (n)	Percentage
<1	5	18	28
1-5	4	13	31
>5	6	7	86
Total	15	38	39

Table 4.6 Number of candidates passing on their first attempt at 12-14 months after the NLS according to number of resuscitations candidates are exposed to each month.

Frequency of resuscitation updates	Number of candidates who passed first time at 3-5 months (n)	Total (n)	Percentage
6 monthly	9	13	69
Yearly	15	50	30
4 Yearly	0	1	0
Never	2	3	67
Total	26	67	39

Table 4.7 Number of candidates passing on their first attempt at 3-5 months after the NLS according to number of resuscitations candidates are exposed to each month.

Frequency of resuscitation updates	Number of candidates who passed first time at 12-14 months (n)	Total (n)	Percentage
6 monthly	4	9	44
Yearly	10	28	36
4 Yearly	1	1	100
Never	1	1	100
Total	16	39	41

Table 4.8 Frequency of resuscitations training updates candidates are exposed to and whether they pass first time on retest at 12-14 months

4.2 Analysis of confidence scores

Prior to each retest all candidates were asked to score themselves on eight questions, based upon a Likert scale scoring system (Appendix 9 for confidence questionnaire). Analysing individual questions on the confidence questionnaire would have been inappropriate, owing to the small numbers of candidates in the fail groups, therefore, from the responses; overall median confidence scores were calculated (Table 4.9)

At 3-5 months there were seven candidates who failed the retest. Among the 60 candidates that passed, all confidence ratings were returned. For the group who failed, the median confidence score was six (inter-quartile range 5.0 to 7.0). For the group who passed, the median was six (inter-quartile range 5.0- 6.0). There were some low scores in the larger group. The data do not therefore suggest that the overall confidence levels are lower in the group that failed the test.

At 12-14 months there were two candidates who failed the test. Among the 41 candidates that passed, there was one data set for confidence scores not returned. The two mean confidence values in the group who failed were 5.0 and 7.0. For the group who passed the median confidence score was 3.0-7.0 (inter-quartile range 5.0-6.0). There is little analysis that could be done on this data as the samples were too small, but the overall results were not inconsistent with the findings for the test at 3-5 months.

Question numbers	Median score at 3-5 months PASS(N=60)	Median score at 3-5 months FAIL(N=7)	Median score at 12-14 months PASS(N=41)	Median score at 12-14 months FAIL(N=2)
Q1	6	6	6	6
Q2	5	5	5	6
Q3	6	5	6	6
Q4	5	5	5	6
Q5	6	7	6	5.5
Q6	6	6	6	6
Q7	6	6	6	6
Q8	5	5	5	6
Median of the median values (IQR)	6 (5-6)	5.5 (5.5-6.75)	6 (5-6.125)	6 (values 5 and 7)

Table 4.9 Confidence values at both retests

4.3 Multisource feedback

At 3-5 months, 280 forms were received regarding 38 of the 60 candidates who passed the test. The median number of forms received for each candidate in this group was five (range one to 18). A total of 40 forms were received regarding five of the seven candidates who failed the test. The median number of forms received for each candidate in this group was seven (range one to nine). The median score for each question for each candidate was calculated and following this the median for each question for each of the pass and fail groups was then calculated (Table 4.10).

At 12-14 months, 145 forms were received regarding 20 of the 41 candidates who passed the test. The median number of forms received for each candidate in this group was 5.5 (range 1-17). A total of 16 forms were received regarding one of the two candidates who failed the test. The median score for each question for each candidate was calculated and following this the median for each question for each of the pass and fail groups was then calculated (Table 4.11).

As the data sample was so small for those who failed, statistical analysis for peer review was inappropriate.

Question number	Median (range) value of the median scores for each candidate who passed (n=38)	Median (range) value of the median scores for each candidate who failed (n=5)
Q1	7 (0-7)	6 (0-7)
Q2	6 (0-7)	6 (0-7)
Q3	6 (0-7)	0 (0-6)
Q4	3 (0-7)	0 (0-6)
Q5	7 (0-7)	6.5 (0-7)
Q6	7 (0-7)	6 (0-7)
Q7	7 (0-7)	3 (0-7)
Q8	6.25 (0-7)	5.5 (0-6)

Table 4.10 Multisource feedback scores at 3-5 months

Question number	Median (range) value of the median score for each candidate who passed (n= 20)	Median scores for one candidate who failed (n= 1)
Q1	7 Range (0-7)	7
Q2	4.75 Range (0-7)	7
Q3	0 Range (0-7)	7
Q4	0 Range (0-7)	7
Q5	7 Range (0-7)	7
Q6	7 Range (0-7)	7
Q7	6.5 Range (0-7)	7
Q8	6.5 Range (0-7)	7

Table 4.11 Multisource feedback scores at 12-14 months

Chapter 5

Study Limitations and Possible Sources of Error

5.1 Systematic review

The literature search for this review was confined to the English language literature. This is often standard practice for systematic reviews, making it possible that articles with relevant data (in another language) which could have contributed to the results may have been overlooked. However, there is no evidence of a systematic bias from the use of language restrictions in systematic reviews (Morrison et al 2009) and the strategy in this review avoided the long potential time delay that obtaining translations may have entailed. By the nature of qualitative analysis of themes, the quality of the final data collection and analysis depends on the integrity and unbiased approach of the researcher. Bias is possible if the researcher approaches the subject with preconceived notions which may affect the findings. In order to minimise this, validation of the researcher's (CM) analysis was carried out by triangulation of findings with those of others in the review group.

5.2 Skills retention study

5.2.1 Consent and possible bias

Recruitment took place at a single centre during the NLS study day. The first information the candidates received about the study was in their welcome packs at registration. They were also verbally informed about the study and asked to read the information leaflet prior to the course commencing. A more detailed description of the study took place following the course introduction. The way consent was obtained may have affected the demographics of those taking part. The consent process was on an opt-in basis. Informing the candidates with information in their pre-course packs which are sent out approximately two weeks prior to their attendance would have allowed more time for them to make their decision about taking part and may have increased the number of candidates who consented. It is also possible that candidates would have felt more comfortable declining consent if they had more time to consider, thus reducing the overall number of candidates consenting. Only two people, however, dropped out of the study after initially consenting.

An alternative to asking candidates to opt in to the study as part of the consenting process would have been to allow candidates to opt out, if they did not wish to take part. They would therefore have been informed that there was a possibility that any one of them would be retested at the two designated times unless they declined. This approach raises ethical issues: on the one hand resuscitation practice and competence is a standard requirement in line with clinical governance and it might be presumed that retesting was acceptable, on the other hand, more people might have opted out of a study they felt pressurised into being part of. The opt-out option was not part of the ethics application and would have thus not been possible in this study.

5.2.2 Population

A large proportion of candidates are based at the course centre where recruitment took place (Liverpool Women's Hospital) therefore most candidates were recruited from this one centre. As this centre is a regional neonatal intensive care unit and hosts a large obstetric department, there was the potential that the candidates recruited from here may have had more experience than others from smaller units. This may have influenced the number of candidates passing on retesting. Owing to the small numbers of candidates distributed around other centres, this issue could not be explored further by statistical analysis.

The NLS courses were largely attended by nurses and midwives. Although there were some medical trainees among the candidates, all grades of medical staff were not equally represented. The relatively small number of trainee doctors and consultants attending the courses therefore meant that comparison of outcomes between professional groups and between grades of medical staff could not be meaningfully performed.

5.2.3 Testing

A significant number of the candidates who took part in the study were based at Liverpool Women's Hospital, where the NLS course, used for recruitment, took

place. As a result many of the candidates were working professionally, on a day to day basis with the author (CM) and the other instructors that acted as the second re-tester, giving rise to the possibility that they may have been aware that retesting was taking place. There is a possibility that they may have been more prepared for the retest than candidates in other centres although the date or time of their re-test was still not known to them until it actually happened. In other centres, however, there could have been the possibility that seeing someone being retested triggered other candidates in that centre to remember that they had consented to the study thus influencing them to prepare for their retest.

Re-testing used the low fidelity mannequin used on the NLS course. As this is not a particularly sophisticated piece of equipment by current simulation standards, it may have been more difficult for candidates to suspend disbelief on retesting compared to on the actual course which may have influenced the way they performed at re-testing. Following the 'airway test' algorithm might have been more difficult for candidates during a 'one-off' when they had been taken unprepared from the clinical area compared to when they were 'zoned-in' to the simulation on the NLS course. It can not necessarily be inferred that a candidate who did not 'pass' the airway test in this study would not be competent at resuscitation in real life. Essentially they were being tested in a 'surprise' simulation – there could be other factors at play in a real resuscitation and not present in the simulated environment which may result in a different performance in real life.

It was impossible to be aware of, or influence, candidates receiving their six monthly or annual resuscitation updates between the NLS course and the re-test. This 'interim training' may have 'boosted' their skills and influenced their performance at the re-test.

There were sometimes logistical problems with re-testing. As two people were always required for the re-testing, it was often difficult to find a registered NLS

instructor who was available when the candidates were on duty. Occasionally the two testers arrived to perform the test to find that the candidates were either off sick or they had changed their shifts. As the candidates were not aware of the booked retest, it was not possible for them to have notified the testers to rearrange. However, once staff in the centre were aware that the testers had arrived, there was the possibility that the candidate could have been forewarned and thus would prepare for re-testing. Candidates in this situation were, therefore, excluded from the study, making recruitment of appropriate numbers and follow- up a longer process.

The sample size for the group tested at 12-14 months was smaller (n=43) than that at 3-5 months (n=66). One reason for this was that those who failed at 3-5 months (n=7) had exited the study. The remaining 16 participants were lost to follow-up because they had moved to a new position and had not left a forwarding contact number. It is possible that this group may have performed differently at 12-14 months than those that were tested. A larger sample size at follow-up at 12-14 months, with correspondingly more candidates who failed may have allowed more detailed statistical analysis to be performed comparing those who passed versus those who failed.

5.2.4 Funding

As funding was limited for travel expenses, it was only possible to re-test candidates who lived within a fifty mile radius from the NLS course centre. This naturally excluded some of the candidates from re-testing. If more funding had been available it might have been possible to have increased the sample size on both retests. There was no sponsorship from any third parties for this project or conflict of interest from the Newborn Life Support fund which supported, in part, this research project.

5.2.5 Peer review

There is always the possibility that, when peer review questionnaires are completed, they may not truly reflect the candidates' clinical ability.

Occasionally, some people are hesitant to score a peer honestly and in doing so may score either too high or too low.

Despite each line manager being given 20 peer review forms with stamped addressed envelopes to distribute to their staff the return rate was very poor. This made meaningful statistical analysis of confidence and competence impossible. It was initially thought that candidates could distribute the peer review forms to their colleagues themselves. This has a potential for biased feedback to occur (as forms are generally given to friends or colleagues who are perceived to give favourable opinions), therefore, it was decided that the forms would be given to their line managers for distribution. There was no system in place to encourage line mangers to 'chase-up' non-returned forms – these individuals were spread around many different centres and did not keep a record of who they had given feedback forms to, making it impossible to get a better return of these forms.

5.2.6 Study methodology

The skills retention study used only quantitative data collection and analysis. The main reason for this was that the study was pre-designed and had received ethics approval prior to the author being involved. The mixed method approach could have been utilised, especially when obtaining data on the candidates' confidence in performing resuscitations. Future research could be undertaken which utilises a mixed methods approach. This would involve the testing of both knowledge and skills over time, but using simulation and video analysis as part of the data collection. Coupled with this would be a candidate interview or questionnaire which would explore their feelings on the course structure and provision and assess their perceived competence in resuscitation provision both prior to the teaching and over a specific time period. Using this added qualitative approach could have provided further rich data about individuals and their competency.

Chapter 6

Discussion

6.1 SRT programmes and retention of knowledge and skills

The overall aim of a SRT programme is to enable the individual to be a safe practitioner who offers optimum standards of evidence based practice and works well in the clinical setting as part of the multidisciplinary team. The majority of SRT is, however, currently facilitated away from the clinical setting, usually in a skills centre or training and education department, on an allocated training day. Unless fully equipped to simulate the clinical setting, the course may, itself, become unreal and based on a false environment which, may not be conducive to transferring of learning to clinical practice.

There were few characteristics of individual training programmes identified within the systematic review that influenced the retention of knowledge and skills at a later date. Some studies reviewed have suggested, that factors which may ameliorate deterioration in knowledge and particularly skills, might be the provision of regular booster or refresher sessions and focusing on discrete skills as part of a task during training and at follow up (Ander et al 2004, De Regge et al 2005, Hiedenreich et al 2004, Kovacs et al 2000, O'Donnell and Skinner 1993, and Wayne et al 2006).

Deliberate practice involves repeating a task until competence is acquired, thus encouraging 'mastery' (Ericsson 2006, McGaghie et al 2011). It has been suggested that, incorporating this into simulation sessions will improve competence (McGaghie et al 2011). Mastery has been referred to by the author as the strategical implementation of a skill in an effective manner. Deliberate practice did not appear to have been specifically or consistently employed in the SRT programmes reviewed. Incorporating this into SRT programmes may involve more time allocated for the programme (some candidates taking longer to achieve competence) and a higher instructor – candidate ratio to ensure that all participants have achieved mastery.

Much of the training offered in SRT consists of lectures with simulation, using a mannequin and is thus very similar across accredited training programmes and

even in those studies that reported non-accredited programmes. Relevant lectures may take place over a whole morning and usually cover the information documented in the course manual. As previously discussed, educationally, this SRT approach seems to be optimal as it offers experiential learning (Kolb 1984) through practical simulation experiences, aimed at supporting experiential and reflective learning (Issenberg et al 1999) and incorporates many facets within the simulation scenarios which facilitate learning (Issenberg et al 2005). Despite this, the review and the NLS study, reported here, suggest that the ability to demonstrate knowledge and skills at a later date does not seem to be sustained.

In the review, there were no differences with respect to the education provided or assessments used in studies where knowledge had deteriorated, compared with those where it was retained. Although it is possible that knowledge retention (given that knowledge is necessary to enable an individual to use their skills in resuscitation) may result in an improvement in clinical resuscitation practice, there was no evidence available that demonstrated this. However, the ability to demonstrate appropriate resuscitation practice in a simulated scenario is more likely than not to deteriorate after SRT as early as three months after training. Therefore, even if knowledge retention did improve clinical resuscitation practice, it appears not to result in maintenance of appropriate practical skills in a simulated scenario.

The study assessing skills after the NLS course carried out by myself demonstrated a marked deterioration in both knowledge and skills as early as three months attendance on the NLS course confirming the findings of many of the other studies in the review. At 3-5 months and 12-14 months post training, the two main reasons for candidate failure on the airway test were; changing the towel and auscultation of the heart rate, especially following the delivery of the inflation breaths. It is possible that, (as this was a low fidelity simulation which used dry towels and a mannequin) candidates may have been more likely to remember to change a wet and soiled towel from the baby in the clinical setting. The assessment of the heart rate is a structured part of the resuscitation process

which alters the subsequent management. In the clinical setting, the assessment of the heart rate is usually made as it becomes part of the Apgar scoring. It is also something that is assigned to an individual team member during a large resuscitation. As the assessment process in this study was very structured, using a tick box system requiring the candidate to respond (alone) in a prescribed way with a low fidelity mannequin it may have altered the way the candidates worked through the resuscitation algorithm as it may not have closely resembled their real clinical experience and practice. The issues of not changing the wet towel and not assessing the heart rate reinforce the need for a better understanding of the impact of the NLS course on candidate's future clinical practice.

The results from the study also showed that, at 3-5 months and 12-14 months post training, the majority of candidates who passed the airway test on their first attempt at retest had been exposed to more than 5 resuscitations per month. This suggests that, as perhaps might be expected, the more resuscitations candidates were exposed to in the clinical area, the more likely they were to pass the airway test. For those candidates working in small district general hospitals, it is less likely that they will be involved in resuscitations on a regular basis compared to those working in a large regional unit. As frequency of resuscitations is not predicable and depends greatly upon work place, clinical role and opportunity, more in-house skills and drills sessions could be offered to health professionals.

At 3-5 months and 12-14 months, the majority of candidates who passed the airway test on their first attempt had been exposed to resuscitation training on a 6 monthly basis thus they were effectively receiving booster sessions. The suggestion from the review that booster sessions may help to retain skills is supported by this finding. The current recommendation set by the U.K. Resuscitation Council is that health professionals repeat the NLS on a 4 yearly basis. Mandatory NLS in-house training for resuscitation is offered, in the main,

on an annual basis. Doctors who change posts every six months are often more fortunate and are offered a booster training session at each new appointment. As candidates who were offered training more frequently were more likely to pass on their first attempt at retest, seeming to retain knowledge and skills longer, it might be advantageous for a short refresher SRT programme as a booster session to be offered in the interim period. Offering a formal SRT programme would allow for consistency of the training which might not be present in in-house sessions. Whether these strategies of 'in-house' drills and short refresher programmes might improve clinical practice, however, is not known, although there was some evidence from the systematic review that they might (Kovacs et al 2000, O'Donnell and Skinner 1993, and Wayne et al. 2006). There is, however, no evidence available from the review to suggest how long after initial training the booster or SRT sessions should take place.

The results of this study could infer that the content of SRT programmes and the NLS, in particular, need reviewing. The scenario sessions within the NLS have recently been re-designed and renamed as simulations but are only simulations in the broadest sense. They do not have high fidelity equipment and there is a great deal of emphasis on 'make believe' rather than simulating a real like resuscitation. A simple renaming and slight change in structure of delivery is not enough for these to be effective.

As the retention of both knowledge and skills in resuscitation practice is necessary to be an effective practitioner, it is possible that the structure and programme of the NLS could be re-designed to change education delivery from an 'en-masse' approach to a tailored delivery of the simulations and skills stations for specific groups of health professionals. If this were to take place, it is possible that the knowledge and skills gained whilst on the course would be retained longer and applied more effectively in the clinical setting. This is an area where future research and evaluation of the NLS course could be carried out.

SRT could be taught as a 'one off' training session, away from the clinical area, which would teach the theory to enhance the practice and the clinical skills required to offer optimum resuscitation skills. The use of simulation with individuals working within their own clinical capacity would enhance the experience which could be repeated as booster sessions within the individual's clinical setting on a more frequent basis and could be a recognised part of their continuing professional development.

The use of in-house 'mock' simulations, on a weekly basis, might aid in the retention of knowledge and skills to increase performance when a resuscitation event does take place. In these, health care professionals would be able to work within their individual sphere of practice and should be assessed on this rather than a tick box system. These should become part of the daily practice, when possible, and act as a booster session to enhance lifelong learning.

The results from the study and the review suggest that intervention, as early as three months, with participants, might be appropriate. This not only has cost, but human resource implications. It would not be practical to offer three monthly cycles of booster resuscitation sessions at institutions- rather it might be more feasible to embed aspects of deliberate practice (including resuscitation drills) at staff induction sessions and into daily work. As well as further simulation sessions, other work has suggested that 'reinforcement' in the clinical area, to strengthen behaviour, will also improve competence (Burns 1995).

If accredited SRT was continued 'in-house' in short booster simulations, then health professionals would be guaranteed appropriate ongoing evidence based training. Both knowledge and skills could be retained to a high standard which could be maintained through ongoing assessment. The difficulty would be ensuring that the training and assessment continued to be delivered at optimum levels. This could be achieved through external assessment on a regular basis. If institutions are to organise and run their own in-house SRT programmes,

however, it is important that they ensure that they incorporate appropriate educational approaches into these.

Simulation, however, needs to be profession specific. Currently, on the NLS, all candidates are required to participate in the insertion of a UVC. Although this is not part of the final summative assessment, it is one of the skill stations which junior nursing candidates often express their anxiety about due to their lack of knowledge and experience. This may lead to a negative learning experience for the individual and could affect their overall learning in other areas of the course. As it is unlikely that these skills will be practiced by the junior nursing staff within the retraining time frame of four years, as it is outside of their remit in the clinical area, it must be questioned how an accurate assessment can be made if a candidate does not truly understand the skill being assessed. If the practical training sessions, including the skill stations, were run as part of a full resuscitation simulation, people could participate appropriately within their job capacity and in turn be assessed accordingly.

No specific characteristics of the SRT programmes have been shown to directly influence the retention of both knowledge or skill retention (all having a similar course content and structure). As all candidates are health professionals and mature learners, more responsibility to pre-course learning could be placed upon the individual and the course content could involve more simulations, rather than didactic teaching sessions.

In the context of SRT programmes, behaviour change (achievement of resuscitation competency) may not be permanent: it is possible that learning can be exhibited in the assessment process following a SRT programme, but there may be factors other than the SRT which are responsible for the medium or long term sustenance of the learning (maintenance of competency) (McGaghie et al 2011). One of these may be combining simulation –based medical education as on a SRT programme with deliberate practice – thus ensuring mastery at a particular skill (Ericsson 2006, and McGaghie et al 2011). However, those

individuals who are not frequently exposed to resuscitation situations after SRT may still lose skills and/or confidence quickly. This problem is illustrated by David and Prior-Willeard (1993) who assert that, survival to hospital discharge depends greatly upon the initial treatment a patient receives during resuscitation, yet they suggest that, based on a clinical assessment of doctors about to take their MRCP exam, the basic life support skills of many doctors, nurses and medical students (who have previously received resuscitation training) is of poor quality.

No studies have assessed possible behavioural changes in the candidates following SRT. Such studies may aid in the formatting of a new training programme, as a behaviour change, may aid in long term retention. It is, however, difficult to effectively assess the retention of both knowledge and skills over time as it depends upon a number of variables. If candidates are not assessed prior to the training or they are assessed differently pre-training, immediately post-training and later, post training, then it is difficult to determine the true extent of the retention for the individual.

The logistics of changing the training programmes is not simple but if the long term benefits were clear then there would be less resistance to change. It is unlikely that SRT programmes will alter this radically in the near future and more likely that there will be a great resistance to the change from many people. However, if current research is suggesting the lack of retention over time, it is inevitable that change is afoot.

6.2 Assessment process within the NLS

Assessment, based on a continuum and including constructive feedback and reflection from the individual may, in turn, act in ensuring continued professional development for the individual. All studies within the review tested knowledge using short answer questions or MCQ's. Assessment of skills was usually made through mock simulations and in some cases these were videoed (Gerrard 2007 and Quann 2001).

Candidate's competence is assessed on the NLS in the form of a post course MCQ and an airway test. The NLS 'primes' candidates throughout the day to pass the final 'airway test' and the overall high success rate seems to support this approach. However, this prescriptive testing does not always ensure that skills are sustained over time, as shown by our study and confirmed by the review, and furthermore may not be transferred into the clinical setting. To establish if SRT programmes are effective in offering candidates both the knowledge and skills to be transferred into the clinical setting, candidates need to be assessed in practice, within the clinical area, on an ongoing basis.

The NLS study assessed candidates at 3-5 months and 12-14 months post the initial training using the NLS 'airway' test in the candidates' own workplace, using the same equipment they were tested on during the SRT. Candidates' confidence was assessed through a questionnaire completed prior to testing but no written test or MCQ paper was completed at these times. As this test is fairly prescriptive it resulted in some candidates requiring retesting, even though their practice would not necessarily have resulted in increased morbidity or mortality for the patient.

The only results candidates are ever informed of on the NLS course are their pre- and post-course MCQ marks and a pass or fail for the airway test. Candidates' performance is marked during the skill stations and simulations but they are never issued their marks or faculty comments. These are under-utilised opportunities for feedback and may make candidates understanding areas for improvement more difficult.

Current practice requires candidates to read the resuscitation manual and complete the pre-course MCQ prior to attending. As these results do not contribute to the overall mark and are usually dependent upon the candidates' commitment to learn, it is questionable as to the overall relevance and significance of this part of the training. The completion of an MCQ prior to attendance does not help the assessors to determine the extent of the learning

that has taken place. Candidates do not have access to the manual for the final MCQ (being able to refer to it for the pre-test) and this is done under examination conditions so it is unlikely that valid comparisons between pre and post training can be made.

The literature has demonstrated that the use of video simulation is increasingly being utilised within medical training (Gelbart, Hiscock and Barfield 2010 and Carbine et al 2000). It is not, to date, used as part of accredited SRT programmes but has been used in research studies to assess knowledge and skill retention within the clinical setting (O'Donnell et al 2008). Video simulation of resuscitation allows health professionals to work through a simulated resuscitation with their peers, using appropriate equipment and high fidelity mannequins. As this has been recognised as an effective tool for knowledge and skill acquisition and short term retention it could be incorporated into SRT programmes and form part of in house booster sessions.

It is difficult to assess the long term retention of knowledge and skills in a high fidelity setting. Video assessment within the clinical setting may be a useful tool in assisting with this. The use of videoing resuscitations, followed by a critical review of the teams actions, may also assist in acting as a 'debrief' for the staff involved. The logistics of this, for example in neonatal resuscitation, would require verbal consent from all labouring women of videoing any possible resuscitation prior to the delivery as it would not be possible once help was required.

The assessment process following video simulation involves self and peer assessment. Although this can sometimes result in tension amongst staff, if used more frequently, would aid in optimizing the learning experience for all staff involved. As clinical exposure to resuscitations is variable and depends greatly upon work place, clinical role and opportunity, video assessment may be particularly useful to those not carrying out frequent resuscitations, although there is no evidence to support this at present.

Booster sessions after the NLS have not been independently assessed to determine their effectiveness. The NLS study reported here offered candidates who failed on their first attempt a mini booster session immediately following the test. It discussed, in brief, the airway opening manoeuvres available and informed the candidate of their reasons for failure allowing a brief time period for practice prior to retesting. It is possible that this may have assisted in a further number of candidates passing on their second attempt but was not part of the study analysis. On the NLS, all candidates who are unsuccessful on their first attempt are offered constructive feedback and a short booster training session prior to retesting. Frequent booster sessions for the individual may encourage a behavioural change by repetitive reinforcement but the effectiveness of this would require further assessment.

6.3 Confidence and Peer review

A number of studies within the review tested confidence at the end of the training, mostly in the form of a questionnaire or survey. This was performed post the training and assessment. Confidence was not tested over time in any of the studies. Apart from the exception of one study, who tested confidence but did not document the results of the confidence testing (Hoadley 2009), an increase in confidence for the candidates at the end of the training was reported, the majority of which were statistically significant (Dobson et al 2003, Featherstone et al 2005, Gerard, Scalzo, and Laffey, 2006, Marshall et al 2001, Owen et al 2006 and Quan et al 2001).

The NLS study tested the candidates' confidence prior to the retesting at 3-5 and 12-14 months post training but did not assess confidence immediately following the SRT. The results from the data collected showed little difference in the confidence scores for the candidates who failed and for those who passed, suggesting that lack of confidence did not necessarily equate to lack of competence. Also – perhaps more importantly – presence of confidence does not always equate with competence.

The confidence mean score for each question showed that, at both 3-5 and 12-14 months post training the lowest mean scores for confidence were for three of the questions (2, 4 and 8). These were; performing a jaw thrust, utilising a two person approach to ventilation and the insertion of a guedel airway. Interestingly, no-one failed for an incorrect single or double jaw thrust on any of the tests, but at 12-14 months the main reason for retest was for incorrect insertion of a guedel. This is possibly due to the fact that very few candidates utilise these manoeuvres in the clinical setting. Guedel airways are rarely routinely carried by community midwives. They do not have access to laryngoscopes and cannot, therefore, insert them appropriately. Therefore, for community midwives to retain this skill with no continuous exposure to it would be difficult and unrealistic. They would be perfectly safe in practicing a single or double jaw thrust or using a shoulder roll to keep the head in the neutral position, but they are required to demonstrate appropriately all the skills taught on the airway test, despite them not being equipped to carry them all out.

Neonatal nurses and midwives do, in the main, have access to the equipment for correct insertion of a guedel; the babies are, however, usually intubated if it has become difficult to achieve a secure airway. If candidates are less confident in this skill and are able to perform it inadequately, it is questionable that it should be part of the overall skills assessment and therefore, should be removed from the airway test. If candidates are learning a skill to simply pass an assessment, then both the knowledge and the skill will not be retained on a long term basis or ever used in clinical practice. This suggests that every attempt should be made to ensure that the SRT programmes are more suited to individual learning and practice requirements.

6.4 Organisational change and patient outcome

It is evident from data in the systematic review that the introduction of SRT programmes within institutions, where no previous training existed, has a positive effect on patient outcome (Arreola et al 2004, Camp, Parish and Andrews 1997, Dane et al. 2000, Moretti et al. 2007, Spearpoint, Gruber and

Brett 2009, Van Olden et al. 2004a, and Woodall et al. 2007) and subsequently leads to an improvement in clinical management (Arreola et al 2004, Camp, Parish and Andrews 1997, Makker, Gray and Evers 1995, Van Olden et al 2004b, Vestrup Stomorken and Wood 1988 and Woodall et al 2007). In particular, mortality rates are reduced, thus driving the need further for SRT to be a mandatory component of nursing and medical training and updates.

There is clearly a 'group' or institutional effect of introducing these courses. However, the relative benefits for sub-groups of different disciplines of healthcare practitioners are unclear. Given that there was no training prior to the introduction of SRT programmes into the institutions who reported improvement, it is likely that resuscitation practice within these institutions was at a low baseline, thus making improvement more likely to occur. There is no evidence available to assess whether further improvement might occur in institutions where all staff are trained (that is a higher baseline of resuscitation practice) and extra training offered prior to mandatory updates.

The NLS study did not specifically assess any possible effects of the training, on either service provision, or patient outcome; this is an area which requires further research. The effect on patient outcome or the organisation needs to be measured on a continuum, with regular audit and patient outcome data, not simply once following the implementation of a new training programme, which is currently the basis of the majority of the published studies. Any changes made to the SRT programmes require full evaluation to ensure their efficacy. The U.K. Resuscitation Council regularly review and update the SRT programmes but any possible effects upon the organisation or the patients don't appear to be frequently monitored.

Organisations require staff to offer a structured team approach to resuscitation and this must be emphasised during the training sessions for it to be effectively implemented into the clinical setting. The gold standard and thus the overall aim must be to decrease patient morbidity and mortality. Effective teamwork and an

understanding of each other's roles will assist in the delivery of optimum standards of care. Although the NLS encourages candidates to call for help and utilise it accordingly, it assesses candidates working as an individual and leading a resuscitation which might not be the case for the candidate in clinical practice.

It is questionable, whether the improvement in patient outcome following attendance on an SRT programme, is simply as a result of an increase in knowledge for the individual, or from more effective teamwork and a deeper understanding of each other's roles. If it is due to the latter, then an increase in both mock simulations amongst health care professionals is required to assist in boosting team work and reinforcing knowledge, as well as simulation courses aimed at emphasising the human factors aspects of team working is required. The latter are likely to increase in the UK as there is a more coordinated approach to simulation training being developed, supported by postgraduate Deaneries.

6.5 Conclusions from the systematic review and the research study

1. The literature suggests that SRT programmes result in an improvement in knowledge and skills in those that attend them.
2. Deterioration in skills and to a lesser extent knowledge is highly likely as early as 3 months following SRT.
3. There is a small amount of evidence that booster or refresher sessions may improve an individual's ability to retain resuscitation skills after initial training. However, the timing and frequency of these in different disciplines has yet to be determined.
4. Ensuring clinical staff of all disciplines in a healthcare institution, where no previous training existed, are trained in resuscitation will improve clinical management during, and mortality rates after resuscitation attempts.
5. Where staff of all disciplines in a healthcare institution are trained in resuscitation, there is a need for research which investigates whether the learning that takes place on subsequent resuscitation courses results

attended by individuals from these institutions results in further behavioural change in the clinical area (that is a change in clinical practice) thus further improving resuscitation management.

6. There is an urgent need for research to determine whether deteriorations in skills after SRT as assessed by simulation correlates with deterioration of skills in clinical practice.
7. A booster session improves the immediate performance when assessment takes place directly after the booster, (as shown by the NLS study) but does not affect the longer-term retention of knowledge and skills.
8. The NLS study confirmed that both knowledge and skills (when assessed in the form of an airway test) significantly deteriorate as soon as three months post-training.
9. The assessment of knowledge and skills at 3-5 months post-training (in the form of an airway test) does not appear to assist with long term retention.
10. The results of prescriptive testing in a simulated environment may not be a true representation of clinical competence.
11. Candidate's confidence does not necessarily match their clinical competence.
12. Candidates are more likely to pass an airway test in a simulated environment if they are exposed to six monthly updates.
13. Candidates are more likely to pass an airway test over time if they are exposed to more than five resuscitations per month.
14. Prescriptive testing in a simulated environment may not be the optimum method of assessment long-term retention of skills and knowledge.

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Appendices

Appendix 1: Initial assessment of quality

Criteria		Yes (2/good)	Partial (1/fair)	No (0/poor)	N/A
Study aims					
1.	Is the hypothesis/aim/ objective of the study clearly & sufficiently described?	Easily identified in introduction/method. Specifies: purpose, subjects/target population, and specific interventions/ associations under investigation.	Vague/incomplete reporting *or* some info has to be gathered from parts of the paper other than intro/background/ objective section.	Question or objective not reported/ incomprehensible.	
Study design & sample characteristics					
2.	Is the study design well described & appropriate? *(If study question not given, infer from conclusions).*	Design easily identified, well described and appropriate.	Design and/or study question not clearly described, *or* design only partially addresses study question.	Design does not answer study question *or* design is poorly described.	
3.	Is the method of intervention group selection described and appropriate?	Described and appropriate.	Selection methods not completely described, but no obvious inappropriateness. *Or* selection strategy likely introduces bias but not enough to seriously distort results.	No information/ inappropriate information provided *or* selection bias which likely distorts results.	
4.	Are the characteristics of intervention group clearly described (i.e. age range, occupation)?	Sufficient relevant demographic information. Reproducible criteria used to categorise participants clearly defined.	Poorly defined criteria *or* incomplete demographic information.	No baseline/ demographic info provided.	

Criteria		Yes (2/good)	Partial (1/fair)	No (0/poor)	N/A
5.	Have the characteristics of participants lost to follow-up been described?	Losses adequately reported & not likely to affect results.	Losses not well reported, but small & not likely to affect results.	No information *or* losses large and likely to affect results.	No participants lost to follow-up.
6.	Are educational intervention(s) clearly described?	Defined and reproducible.	Partially defined, but insufficient detail to reproduce design.	Not described.	
7.	Is method of delivery of educational intervention and subsequent follow up clearly defined?	Sufficient relevant descriptive information. Reproducible criteria used to replicate intervention defined.	Poorly defined criteria *or* incomplete descriptive information.	No criteria/descriptive info provided.	
Data analysis & results					
8.	Are the main outcomes to be measured clearly described in the introduction/method?	Defined and measured according to reproducible criteria.	Definition leaves room for subjectivity, *or* not sure (i.e. not reported in detail, but probably acceptable). *Or* precise definition(s) are missing, but no evidence of major problems. *Or* instrument/mode of assessment(s) not reported.	Main outcomes first mentioned in results section. *Or* measures not defined/inconsistent/ poorly defined.	

9.	If possible, was an attempt made to blind those measuring the main outcomes of the intervention?	Assessor blind to intervention/study group.	Inadequate blinding: i.e. assessor may have been aware of group participant assigned to.	No attempt made to blind assessor.	Not possible/ appropriate – e.g. observational/ before & after study.
10.	Are population characteristics (if measured & described) controlled for and adequately described?	Appropriate control at design/analysis stage *or* randomised study with comparable baseline characteristics.	Incomplete control/ description. *Or* not considered but unlikely to seriously influence results.	Not controlled for and likely to seriously influence results.	
Criteria		**Yes** **(2/good)**	**Partial** **(1/fair)**	**No** **(0/poor)**	**N/A**
11.	Are the outcomes chosen to evaluate the intervention appropriate?	Appropriate outcomes selected and reported.	Some outcomes not relevant to assessing appropriateness of intervention.	Outcome measures do not evaluate intervention *or* poorly reported/not defined/inconsistent.	
12.	Are the main findings clearly described?	Simple outcome data (e.g. mean/prevalence) reported for all major findings.	Incomplete or inappropriate descriptive statistics.	No/inadequate descriptive statistics.	
13.	Are methods of analysis adequately described and appropriate?	Described and appropriate.	Not reported but probably appropriate *or* some tests appropriate, some not.	Methods not described and cannot be determined.	

14.	Are estimates of variance reported for the main results?	Appropriate estimates provided (SD/SE, confidence intervals).	Undefined *or* estimates provided for some but not all outcomes.	No information.	
15.	In trials/cohort studies, do analyses adjust for different lengths of follow-up, or in case-control studies, is the time between intervention and outcome the same for cases/controls?	Different lengths of follow-up adjusted for (e.g. survival analysis) and adequately described.	Different lengths of follow-up probably adjusted for but not adequately described.	Differences in follow-up ignored.	Cross-sectional design *or* same length of follow-up.
Conclusions					
16.	Are the conclusions supported by the results?	All conclusions supported by data.	Some of the major conclusions are supported by the data; some are not. *Or* speculative interpretations are not indicated as such.	None/few of major conclusions supported by the data.	

Appendix 2: Final quality assessment criteria

Sample number	K.P. Score	Topic of Study (Adult,Paediatric,Neonatal)	Methodology type (1-5)	Quality rating (1-5)

Methodology- (Logged for each article)

Methodology

1. Randomised control Trials-

Individuals are randomly allocated to a control group and another group who receive a specific intervention- groups are identical for significant variables.

2. Cohort Study

Groups are selected based upon their exposure to something and followed up for a specific outcome.

3. Case control studies

"Cases with the condition/subject of interest are matched with "controls" without

4. Cross sectional surveys/studies

Interview/questions are of a sample of the population of interest at a certain point in time

5. Case Study Report

A report based upon a single patient

Quality score

4. Results from this are clear with good methodology.

3. Results are unclear with good methodology.

2. Results are clear but with poor methodology.

1. Results are unclear and specific to the individual study.

Appendix 3 Coding Sheet printed computerised version

Title of BEME review

What is the impact of structured resuscitation training on healthcare practitioners, their clients and the wider service?

Administrative Data

Date Coded _____ Kirkpatrick score_____

Reference number _____ Reviewer 1._____

Reviewer 2._____

Agree with coding Y ☐ N ☐ (If N) Why? _____

Impact of intervention studied

Code the level of impact being studied in the item and summarize any results of the intervention at the appropriate level. Note: include both predetermined and unintended outcomes.

- Modified **Kirkpatrick hierarchy**

Level 1 ☐ **Participation -** covers learners' views on structured resuscitation programmes, their presentation, content, teaching methods, and aspects of the instructional organization, materials, quality of instruction

_____

_____

Level 2a

☐ **Modification of attitudes / perceptions** - outcomes here relate to changes in the attitudes or perceptions between participant groups toward structured resuscitation programmes (e.g. do candidates feel more confident following the course).

_____

_____

Level 2b

☐ **Modification of knowledge or skills** –Is there a change in knowledge or skills following a structured resuscitation programme (i.e. does the candidate acquire skills in problem solving, practical and psychomotor skills?)

_____

_____

Level 3

☐ **Behavioural change** –Identifies the individuals transfer of learning to the workplace or the willingness of learners to apply new knowledge & skills following attendance on a structured resuscitation programme. (Was there retention of knowledge or skills over time?)

_____

_____

Level 4a ☐ **Change in organizational practice** – looks at the wider changes in the organizational delivery of care, attributable to structured resuscitation programmes

_____

_____

Level 4b ☐ **Benefits to patient Identifies** any improvement in the health & well being of patients as a direct result of attending a structured resuscitation programmes

_____

_____

What levels have been obtained? _____

Does the abstract fulfil the objective criteria and how? (Modified Kirkpatrick Hierarchy)

Yes... Level achieved? _____

No.... Why not? _____

Article Volume No _____ Issue _____ Pages_____ Year _____

Qualitative ☐

Quantitative ☐

Search Method

Electronic search ☐ Hand search ☐

Grey literature ☐ Recommendation ☐

Aim of the study

Was the aim/objective? Implied ☐ Stated ☐ unclear (after checking) ☐

Why was the article written?

In an attempt to change practice ☐

In response to new guidelines ☐

To investigate the effects of a training programme on knowledge retention ☐

As a look at patient outcome following attendance on a resuscitation programme ☐

Was ethical approval sought and gained prior to commencing the study? Y ☐ N ☐

Research design

1. Qualitative? Y ☐ N ☐

If so what type? _____

2. Quantitative? Y ☐ N ☐

If so what type? _____

	Y	N		Y	N
Cross-Sectional	☐	☐	Case Control	☐	☐
Trials			Cohort Study		
Non-randomized	☐	☐	Prospective	☐	☐
Randomized	☐	☐	Retrospective	☐	☐

Over what period of time was the data collected? _____

Type of structured resuscitation programme (status)

Title of the training programme if stated (E.g. NLS)_____

_____

Is it a national programme? _____

Is it an in house training programme? _____

Specify the type of skills that were being taught. _____

Was this a mandatory training update? Y ☐ N ☐

Cost of the course_____ Unknown ☐

Duration of the course (please tick)

< 1 day ☐ 1 day ☐ 2 days ☐ > 2 days ☐ unknown ☐

Location of course _____

Country set in _____

Was there any e-learning involved? Y ☐ N ☐

Number of instructors_____ unknown ☐

Number of candidates in the group _____ unknown ☐

Were the participants Drs ☐ Nurses ☐ Students ☐ Other? ☐

If other please specify _____

Was their place of work specified? Y ☐ N ☐ if yes where did they work? _____

Was their age specified? Y ☐ N ☐

If yes how old were they _____

Was their gender specified Y ☐ N ☐

If yes were they mostly male or female? _____

Had the attendees any knowledge of the subject before attending? Y ☐ N ☐

unknown? ☐

Had they attended a similar course or been taught to the same level prior to attending?

Y ☐ N ☐ unknown? ☐

Were they given any pre-course material to read prior to attending? Y ☐ N ☐

If yes was this an official resuscitation manual? Y ☐ N ☐ unknown? ☐

Certification of course if stated

Is this a pass or fail course? Y ☐ N ☐ not known ☐

Were all the assessments formative ☐ or summative ☐

How much of the course was skills based? <1/3 ☐ 1/3-2/3 ☐ >2/3 ☐

How much was knowledge based? <1/3 ☐ 1/3-2/3 ☐ >2/3 ☐

ASSESSMENT PROCESS

Pre- course (prior to attending)	**Yes**	**No**
Were participants tested 'pre course'?	☐	☐
Was there a written paper prior to instruction? (i.e. was knowledge assessed)?	☐	☐
If yes did they complete the paper prior to attending?	☐	☐

Was a practical exam involved prior to instruction? ☐ ☐

(i.e. were skills assessed)?

(If Yes) What were these? _____

How many observers where there? _____

Was it done under exam conditions? ☐ ☐

Was 360 degree review used? ☐ ☐

Were candidates asked their confidence levels prior to attending the course? Y ☐

N ☐

Were the pre-course assessments formative ☐ summative ☐

Were there any skill stations **Pre course** (tick any that apply)

- Vascular access (UVC) ☐
- Cannulation ☐
- Inflation breaths ☐
- Chest compressions ☐
- Drug calculations ☐
- Needle thoracentisis ☐
- Crichoidotomy ☐
- Scenarios ☐
- Other ☐ please state _____

During the course (Inc the end)	**Yes**	**No**
Was a practical exam involved (i.e. were skills assessed)?	☐	☐

(If Yes) What was this? _____

How many observers where there? _____

Was there a written paper (i.e. was knowledge assessed)? y ☐ N ☐

Was 360 degree review used? y ☐ N ☐

Was there a behavioural change in candidates? (skills) y ☐ N ☐

(i.e. had learning occurred?) not known ☐

Was this implied ☐ Stated ☐

Was an improvement noted between pre-course and course test? Y ☐ N ☐

(knowledge/ written paper) e.g had learning taken place? not known ☐

Was this? Implied ☐ Stated ☐

Were the course assessments formative ☐ summative ☐ not known ☐

Were there any skill stations at the final assessment (tick any that apply)

- Vascular access (UVC) ☐
- Cannulation ☐
- Inflation breaths ☐
- Chest compressions ☐
- Drug calculations ☐
- Needle thoracentisis ☐
- Crichoidotomy ☐
- Scenarios ☐
- Other ☐ (state) _____

Post course (if reviewed after a period of time)

Did the candidates get tested at a later date? Y ☐ N ☐

If retesting was done- How many times

1 ☐ 2 ☐ 3 ☐ >3 ☐

How long after the initial exposure was this carried out?

< 1 month ☐ 1-3 months ☐ 4- 6 months ☐ 6 months -1 year ☐

Were the assessments formative ☐ summative ☐

	Yes	No
Was a practical exam involved (ie were skills assessed)?	☐	☐

(If Yes) What was this?_____

How many observers were there? _____

Was there a written paper (ie was knowledge assessed)? y ☐ N ☐

Were there any skill stations **post-course** (tick any that apply)

- Vascular access (UVC) ☐
- Cannulation ☐
- Inflation breaths ☐
- Chest compressions ☐
- Drug calculations ☐
- Needle thoracentisis ☐
- Crichoidotomy ☐
- Scenarios ☐
- Other ☐

(state)_____

Was 360 degree review used? Y ☐ N ☐

Were questionnaires used for self evaluation? Y ☐ N ☐

Was there evidence of loss of confidence? Y ☐ N ☐

Was there any evidence that knowledge had been maintained at the same level as the end of the course? Y ☐ N ☐

Was there any evidence that skills were maintained at the same level as the end of the course? Y ☐ N ☐

Did the candidates feel that they have lost their skills? Y ☐ N ☐

Did the candidates feel that they have lost their knowledge? Y ☐ N ☐

Was there evidence of organisational change? Y ☐ N ☐

Was there evidence of alteration of clinical outcome? Y ☐ N ☐

Conclusions

Did the recommendations of the study:-

Suggest that further studies were required? Y ☐ N ☐

Make recommendations for change? Y ☐ N ☐

Suggest further training was required? Y ☐ N ☐

Suggest that the training should be offered more frequently? Y ☐ N ☐

Quality (Statistical analysis)

Was the study design appropriate? Y ☐ N ☐ unsure ☐

Were statistical tests were used to evaluate the results Y ☐ N ☐

Please list _____

Were these appropriate? Y ☐ N ☐ unsure ☐

Were the results of the main aim of the study statistically significant? Y ☐ N ☐

Comment on the evaluation methods if appropriate

_____

_____

_____

Appendix 4 Example of tabular coding forms

Kirkpatrick 2 A and B

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training

Kirkpatrick 2C

Author	AP	Nature of the training	No of participants followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested K	Components of ability tested S	Knowledge change	Notes	P	Skill change	Notes	P

Kirkpatrick 4

Author	Accredited programme	Nature of the training	Period studied	Significant impact on patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)

Appendix 5 Ethics Application Form

Online Form

APPLICANT'S CHECKLIST

REC Ref:	
Short Title of Study:	Retention of neonatal resuscitation skills after the NLS course
CI Name:	Dr NJ Shaw
Sponsor:	Liverpool Womens Hospital

Please complete this checklist and send it with your application

- Send ONE copy of each document (except where stated)
- ALL accompanying documents must bear version numbers and dates (except where stated)
- Delete 'yes/no' as applicable if completing the form electronically; circle the appropriate option if completing the form by hand
- When collating please do NOT staple documents as they will need to be photocopied.

Document	Enclosed?	Date	Version	Office use
Covering letter on headed paper	○ Yes ○ No			
NHS REC Application Form, Parts A&B	Mandatory			
NHS REC Application Form, Part C (SSA)	○ Yes ○ No			
Research protocol (6 copies) or project proposal	Mandatory			
Summary C.V. for Chief Investigator (CI)	Mandatory			
Summary C.V. for supervisor (student research)	○ Yes ○ No			
Research participant information sheet (PIS)	○ Yes ○ No			
Research participant consent form	○ Yes ○ No			
Letters of invitation to participants	○ Yes ○ No			
GP/Consultant information sheets or letters	○ Yes ○ No			
Statement of indemnity arrangements	○ Yes ○ No			
Letter from sponsor	○ Yes ○ No			
Letter from statistician	○ Yes ○ No			
Letter from funder	○ Yes ○ No			
Referees' or other scientific critique report	○ Yes ○ No			
Summary, synopsis or diagram (flowchart) of protocol in non-technical language	○ Yes ○ No			
Interview schedules or topic guides for participants	○ Yes ○ No			
Validated questionnaire	○ Yes ○ No			
Non-validated questionnaire	○ Yes ○ No			
Copies of advertisement material for research participants, e.g. posters, newspaper adverts, website. For video or audio cassettes, please also provide the printed script.	○ Yes ○ No			

WELCOME TO THE NHS RESEARCH ETHICS COMMITTEE APPLICATION FORM

This page is important. An application form specific to your project will be created from the answers you give.

1. Select one research category from the list below:

- ○ Clinical trials of investigational medicinal products (including phase 1 drug development)
- ○ Clinical investigations of medical devices
- ○ Research administering questionnaires for quantitative analysis
- ○ Research involving qualitative methods only
- ○ Research limited to taking and working with new samples
- ○ Non-interventional research

If your work does not fit any of these categories, select the option below:

- ◉ Other research

1a. Please answer the following questions:

a) Does your study involve the use of any radiation?	○ Yes	◉ No
b) Will you be taking new samples?	○ Yes	◉ No
c) Will you be using existing samples?	○ Yes	◉ No

2. Is your research confined to one site?

○ Yes ◉ No

3. Does your research involve work with prisoners?

○ Yes ◉ No

4. Does your research involve adults unable to consent for themselves through physical or mental incapacity?

○ Yes ◉ No

5. Is your work an educational project?

○ Yes ◉ No

6. Is your project an audit or service evaluation?

○ Yes ◉ No

NHS Research Ethics Committee NHS
Application form

This form should be completed by the Chief Investigator, after reading the guidance notes. See glossary for clarification of different terms in the application form.

Short title and version number: (maximum 70 characters – this will be inserted as header on all forms)
Retention of neonatal resuscitation skills after the NLS course

Name of NHS Research Ethics Committee to which application for ethical review is being made:

Project reference number from above REC:
Submission date:

PART A: Introduction

A1. Title of the research

Full title: Retention of neonatal resuscitation skills after the NLS course

Key words: Neonatal, Resuscitation

A2. Chief Investigator

Title:	Dr
Forename/initials:	NJ
Surname:	Shaw
Post:	Consultant in neonatal and respiratory paediatrics
Qualifications:	MB ChB, MD, FRCPCH, PGCertTLCP
Organisation:	Liverpool Women's Hospital NHS Trust
Address:	Neonatal Unit
	Crown Street
	Liverpool
Post Code:	L8 7SS
E-mail:	Ben.shaw@lwh.nhs.uk
Telephone:	0151 7089988
Fax:	0151 7024313

A copy of a current CV (maximum 2 pages of A4) for the Chief Investigator must be submitted with the application

A3. Proposed study dates and duration

Start date: 01/01/2006
End date: 01/01/2008
Duration: Months: 0 ; Years: 2

A4. Primary purpose of the research: *(Tick as appropriate)*

- ☐ Commercial product development and/or licensing
- ☐ Publicly funded trial or scientific investigation
- ☐ Educational qualification
- ☐ Establishing a database/data storage facility
- ☑ Other

If Other, give details:

1. To investigate whether airway management and non invasive ventilatory skills are retained after the NLS course.
2. To compare the relationship between the resuscitation providers confidence in,and their competence at performing these skills.

A6. Does this research require site-specific assessment (SSA) of each research site? (Advice can be found in the guidance notes on this topic.)

○ Yes ◉ No

If No, please justify:

If Yes, Part C of the form will need to be completed for each research site and submitted for SSA to the relevant Local Research Ethics Committee. Do not submit Part Cs for other sites until the application has been booked for review and validated by the main Research Ethics Committee.

Management approval to proceed with the research will be required from the R&D department for each NHS care organisation in which research procedures are undertaken. This applies whether or not the research is exempt from SSA.

PART A: Section 1

A7. What is the principal research question/objective? *(Must be in language comprehensible to a lay person.)*

To determine if there is a rapid loss of the skills that are acquired on the Neonatal Life Support(NLS)course.

A8. What are the secondary research questions/objectives? *(If applicable, must be in language comprehensible to a lay person.)*

To determine the relationship between self–reported confidence and a formal assessment of competence in NLS skills.

A9. What is the scientific justification for the research? What is the background? Why is this an area of importance? *(Must be in language comprehensible to a lay person.)*

The Newborn Life Support (NLS) course has been developed to provide clear practical instruction in airway support and the theoretical background to illustrate its importance in resuscitation of the newborn. The aim of the course is to give those responsible for initiating resuscitation at birth the background knowledge and skills to approach the management of a newborn infant during the first 10–20 minutes in a competent manner. The course concentrates on the importance of temperature control, practical airway management and ventilatory support. The development and retention of practical skills are of great importance for professionals involved in neonatal resuscitation. Studies on professionals attending adult cardiopulmonary resuscitation courses suggest that the retention of both knowledge and practical skills declines markedly with time, and is reduced significantly after 4 to 6 months. It is not known, however, whether this phenomenon occurs after attending an NLS course.

A10. Give a full summary of the purpose, design and methodology of the planned research, including a brief explanation of the theoretical framework that informs it. It should be clear exactly what will happen to the research participant, how many times and in what order. Describe any involvement of research participants, patient groups or communities in the design of the research.

This section must be completed in language comprehensible to the lay person. It must also be self–standing as it will be replicated in any applications for site–specific assessment on Part C. Do not simply reproduce or refer to the protocol. Further guidance is available in the guidance notes.

There are many NLS courses run throughout the year in the United Kingdom (6 – 8 a year in Liverpool) with a maximum of 25 candidates attending each one. Despite this time, resource and expense dedicated to NLS training, little is known about the effectiveness of these efforts and whether the courses are meeting their educational objectives. No research has been performed to assess the competence of individuals who pass the NLS course.

The purpose of this study is therefore to determine how well skill competency is retained after the NLS course.

Study Design

This is a prospective longitudinal study. Retention of competency in airway management is the primary outcome. A self–report of confidence in airway management and a 360 degree assessment of the providers competence by their peers will be obtained as secondary outcome measures.

Methodology

All professionals (senior house officers, specialist registrars, neonatal nurses and Midwives) who have successfully passed one of the NLS courses taking place at Liverpool Women's Hospital in 2006 will be eligible to participate in the study. After gaining their consent for future contact, arrangements will be made to test them at between 3 – 5 months and 12 – 14 months after the course in their competence in airway management. This test will be the same airway management test used on the NLS course to determine whether a candidate has passed or failed. There will be two testers on each occasion taken from a pool of six certified instructors. In order to reduce the amount of time a participant might prepare for the test, arrangements will be made with their line manager for them to be made available at a specific time and date without their knowledge. If the participant fails the airway test they will receive feedback on the areas where they could improve their airway management skills.
Immediately prior to the test the confidence of the participant in their airway management ability will be assessed by using a

standardised self rating questionnaire (appendix 1). After the test the participant will be asked to distribute a 360 degree rating questionnaire (appendix 2) asking about their competence in airway management to 10 of their colleagues. These will have stamped addressed envelopes for their return to the research coordinator. On receipt the average scores will be calculated and original questionnaires will be destroyed as confidential waste. The participant will receive a copy of the averaged score sheet.

A11. Will any intervention or procedure, which would normally be considered a part of routine care, be withheld from the research participants?

○ Yes ◉ No

A12. Give details of any clinical intervention(s) or procedure(s) to be received by research participants over and above those which would normally be considered a part of routine clinical care. *(These include uses of medicinal products or devices, other medical treatments or assessments, mental health interventions, imaging investigations and taking samples of human biological material.)*

Additional intervention	Average number per patient		Average time taken (mins/hours/days)	Details of additional intervention or procedure, who will undertake it, and what training they have received.
	Routine Care	Research		
Other				

A13. Give details of any non-clinical research-related intervention(s) or procedure(s). *(These include interviews, non-clinical observations and use of questionnaires.)*

Additional intervention	Average number per patient	Average time taken (mins/hours/days)	Details of additional intervention or procedure, who will undertake it, and what training they have received.
Other	1	15 min	Participants who have been successful on the NLS course will be tested at between 3 – 5 months and 12 – 14 months after the course in their competence in airway management. This test will be the same airway management test used on the NLS course to determine whether a candidate has passed or failed. There will be two testers on each occasion taken from a pool of six certified instructors. In order to reduce the amount of time a participant might prepare for the test, arrangements will be made with their line manager for them to be made available at their place of work at a specific time and date without their knowledge.
Other Questionnaire	1	10 min	Prior to the airway test the confidence of the participant in their airway management ability will be assessed by using a standardised self rating questionnaire
Other Questionnaire	10	10 min	After the test the participant will be asked to distribute a 360 degree rating questionnaire asking about their competence in airway management to 10 of their colleagues. These will have stamped addressed envelopes for their return to the research coordinator.

A14. Will individual or group interviews/questionnaires discuss any topics or issues that might be sensitive, embarrassing or upsetting, or is it possible that criminal or other disclosures requiring action could take place during the study (e.g. during interviews/group discussions, or use of screening tests for drugs)?

○ Yes ◉ No

The Information Sheet should make it clear under what circumstances action may be taken

A15. What is the expected total duration of participation in the study for each participant?

14 months

A16. What are the potential adverse effects, risks or hazards for research participants either from giving or withholding medications, devices, ionising radiation, or from other interventions (including non-clinical)?

No forseeable risks

A17. What is the potential for pain, discomfort, distress, inconvenience or changes to lifestyle for research participants?

None

A18. What is the potential for benefit to research participants?

Those failing the airway test will be given feedback which may improve their competency.

A19. What is the potential for adverse effects, risks or hazards, pain, discomfort, distress, or inconvenience to the researchers themselves? *(if any)*

None

A20. How will potential participants in the study be (i) identified, (ii) approached and (iii) recruited?
Give details for cases and controls separately if appropriate

All professionals (senior house officers, specialist registrars, neonatal nurses and Midwives) who have successfully passed one of the NLS courses taking place at Liverpool Women's Hospital, Liverpool in 2006 will be eligible to participate in the study. They will be given an information sheet and consent form at the beginning of the course and will have the opportunity to return these either at the end of the course or by post.

A21. Where research participants will be recruited via advertisement, give specific details.

☑ Not Applicable

If applicable, enclose a copy of the advertisement/radio script/website/video for television (with a version number and date).

A22. What are the principal inclusion criteria? *(Please justify)*

All professionals (senior house officers, specialist registrars, neonatal nurses and Midwives) who have successfully passed one of the NLS courses taking place at Liverpool Women's Hospital, Liverpool in 2006 may be included.

A23. What are the principal exclusion criteria? *(Please justify)*

Professionals failing the NLS course in Liverpool.

A24. Will the participants be from any of the following groups? *(Tick as appropriate)*

- ☐ Children under 16
- ☐ Adults with learning disabilities
- ☐ Adults who are unconscious or very severely ill
- ☐ Adults who have a terminal illness
- ☐ Adults in emergency situations
- ☐ Adults with mental illness (particularly if detained under Mental Health Legislation)
- ☐ Adults with dementia
- ☐ Prisoners
- ☐ Young Offenders
- ☐ Adults in Scotland who are unable to consent for themselves
- ☐ Healthy Volunteers
- ☐ Those who could be considered to have a particularly dependent relationship with the investigator, e.g. those in care homes, medical students
- ☐ Other vulnerable groups

Justify their inclusion.

A25. Will any research participants be recruited who are involved in existing research or have recently been involved in any research prior to recruitment?

○ Yes ◉ No ○ Not Known

If Yes, give details and justify their inclusion. If Not Known, what steps will you take to find out?

A26. Will informed consent be obtained from the research participants?

◉ Yes ○ No

If Yes, give details of who will take consent and how it will be done. Give details of any particular steps to provide information (in addition to a written information sheet) e.g. videos, interactive material.

If participants are to be recruited from any of the potentially vulnerable groups listed in A24, give details of extra steps taken to assure their protection. Describe any arrangements to be made for obtaining consent from a legal representative.

If consent is not to be obtained, please explain why not.
Professionals attending the NLS courses in Liverpool will be given an introductory talk by one of the 3 members of the research team and an information sheet and consent form at the beginning of each course and will have the opportunity to return these either at the end of the course or by post.

Copies of the written information and all other explanatory material should accompany this application.

A27. Will a signed record of consent be obtained?

◉ Yes ○ No

If Yes, attach a copy of the information sheet to be used, with a version number and date.

A28. How long will the participant have to decide whether to take part in the research?

Up to one month after the end of the course. If they have not returned their consent form by two weeks, a reminder will be sent. If they have not replied by a month after the course it will be assumed that they do not wish to participate.

A29. What arrangements have been made for participants who might not adequately understand verbal explanations or written information given in English, or who have special communication needs? *(e.g. translation, use of interpreters etc.)*

not applicable

A30. What arrangements are in place to ensure participants receive any information that becomes available during the course of the research that may be relevant to their continued participation?

If the participant fails the airway test they will receive feedback on the areas where they could improve their airway management skills.

On receipt of the 360 degree rating questionaire the average scores will be calculated. The participant will receive a copy of the averaged score sheet.

A31. Does this study have or require approval of the Patient Information Advisory Group (PIAG) or other bodies with a similar remit? *(see the guidance notes)*

○ Yes ◉ No

A32a. Will the research participants' General Practitioner be informed that they are taking part in the study?

○ Yes ◉ No

If Yes, enclose a copy of the information sheet/letter for the GP with a version number and date.

A32b. Will permission be sought from the research participants to inform their GP before this is done?

○ Yes ◉ No

If No to either question, explain why not
This is not a clinical study.

It should be made clear in the patient information sheet if the research participant's GP will be informed.

A33. Will individual research participants receive any payments for taking part in this research?

○ Yes ◉ No

A34. Will individual research participants receive *reimbursement of expenses* or any other *incentives or benefits* for taking part in this research?

○ Yes ◉ No

A35. What arrangements have been made to provide indemnity and or compensation in the event of a claim by, or on behalf of, participants for *negligent* harm?

Liverpool Women's Hospital NHS Trust will provide indemnity cover as per the NHS Guidance. This means that if during the event of the research clinical negligence is identified, indemnity arrangements provide cover via the Clinical Negligence Scheme for Trusts (CNST).

Please forward copies of the relevant documents

A36. What arrangements have been made to provide indemnity and/or compensation in the event of a claim by, or on behalf of, participants for *non-negligent* harm?

As a public organisation the NHS is unable to provide cover for non-negligent harm according to Department of Health Guidelines. Thus for non-negligent (no fault) claims, there are no arrangements via the CNST or other NHSLA schemes or professional indemnity arrangements.

Please forward copies of the relevant documents

A37. How is it intended the results of the study will be reported and disseminated? *(Tick as appropriate)*

- [x] Peer reviewed scientific journals
- [ ] Internal report
- [x] Conference presentation
- [x] Other publication
- [x] Submission to regulatory authorities
- [ ] Access to raw data and right to publish freely by all investigators in study or by Independent Steering Committee on behalf of all investigators
- [x] Written feedback to research participants
- [x] Presentation to participants or relevant community groups
- [ ] Other/none e.g. Cochrane Review, University Library

A38. How will the results of research be made available to research participants and communities from which they are drawn?

By publishing in medical journals and submission of results to resuscitation council publications.

A39. Will the research involve any of the following activities at any stage (including identification of potential research participants)? *(Tick as appropriate)*

- [ ] Examination of medical records by those outside the NHS, or within the NHS by those who would not normally have access
- [ ] Electronic transfer by magnetic or optical media, e-mail or computer networks
- [ ] Sharing of data with other organisations
- [ ] Export of data outside the European Union
- [ ] Use of personal addresses, postcodes, faxes, e-mails or telephone numbers
- [ ] Publication of direct quotations from respondents
- [ ] Publication of data that might allow identification of individuals
- [ ] Use of audio/visual recording devices
- [ ] Storage of personal data on any of the following:
  - [ ] Manual files including X-rays
  - [ ] NHS computers
  - [ ] Home or other personal computers

- ☐ University computers
- ☐ Private company computers
- ☐ Laptop computers

Further details:

A40. What measures have been put in place to ensure confidentiality of personal data? Give details of whether any encryption or other anonymisation procedures have been used and at what stage:

Names and contact details will be kept in paper form in a filing cabinet in Dr Shaws office at Liverpool Womens Hospital. Each participant will be allocated a unique number. Study data which will be stored on a password protected PC or laptop will only be identified by this unique number.

A41. Where will the analysis of the data from the study take place and by whom will it be undertaken?

Analysis of study data will take place at Liverpool Womens Hospital by Drs Shaw, Roy and Yoxall.

A42. Who will have control of and act as the custodian for the data generated by the study?

Dr Shaw.

A43. Who will have access to the data generated by the study?

Study data in an anonymous form will be in the public domain.

A44. For how long will data from the study be stored?

15 Years Months

Give details of where they will be stored, who will have access and the custodial arrangements for the data:
In a designated file in Dr Shaws office at Liverpool Womens Hospital which is locked when he is not there.

A45–1. How has the scientific quality of the research been assessed? *(Tick as appropriate)*

- ☐ Independent external review
- ☐ Review within a company
- ☐ Review within a multi–centre research group
- ☐ Internal review (e.g. involving colleagues, academic supervisor)
- ☑ None external to the investigator
- ☐ Other, e.g. methodological guidelines *(give details below)*

Justify and describe the review process and outcome. If the review has been undertaken but not seen by the researcher, give details of the body which has undertaken the review:

If you are in possession of any referees' comments or other scientific critique reports relevant to the proposed research, these must be enclosed with the application.

A45–2. Has the protocol submitted with this application been the subject of review by a statistician independent of the research team? *(Select one of the following)*

○ Yes – copy of review enclosed

◉ Yes – details of review available from the following individual or organisation (give contact details below)

Mr. Ashley Jones
Medical Statistician
Institute of Child Health, Alder Hey Hospital children's Hospital
Eaton Road
Liverpool
L12 2AP
Tel:0151 2525696, Fax: 0151 2525496

○ No – justify below

A48. What is the primary outcome measure for the study?

The primary outcome is retention of competency in airway management.

A49. What are the secondary outcome measures? *(If any)*

Secondary outcome measures are self–reported confidence in airway management and a 360 degree assessment of the providers competence by their peers.

A50. How many participants will be recruited?
If there is more than one group, state how many participants will be recruited in each group. For international studies, say how many participants will be recruited in the UK and in total.

Approximately 100 participants

A51. How was the number of participants decided upon?

The sample will be a convenience sample of paticipants recruited from the 6 NLS course held at the Liverpool Women's Hospital over a 1 year period in 2006.

If a formal sample size calculation was used, indicate how this was done, giving sufficient information to justify and reproduce the calculation.

A52. Will participants be allocated to groups at random?

○ Yes ◉ No

A53. Describe the methods of analysis (statistical or other appropriate methods, e.g. for qualitative research) by which the data will be evaluated to meet the study objectives.

The primary outcome data will be binary as the outcome for the test for competence in airway management will either be pass or fail. McNemar's test will be used for paired binary data. The responses on the self–rating questionnaire and the 360 degree rating questionnaire will be reported as descriptive statistics.

A54. Where will the research take place? *(Tick as appropriate)*

- [x] UK
- [ ] Other states in European Union
- [ ] Other countries in European Economic Area
- [ ] Other

If Other, give details:

A55. Has this or a similar application been previously rejected by a Research Ethics Committee in the UK, the European Union or the European Economic Area?

○ Yes ◉ No

A56. In how many and what type of host organisations (NHS or other) in the UK is it intended the proposed study will take place?

Indicate the type of organisation by ticking the box and give approximate numbers if known:

	Number of organisations
[x] Acute teaching NHS Trusts	
[x] Acute NHS Trusts	
[ ] NHS Primary Care Trusts or Local Health Boards in Wales	
[ ] NHS Trusts providing mental healthcare	
[ ] NHS Health Boards in Scotland	
[ ] HPSS Trusts in Northern Ireland	
[ ] GP Practices	
[ ] NHS Care Trusts	
[ ] Social care organisations	
[ ] Prisons	
[ ] Independent hospitals	
[ ] Educational establishments	
[ ] Independent research units	
[ ] Other (give details)	

Other:

A57. What arrangements are in place for monitoring and auditing the conduct of the research?

Regular meetings will take place between the three investigators to discuss recruitment and other operational issues associated with the research.

Will a data monitoring committee be convened?

○ Yes ◉ No

If Yes, details of membership of the data monitoring committee (DMC), its standard operating procedures and summaries of reports of interim analyses to the DMC must be forwarded to the NHS Research Ethics Committee which gives a favourable opinion of the study.

What are the criteria for electively stopping the trial or other research prematurely?

Not applicable.

A58. Has external funding for the research been secured?

○ Yes ◉ No

If No, what arrangements are being made to cover any costs of the research? If no external funding is being sought, please say so:

An application will be made to the resuscitation council (and possibly other grant giving bodies) to support this research.

A59. Has the funder of the research agreed to act as sponsor as set out in the Research Governance Framework?

○ Yes ◉ No

Has the employer of the Chief Investigator agreed to act as sponsor of the research?

◉ Yes ○ No

Sponsor *(must be completed in all cases)*

Name of organisation which will act as sponsor for the research:

Liverpool Womens Hospital

Status:

◉ NHS or HPSS care organisation ○ Academic ○ Pharmaceutical industry ○ Medical device industry ○ Other

If Other, please specify:

Address:	Crown Street Liverpool		
Post Code:	L8 7SS		
Telephone:	0151 708 9988	Fax:	0151 702 4313
E-mail:			

The responsibilities of the sponsor may be shared between co-sponsors. If this applies, name the lead sponsor for the REC application in this box and enclose a letter giving further details of co-sponsors and their responsibilities.

Sponsor's UK contact point for correspondence with the main REC

Title: Ms Forename/Initials: Lynne Surname: Webster

Address: Liverpool Womens Hospital
Crown Street

Post Code: L8 7SS
Telephone: 0151 708 9988 Fax:
E-mail: LYNNE.WEBSTER@lwh.nhs.uk

A60. Has any responsibility for the research been delegated to a subcontractor?

○ Yes ◉ No

A61. Will individual *researchers* receive any personal payment over and above normal salary for undertaking this research?

○ Yes ◉ No

A62. Will individual *researchers* receive any other benefits or incentives for taking part in this research?

○ Yes ◉ No

A63. Will the host organisation or the researcher's department(s) or institution(s) receive any payment or benefits in excess of the costs of undertaking the research?

○ Yes ◉ No

A64. Does the Chief Investigator or any other investigator/collaborator have any direct personal involvement (e.g. financial, share-holding, personal relationship etc.) in the organisation sponsoring or funding the research that may give rise to a possible conflict of interest?

○ Yes ◉ No

A65. Other relevant reference numbers if known*(give details and version numbers as appropriate)*:

Applicant's/organisation's own reference number, e.g. RD(if available):
Sponsor's/protocol number:
Funder's reference number:
International Standard Randomised Controlled Trial Number (ISRCTN):
European Clinical Trials Database (EudraCT) number:
Project website:

A66. Other key investigators/collaborators *(all grant co-applicants should be listed)*

Title:	Dr	
	Forename/Initials: Rahul	Surname: Roy
Post:	Specialist Registrar in Paediatrics Mersey Deanery	
Qualifications:	MRCPCH DCH	
Organisation:	Mersey Deanery rotation	
Address:	Liverpool Womens Hospital	
	Crown Street	Telephone: 0151 708 9988
		Fax:
Postcode:	L8 7SS	
E-mail:	rahulroy1999@yahoo.co.uk	

Title:	Dr	
	Forename/Initials: W C	Surname: Yoxall
Post:	Consultant neonatologist	
Qualifications:	FRCPCH MD	
Organisation:	Liverpool Womens Hospital	
Address:	Liverpool Womens Hospital	
	Crown Street	Telephone: 0151 708 9988
		Fax:
Postcode:	L8 7SS	
E-mail:	Bill.Yoxall@lwh.nhs.uk	

A67. If the research involves a specific intervention, (e.g. a drug, medical device, dietary manipulation, lifestyle change etc.), what arrangements are being made for continued provision of this for the participant (if appropriate) once the research has finished?

☑ Not Applicable

PART A: Summary of Ethical Issues

A68. What do you consider to be the main ethical issues which may arise with the proposed study and what steps will be taken to address these?

If the participant fails the airways test it would be incumbent on the investigator to provide feedback to improve competency.

PART B: Section 1 – Conduct of the research at local sites

From the answer given to question A6, it is assumed that:

- *Local Principal Investigators will not be appointed at each research site participating in this study.*
- *Applications for site-specific assessment by local Research Ethics Committees on Part C of the form will not be required.*
- *There will be no requirement for individual research sites to be approved by the main REC as part of the ethical review.*

The following general information should be provided to the main REC about the local conduct of the study.

1. What research procedures will be carried out at individual research sites?

Testing of the professionals competency at the airway test and administration of two questionnaires.

2. Are any ethical issues likely to arise at individual sites that are not covered in the protocol for the study and if so how will these be addressed?
For example, a need for particular facilities, or to notify local clinicians or departments about the research, or to arrange additional local support for participants.

As previously stated the line manager of each participant will be contacted to ensure they are free and that there will be facilities available for testing (a resuscitaire – which is standard equipment).

3. How will the Chief Investigator and his/her team supervise the conduct of the research at individual sites? What responsibilities will be delegated to local collaborators?

No responsiblity to local collaborators. The research team will visit the place of work of the participant to conduct the airway test locally.

Management approval to proceed with the research will be required from the R D Department for each NHS care organisation in which research procedures are undertaken.

PART B: Section 7 – Declaration

– The information in this form is accurate to the best of my knowledge and belief and I take full responsibility for it.

– I undertake to abide by the ethical principles underlying the Declaration of Helsinki and good practice guidelines on the proper conduct of research.

– If the research is approved I undertake to adhere to the study protocol, the terms of the full application of which the main REC has given a favourable opinion and any conditions set out by the main REC in giving its favourable opinion.

– I undertake to seek an ethical opinion from the main REC before implementing substantial amendments to the protocol or to the terms of the full application of which the main REC has given a favourable opinion.

– I undertake to submit annual progress reports setting out the progress of the research.

– I am aware of my responsibility to be up to date and comply with the requirements of the law and relevant guidelines relating to security and confidentiality of patient or other personal data, including the need to register when necessary with the appropriate Data Protection Officer.

– I understand that research records/data may be subject to inspection for audit purposes if required in future.

– I understand that personal data about me as a researcher in this application will be held by the relevant RECs and their operational managers and that this will be managed according to the principles established in the Data Protection Act.

– I understand that the information contained in this application, any supporting documentation and all correspondence with NHS Research Ethics Committees or their operational managers relating to the application, will be subject to the provisions of the Freedom of Information Acts. The information may be disclosed in response to requests made under the Acts except where statutory exemptions apply.

Signature: .....

Date: (dd/mm/yyyy)

Print Name:

NHS

2 March 2006

Dr N Shaw
Consultant in Neonatal and Respiratory Paediatrics
Liverpool Women's Hospital
Crown Street
Liverpool
L8 7SS

Dear Dr Shaw

Full title of study: Retention of neonatal resuscitation skills after the NLS course
REC reference number: 05/Q1505/137

Thank you for your correspondence responding to the Committee's request for further information on the above research.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation.

Ethical review of research sites

The Committee has designated this study as exempt from site-specific assessment (SSA). The favourable opinion for the study applies to all sites involved in the research. There is no requirement for other Research Ethics Committees to be informed or SSA to be carried out at each site.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Application		05 November 2005
Investigator CV	Dr N J Shaw	14 November 2005
Protocol	1	14 November 2005
Participant Information Sheet	2	05 January 2006
Participant Consent Form	1	14 November 2005
Peer Assessment of resuscitation skills	1	14 November 2005

Research governance approval

The study should not commence at any NHS site until the local Principal Investigator has obtained final research governance approval from the R&D Department for the relevant NHS care organisation.

You should arrange for all relevant NHS care organisations to be notified that the research will be taking place, and provide a copy of the REC application, the protocol and this letter.

All researchers and research collaborators who will be participating in the research must obtain research governance approval from the relevant care organisation before commencing any research procedures. Where a substantive contract is not held with the care organisation, it may be necessary for an honorary contract to be issued before approval for the research can be given.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

05/Q1505/137	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project

Yours sincerely

Dr T S Purewal
Chair

E-mail: jenny.cross@centralliverpoolpct.nhs.uk

Enclosures *Standard approval conditions*

Copy to: Dr L Webster, R&D Department, Liverpool Women's Hospital

Appendix 6 Information for participants

Information sheet for Participants

Retention of neonatal resuscitation skills after the neonatal life support (NLS) course

Dr N Shaw (Consultant Neonatologist)

Dr B Yoxall (Consultant Neonatologist)

Miss Chiara Mosley (Advanced Neonatal Nurse Practitioner)

We are inviting you to take part in a research study. Before you decide whether to take part, it is important for you to understand why the research is being done and what it will involve. Please ask one of the research team if there is anything that is not clear or if you would like further information.

Why have I been chosen?

We are approaching all professionals (senior house officers, specialist registrars, neonatal nurses and midwives) who have successfully passed the NLS course organized at Liverpool Women's Hospital to take part in the study.

What is the study about?

The development and retention of practical skills are of great importance for medical professionals involved in neonatal resuscitation. Studies on professionals attending adult cardiopulmonary resuscitation courses suggest that the retention of both knowledge and practical skills declines markedly with time, and is reduced significantly after 4 to 6 months. It is not known, however, whether this phenomenon occurs after attending an NLS course. The aim of this study is, therefore, to determine how well skill competency is retained after the NLS course

What will the study involve?

If you agree to take part we will contact you approximately 3 and 12 months after the NLS course in order for you to be tested in airway management skills in the same way as you were on the NLS course. In order to minimise you preparing for the test, arrangements will be made with your line manager for you to be made available at a specific time and date without your knowledge. The test will take approximately 15 minutes to complete.
We will also ask you to complete a short questionnaire in which you rate your own competence in airway management. We would also like you to nominate10 people who know you professionally and ask them to complete a questionnaire in which they (confidentially) assess your competence at airway management.

What are the benefits in taking part in the study?

There are no benefits to you in taking part, although it will be highlighted to those that fail the airway test that extra training is needed and they will be given feedback immediately after the test which may improve their competency.

What are the risks in taking part in the study?

There are no foreseeable risks.

Will my taking part in this study remain confidential?

All the information collected about you during the course of this research will be strictly confidential. All data will be given a unique number and no one will be referred to by name in any publication or report. Feedback on your colleagues assessment of your competence will be provided as an average score and all original questionnaires will be destroyed as confidential waste.

Can further information be obtained?

For further information contact Dr Shaw, Consultant Neonatologist 0151 708 9988, Dr Yoxall, Consultant Neonatologist 0151 708 9988 or Miss Chiara Mosley, Advanced Neonatal Nurse Practitioner 0151 708 9988

Appendix 7 Consent Form

Retention of neonatal resuscitation skills after the NLS course

Dr N Shaw (Consultant neonatologist)

Dr B Yoxall (Consultant neonatologist)

Miss Chiara Mosley (Advanced Neonatal Nurse Practitioner)

	Please Initial box
I confirm that I have read and understood the information sheet for the above study.	☐
I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	☐
I give permission for the research team to contact my line manager to organise a time to take the airway test at 3 and 12 months after the NLS course and have indicated my place of work and line managers name and contact number on the accompanying sheet.	☐

I agree to take part in the above study.

Participants name	Date	Signature
Researcher	Date	Signature

PLEASE PRINT ALL DETAILS CLEARLY

Your Name (please print) .....

Profession .....

We will need to contact your **line manager/consultant** in **2 months** time in order to meet up with **you** in **3 months time**

Please, therefore, complete the following:

Two months from now who will be your line manager/consultant (please print their name)

..... **Their** Contact number .....

Your contact number .....

Appendix 8 Demographic Questionnaire

Name.....Date.....

E-mail Address.....

Contact number.....

- **What is your job title?.....**
- **What band are you?.....**
- **Have you done the NLS before? Y or N (please circle)**
- **What level unit do you work in?.....**
- **Do you take shift lead? Y or N (please circle)**
- **Are you regularly rotated to delivery suite? Y or N (please circle)**
- **How often are you offered resuscitation updates?.....**
- **Ave you successfully completed the 405 or equivalent? Y or N (please circle)**
- **How many resuscitations per month do you attend? (please circle)**

  <1 **3-5**

  1-3 **>5**

Appendix 9 Confidence questionnaire
Study number .....

Your confidence in neonatal airway management

Please answer all the following questions honestly.

Please circle the number on the scale (1 – 7) to identify how confident you are in performing each of the skills

1. How confident are you that you are able to place and maintain a newborn babies head in the neutral position?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

2. How confident are you that you can use jaw thrust to open the airway in a newborn baby?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

3. How confident are you at determining the size of a guedel airway for use in a newborn baby?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

4. How confident are you that you can correctly insert a Guedel airway?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

5. How confident are you in choosing the correct size face-mask for neonatal resuscitation?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

6. How confident are you in performing face-mask resuscitation on a newborn baby using a self inflating (Laerdel) bag or a 'T' piece?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

7. How confident are you in giving 5 inflation breaths and checking for an adequate response?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

8. How confident are you that you can instruct an assistant to help with the two-person technique for maintaining airway patency and giving ventilation breaths?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

Thank you for completing this questionnaire

Appendix 10 NLS Airway test

Resuscitation Council (UK) **NLS**

Newborn assessment and airway management - Test Scenario Sheet

Candidate Name:		**Candidate Number:**	
Course Centre:		**Course date(s)**	

Dialogue: ***"You have learnt an approach to newborn resuscitation. I would like you to demonstrate these skills in a short test scenario which I will lead you through. We shall be assessing all the airway manoeuvres you have learnt today and will use both manikins during this test to do so"***

"A full term new born baby is delivered to you. Please show me the approach to assessment and resuscitation that you would use".

Actions indicated by boxes must be done. Solid boxes indicate pass/fail actions

1. Start the clock, switch on heater, call for help etc.
2. Dry the baby, remove the wet cloth and cover ☐
3. Assess - Colour, Tone, Breathing, Heart rate ☐

"The baby is blue, floppy, not breathing, with a slow heart rate"

4. Airway control - Head position (neutral) ☐
5. Choose an appropriate sized face mask ☐
6. Mask inflation - Five inflation breaths ☐
7. Check response - Has the heart rate increased? (**If not**, is there chest movement?) ☐

"We can see the manikin's chest is moving. However, for the purposes of the test, imagine that you have not yet confirmed chest movement and the heart rate is still slow. What would you do next?"

8. Double check head position, apply jaw thrust and repeat inflation breaths ☐
9. Check for a response - Has the heart rate increased? (**If not**, is there chest movement?) ☐

"That does not work. We can again see movement but, for the purposes of the test, imagine that you have not yet confirmed chest movement and the heart rate is still slow. What would you do next? A second person is available to help"

10. *Two person airway control with inflation breaths ☐
    *and / or Inspect oropharynx using a laryngoscope and repeat inflation breaths ☐
    *and / or Insert a Guedel airway and repeat inflation breaths ☐
    (Whichever manoeuvre the candidate chooses will then work (if done correctly). Those not demonstrated in the scenario are assessed later in the test).
11. Check for a response. Has the heart rate increased? (**If not**, is there chest movement?) ☐

"The heart rate remains slow, but there is now chest movement"

12. Confirm chest movement before commencing cardiac compressions. ☐
13. The candidate should commence cardiac compressions. *(The candidate should realise the need for chest compressions – this IS a pass/fail issue. Competence should also be assessed and feed back provided – although this aspect is NOT a pass/fail issue - see guidance notes).* ☐

After a very brief assessment of chest compressions stop the scenario and ask the candidate:
"When you were having difficulty obtaining chest movement you tried xxxxxx (as chosen in 10 above) – what other manoeuvres might you have tried?"

14. The candidate should identify the manoeuvres not used and the instructor should then ask the candidate to demonstrate them on appropriate manikins. To pass, the candidate should demonstrate competence in all manoeuvres. ☐

PASS ☐ RETEST ☐ FAIL ☐

Assessor	

Appendix 11 Peer assessment of resuscitation skills

Name of colleague being assessed .....

Place of work .....

Please answer all the following questions honestly.

Please circle the number on the scale (1 – 7) to identify how competent you think your colleague is in performing each of the skills. If you have not observed them doing the skill please tick the 'can't comment' box. After completion please return in the SAE provided.

1 How competent is he/she at being able to place and maintain a newborn babies head in the neutral position?

Can't comment

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

2. How competent is he/she at using jaw thrust to open the airway in a newborn baby?

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

3. How competent is he/she at determining the size of a Guedel airway for use in a newborn baby?

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

4. How competent is he/she at correctly inserting a Guedel airway?

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

4. How competent is he/she at choosing the correct size face-mask for neonatal resuscitation?

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

6. How competent is he/she at performing face-mask resuscitation on a newborn baby using a self inflating (Laerdel) bag or a 'T' piece?

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

7. How competent is he/she at giving 5 inflation breaths and checking for an adequate response?

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

8. How competent is he/she at instructing an assistant to help with the two-person technique for maintaining airway patency and giving ventilation breaths?

(Not at all) 1 2 3 4 5 6 7 (Extremely) ☐

Thank you for completing this questionnaire – your responses will remain anonymous.

Published Article

2012; 34: e349–e385 MEDICAL TEACHER

WEB PAPER
BEME GUIDE

What is the impact of structured resuscitation training on healthcare practitioners, their clients and the wider service? A BEME systematic review: BEME Guide No. 20

CHIARA MOSLEY, CHRISTOPHER DEWHURST, STEPHEN MOLLOY & BEN NIGEL SHAW
Liverpool Womens Hospital, UK

Abstract

A large number of resuscitation training courses (structured resuscitation training programmes (SRT)) take place in many countries in the world on a regular basis. This review aimed to determine whether after attending SRT programmes, the participants have a sustained retention of resuscitation knowledge and skills after their initial acquisition and whether there is an improvement in outcome for patients and/or their healthcare organisation after the institution of an SRT programme. All research designs were included, and the reported resuscitation training had to have been delivered in a predefined structured manner over a finite period of time. Data was extracted from the 105 eligible articles and research outcomes were assimilated in tabular form with qualitative synthesis of the findings to produce a narrative summary. Findings of the review were: SRTs result in an improvement in knowledge and skills in those who attend them, deterioration in skills and, to a lesser extent, knowledge is highly likely as early as three months following SRTs, booster or refresher sessions may improve an individual's ability to retain resuscitation skills after initial training and the instigation of resuscitation training in a healthcare institution significantly improves clinical management of resuscitations and patient outcome (including survival) after resuscitation attempts.

Background and context

SRT programmes

SRT programmes in the form of resuscitation courses are used worldwide to attempt to optimise standards of clinical practice in resuscitation management, minimise error and decrease patient morbidity and mortality. Most often, SRT programmes are evaluated at a local level in terms of participant's enjoyment and engagement. The most important question, however, must be whether these programmes are effective. To date, there has been no cross disciplinary systematic review investigating whether this is the case.

SRT programmes differ in their content and target audience (e.g. the Adult Life Support, Advanced Paediatric Life Support and Neonatal Life Support). However, many aspects are similar, such as the delivery of lectures, use of simulation (often low fidelity) and assessment. Resuscitation governing bodies in different countries (e.g. the Resuscitation Council in the UK) have attempted to standardise each type of course. Courses generally take place over one day and on each, candidates are assessed in relation to their knowledge and skills in resuscitation. If successful, candidates are issued a certificate, which is usually valid for four years.

The Resuscitation Council (UK; 2010) oversees SRT for many adult and paediatric (including neonatal) specialities in the United Kingdom. There is a European Resuscitation Council, which coordinates and oversees SRT programmes in Europe and an International Liaison Committee on Resuscitation whose aim is to provide a forum for liaison between principal resuscitation organisations worldwide. A central feature of these SRT courses is that attendees are from a variety of backgrounds (medical, nursing, etc.), which helps to replicate the multidisciplinary involvement in resuscitations (Resuscitation UK 2010).

Some training programmes are mandatory requirements for healthcare professionals, and are thus funded by employers as part of a professional update. Others, however, are attended voluntarily by healthcare professionals who want to further their clinical skills. In the latter case, candidates usually pay an

Practice points

- Ensure all staff in a healthcare organisation attends an SRT programme pertaining to their speciality.
- Ensure that any reassessment of staff clinical practice skills takes place in an authentic, as well as a simulated, clinical learning context.
- Assess staff for competency in resuscitation skills three to six months after the SRT.
- Provide regular booster or refresher sessions three to six months after the SRT.

Correspondence: N. Shaw, 1st Floor, Regatta Place, Brunswick Business Park, Summers Road, Liverpool L3 4BL, UK. Tel: 0151 708 9988; Fax: 0151 702 4313; E-mail: ben.shaw@lwh.nhs.uk

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attendance fee, and the course must often be attended in the candidates own time, which may potentially result in barriers to learning. For the purposes of this review, courses, whether mandatory or not, were included as long as they fulfilled the definition of an SRT programme as mentioned earlier in the text.

Because of the financial constraints facing most UK National Health Service organisations, especially in training budgets, organisations are developing their own in-house advanced, immediate and neonatal life support courses. Despite this resolving a problem in the short term (the training and updating of healthcare workers), it may, unfortunately, have implications regarding the quality and standardisation of resuscitation training provision (Resuscitation UK 2010).

An SRT programme for the purposes of this review was defined as a resuscitation training curriculum (not necessarily accredited) delivered to a group of learners over any reported finite period of time in a predefined, structured manner. SRT programmes have been developed around the world to train healthcare professionals in adult, paediatric and neonatal resuscitation. A healthcare professional for this review is defined as an individual who as a result of their role, has contact with patients and has direct responsibility for their clinical care.

Learning and SRT programmes

Learning can be defined as changes in knowledge, understanding and skills (Brown et al. 1997). This can occur following organised training similar to that which takes place during SRT programmes or through more casual self-directed activities such as browsing the literature. An SRT course aims to equip the participant with the knowledge and skills to perform optimal resuscitation in their clinical work place. Knowledge is enhanced by the use of lectures and skills by repeated exposure to simulation scenarios. Overall, the SRT 'experience' takes the candidate through Kolb's learning cycle: they build on their prior knowledge by learning new skills and after practicing these new skills they reflect on their 'action', resulting in behavioural change (learning; Kolb 1984).

Simulation is specifically used in SRTs and incorporates many of the attributes that have been reported to facilitate learning. These are: appropriate use of feedback, engagement in repetitive practice, the simulator being embedded in a controlled environment and permitting individual learning and learning outcomes being clearly defined. It is also important that the simulator being used is a valid (high-fidelity) approximation of clinical practice (Issenberg et al. 2005).

Tight (2002) suggests that although adults have considerable experience of education, for some, this will have been largely confined to childhood. The concept of andragogy encompasses the idea of how adults learn. This places a greater emphasis on what the learner is doing (Reece & Walker 2000), as opposed to pedagogy, which, as it highlights the teacher dominating and leading the session completely, is used more in the teaching of children. Adults have reached a stage of independence and are, therefore, successfully able to undertake self-directed study (Knowles 1984). Prior to their attendance on an SRT course, learners are encouraged to read and digest the manuals to assist with their learning experience on the day of the training. Prior knowledge and exposure also seem to be key factors influencing learning (Marton et al. 1997). All candidates attending SRTs have had either, as undergraduates, some prior theoretical exposure, or as postgraduates, practical exposure to resuscitation.

Most SRT courses utilise a visual and kinaesthetic approach to learning enhanced by a behaviourist approach to learning based upon repeated practice, where students learn mainly through association. The SRT courses are designed to give candidates the skills to provide effective resuscitation, partially through an approach of repetitive practice during the training. The principle of the educator acting as the facilitator (Dunn 2000) stems from a belief that human beings have a natural eagerness to learn, thus learners become more empowered to take responsibility for their own learning when facilitated to do so by an expert. On SRT courses, candidates are encouraged by instructors to share their knowledge and experiences with their peers during the various simulation scenarios. Burns (2000) suggests that the majority of 'competency-based' training is founded upon the theory of reinforcement to strengthen behaviour. It works on the premise that the learner will repeat the desired behaviour if positive reinforcement follows the behaviour. This is used by faculty on SRT programmes repeatedly: candidates are frequently praised and given positive feedback when they perceive that a candidate has shown evidence of knowledge acquisition or improved their skills.

Knowledge and skill acquisiton and retention

Most individuals can pass resuscitation courses by achieving a certain mark in a written examination together with demonstrating ability to carry out predetermined tasks on a simulator. The degree of knowledge and skill acquisition may vary (Wynne 1986). Furthermore, the assessment of the magnitude of any transfer of knowledge and skills into the clinical setting may be difficult owing to ethical difficulties observing participants in an acute real-life resuscitation scenario and the lack of any validated measures to do so.

In the context of SRTs, behavioural change (achievement of resuscitation competency) may not be permanent: it is possible that learning can be exhibited in the assessment process following an SRT but there may be factors other than the SRT, which are responsible for the medium or long-term sustenance of the learning (maintenance of competency; McGaghie et al. 2010). One of these may be combining simulation-based medical education as on an SRT with deliberate practice – thus ensuring mastery at a particular skill (Ericsson KA 2006; McGaghie et al. 2011). However, those individuals who are not frequently exposed to resuscitation situations after an SRT may still lose skills and/or confidence quickly. This problem is illustrated by David and Prior-Willeard (1993) who assert that survival to hospital discharge depends greatly upon the initial treatment a patient receives during resuscitation, yet they suggest that, based on a clinical assessment of doctors about to take their MRCP exam, the basic life support skills of many doctors, nurses and medical students (who have previously received resuscitation training) is of poor quality.

Review aims

To determine:

(1) Whether after attending SRT programmes, the participants have a sustained retention of resuscitation knowledge and skills after their initial acquisition.
(2) Whether participants attending SRT programmes exhibit behavioural change in the work setting.
(3) Whether there is an impact on outcome for patients and/or their healthcare organisation after the institution of an SRT programme.

Review methodology

Group formation

A systematic review group was formed of staff from different disciplines working at the Liverpool Women's Hospital Foundation Trust. All group members (two consultant neonatologists (B.N.S. and C.D.), an advanced neonatal nurse practitioner (C.M.) and a hospital librarian (S.M.)) attended a one-day training course on how to conduct a BEME review. After this, individual roles were defined within the group and a timeline set for completion of the study.

Search strategies

A search strategy was developed by the group led by C.M. (see Appendix 1 for the search terms). The following databases were searched by S.M.: Medline, CINHAL, Pub Med and the Cochrane Database of systematic reviews. This search was confined to the English language literature as there is no evidence of a systematic bias from the use of language restrictions in systematic reviews (Morrison A et al. 2009) and to avoid the long potential time delay that obtaining translations may have entailed. Two search updates were performed over the two years of conducting the review to allow for the inclusion of new publications.

All articles that described an SRT, as previously defined, were identified by the presence of one or more of the key words from Appendix 1 in the title.

The majority of reference titles obtained clearly had no relevance to the review (for example, those related to basic science or animal work). In order to streamline the process, the decision was taken for one group member (C.D.) to discard those which unambiguously had no relevance. The abstracts of the remaining articles (where the article was of relevance or where there was uncertainty from just reading the title) were then distributed throughout the group. Each abstract was initially read by one of the group members who then decided on whether the article was likely to fulfil the inclusion criteria, and if it did, allocated a provisional Kirkpatrick (1994) level (see details in Box 1).

All abstracts were subsequently reviewed blindly by C.M. in order to confirm that the provisional Kirkpatrick level had been appropriately assigned and that the article should be included in the review, pending receipt of the full article, or otherwise. If there was disparity between the coder's Kirkpatrick level, and/or disagreement whether the article should be included, further discussion took place between the two coders in order to agree these issues by consensus.

The full article of each included study was then requested. When received, each article was categorised according to discipline (adult, paediatric and neonatal) and assigned a unique reference number. Each article was read by C.M., and the provisional Kirkpatrick level was again reviewed and confirmed or changed accordingly. The full text of all the articles identified for provisional inclusion together with allocated Kirkpatrick levels were then distributed to a second reviewer in the group for confirmation of the Kirkpatrick level allocation and final decision regarding inclusion.

The bibliographies of all articles to be included in the review were also searched to capture any further relevant articles which were categorised and coded as mentioned earlier.

Quality assessment and final inclusion of articles

Initially, articles were assessed independently by two members of the group (C.D. and C.M.) and scored in relation to two different quality assessments related to level of evidence presented and clarity of methodology and results reported (Appendix 2B and C). There were few randomised trials (7), but the vast majority of studies were cohort studies reporting data of a similar evidence level. All studies had a clarity of results and methodology reporting sufficient to merit inclusion: as a result, it became evident that neither 'quality' assessment could be used to define appropriate articles for inclusion. It was, therefore, decided to include articles using all research designs, and a number of criteria for inclusion based on a minimum requirement for results reporting were agreed upon as follows:

- The reported resuscitation training had to have been delivered in a predefined structured manner over a reported finite period of time.
- The participants had to be healthcare practitioners (including preregistration and postregistration, undergraduate and postgraduate).
- Participants had to be assessed by a marked or scored assessment at the end of the training, and the result of this assessment had to be stated.
- If participants were assessed some time after the training, the immediate posttraining assessment result also had to be stated.
- Where there was an improvement in any outcome for patients and/or their healthcare organisation, the magnitude and type of the effect had to be stated.

Any lack of clarity in an article in relation to the above-mentioned criteria was discussed and final agreement of the articles inclusion or exclusion was reached by consensus.

The search process yielded 3781 article titles. Of these, 425 abstracts were reviewed and 196 full articles obtained. Of these, 105 were included as there were 11 duplicate publications identified and 80 did not completely fulfil the results reporting inclusion criteria (Figure 1)

Box 1. Possible levels of outcome of articles (Modified from Kirkpatrick, 1994).

The Kirkpatrick system below was modified from Kirkpatrick's 1994 model of outcomes at four levels. Articles were allocated a Kirkpatrick level according to the outcomes described – some articles described outcomes relating to more than one level in which case they were included in the analysis for each outcome level.

Kirkpatrick Level 1 Reaction to learning experience
Evidence of learners' views on the overall learning experience and its inter-professional nature including the training programme, rather than any specific learning outcomes.

Kirkpatrick Level 2a Modification of attitudes and perceptions
Evidence of documented changes in reciprocal attitudes or perceptions between participant groups and possible changes in perception or attitude towards the value and/or use of team approaches to caring for a specific client group.

Kirkpatrick Level 2b Acquisition of knowledge and skills
Evidence of knowledge and skills acquisition immediately following completion of a SRT.

Kirpatrick Level 2c
Evidence of the retention of knowledge and/or skills over a period of time after the SRT.

Kirkpatrick Level 3 Behavioural change
Evidence of transfer of learning to clinical practice.

Kirkpatrick Level 4a Change in organisational practice
Evidence of changes within the organisational practice and delivery of care after the SRT.

Kirkpatrick Level 4b Benefits to patients/clients, families and communities
Evidence of documented impacts in the health or well being of patients/clients, families and communities after the SRT.

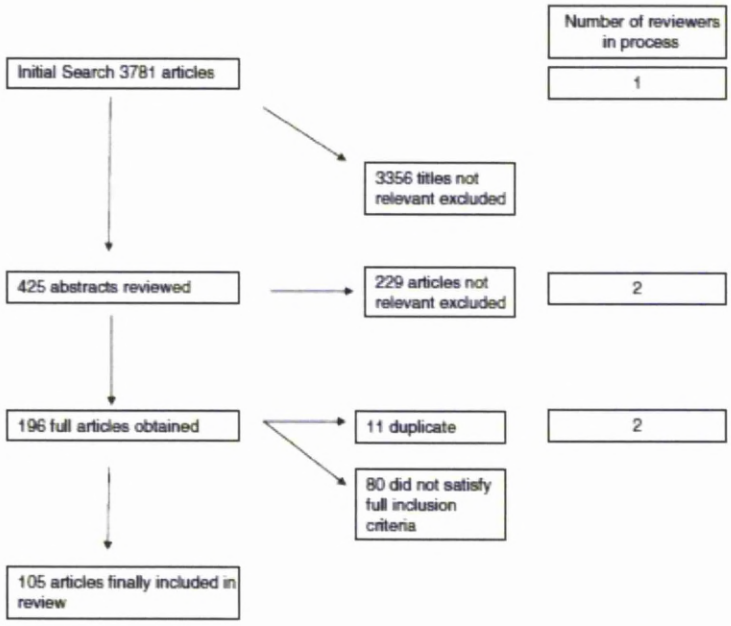

Figure 1. Flow chart of the process for final inclusion of papers in the review.

Coding and analysis

An initial coding sheet was designed by the group and produced in an Access Data Base electronic format. To pilot this, five of the selected articles were coded by two independent coders (C.D. and C.M.), and the sheet was redesigned to exclude any ambiguities. Following this, 20 articles were coded by the same two coders. It was felt that there were too many fields present with irrelevant information in the electronic format, so a simplified (paper) coding sheet was then produced (Appendix 2A). All articles were subsequently coded independently by C.M. and B.N.S., and the results were periodically reviewed to ensure that they were in agreement prior to data being inputted. Very few differences in coding occurred – these were discussed by the two coders in question and agreement by consensus reached.

For ease of reference, the relevant results were displayed on a final coding sheet in tabular form for each Kirkpatrick group for adult, paediatric and neonatal resuscitation separately using a Microsoft word document (Appendix 3).

Data relating to Kirkpatrick level 1 (satisfaction with the SRT) have not been analysed or reported in this study as, although satisfaction with teaching may affect learning, it was not directly relevant to the aims of the review.

Heterogeneity of research designs, educational interventions and outcome measures precluded meta-analysis of quantitative data (for Kirkpatrick level 2c studies, each assessment outcome used a different marking system (Tables A4–A6) and for level 4 studies outcomes were different in many studies (Tables A7–A9)). Qualitative data synthesis of research methods and outcomes was carried out by two members of the group (C.M. and B.S.) independently identifying themes from the interventions and outcomes from studies at each Kirkpatrick level. C.M. and B.S. then discussed these themes and agreed by consensus the key themes that had emerged. The narrative that emerged described the key themes and overall outcomes within groups of studies. This was discussed and refined by the review team who agreed the final narrative findings given below.

Findings

The findings will be presented for each of Kirkpatrick levels 2, 3 and 4, subdivided into adult, paediatric and neonatal resuscitation data. This allows the reader to view data that exists for their own discipline. A description of the studies for each level and each discipline, linked to the tables in Appendix 3 that display the full relevant data for each level, is followed by a description of the themes, which emerged from the data for each Kirkpatrick level.

Kirkpatrick 2A and 2B: Modification of attitudes and perceptions (2A) and acquisition of knowledge and skills (2B)

Neonates (Appendix 3, Table A1). There were three studies in this category (Ergenekon et al. 2000; Trevisanuto et al. 2005; Cavaleiro et al. 2009). The nature of the SRT offered was a mixture of lectures and simulation, and one study reported an accredited training programme. All three tested knowledge at the end of the training by multiple choice questionnaire (MCQ), and all three demonstrated statistically significant improved knowledge at the end of training (p more significant than < 0.01 in all cases). None reported testing skills at the end of training; however, one assessed confidence (Kirkpatrick level 2A) in resuscitation revealing an improvement (Ergenekon et al. 2000). One subgroup of students in one study (Cavaleiro et al. 2009), using self-study alone, showed no improvement in knowledge compared to those receiving a lecture.

Paediatrics (Appendix 3, Table A2). There were five articles in this category. The nature of the SRT that where stated included lectures and simulation (three reporting an accredited training programme). Three studies tested knowledge at the end of training (two with an MCQ and one with written case scenarios; Quan et al. 2001; Walsman et al. 2002; Gerard et al. 2006). In one study, there was a statistically significant improvement in knowledge (Walsman et al. 2002) and in another one there was no change (Quan et al. 2001). In the third study, knowledge change was not stated (Gerard et al. 2006). Three studies reported testing skills at the end via simulation with or without video, two (Quan et al. 2001, Donoghue et al. 2009) reporting statistically significant improvement in skills (one not reporting outcomes; Gerard et al. 2006). Three studies (Quan et al. 2001; Dobson et al. 2003; Gerard et al. 2006) assessed confidence (Kirkpatrick 2A) by questionnaire and reported statistically significant improvements in confidence score after training. A subgroup of participants in one study who received high fidelity simulation training had improved skills on testing compared to a low fidelity training group (Donoghue et al. 2009).

Adults (Appendix 3, Table A3). There were 23 articles in this category. The nature of the SRT in most cases included simulation with mannequins combined with lectures (14 used an accredited training programme). Eleven studies reported testing knowledge at the end of training (10 with an MCQ and one with short answer questions; Girdley et al. 1993; Ali et al. 1995; Ali et al. 1996a,b; Ali et al. 1998; Azeona et al. 2002; Tippet 2004; Owen et al. 2006; Aboutanos et al. 2007; Dauphin et al. 2007; Hoadley 2009; Jenson et al. 2009). All of these studies reported statistically significant improved exam scores at the end of the training compared to before training. Eighteen studies reported testing skills at the end of training using simulation mannequins (Ali et al. 1995; Ali et al. 1996a,b; Greig et al. 1996; Bilger et al. 1997, Ali et al. 1998; Marshall et al. 2001; Azeona et al. 2002; Mayo et al. 2004; Cimrin et al. 2005; Devita et al. 2005; Monsieurs et al., 2005; Wayne et al. 2005; Dunning et al. 2006; Owen et al. 2006; Rosenthal et al. 2006; Aboutanos et al. 2007; Hoadley 2009; Jenson et al. 2009). In three studies, the testing took the form of an objective structured clinical examination and in one only telephone skills conveying the severity of the collapse requiring resuscitation to other professionals were tested. Seven studies reported statistically significant improvements in postcourse skill scores compared to those of precourse (Ali et al. 1996a,b; Ali et al. 1998; Marshall et al. 2001; Cimrin et al. 2005; Devita et al. 2005; Dunning et al. 2006; Rosenthal et al. 2006). In addition, four studies reported skill improvement but with no p value reported to indicate whether this was statistically significant (Greig et al. 1996; Azeona et al. 2002; Owen et al. 2006; Jenson et al. 2009), and six studies reported improved scores in skills in a group receiving the training compared with a control group who did not (four of these were randomised controlled trials; Ali et al. 1995; Ali et al. 1996a,b; Bilger et al. 1997; Ali et al. 1998; Mayo et al. 2004; Wayne et al. 2005). Three studies did not report the levels of skill before and after the training despite reporting testing it (Monsieurs et al. 2005; Aboutanos et al. 2007; Hoadley 2009).

Summary of Kirkpatrick 2A and 2B studies

The overwhelming message from these studies is that both knowledge and skills are significantly improved after SRT compared with pretraining levels. This has been confirmed both when individuals are tested pretraining and posttraining and also, in the context of randomised controlled trials, when groups of participants who have been trained are compared with control groups who have not. The assessment of knowledge and skills levels and changes in these were reported using scoring systems, which were unique to each

study in most cases thus precluding meta-analysis. There is a suggestion from one study that high fidelity simulation compared to low fidelity may be more effective in improving skills (Donoghue et al. 2009), and that attending a training session compared to self-study might be more effective in improving knowledge (Cavaleiro et al. 2009). There were no clear differences in outcomes between accredited and non-accredited training programmes. Where reported, confidence at performing resuscitation tasks is universally improved in participants who have undertaken SRT. There is no evidence available to indicate whether the improvement in knowledge and/or skills after SRT results in improved clinical performance immediately after SRT.

Kirkpatrick 2C – Retention of knowledge and skills over a period of time after SRT

Neonates (Appendix 3, Table A4) There were eight studies in this category. In those studies that stated the nature of the training, all used simulation with mannequins and most used lectures (four described accredited programmes). The number of participants followed up after SRT in the studies ranged from 6 to 166. The period of follow-up ranged from 6 weeks to 12 months. All studies reported knowledge retesting at follow-up with an MCQ and five reported skill testing using mannequins. Four studies reported a decrease in knowledge (Kaczorowski et al. 1998; Curran et al. 2004; Trevisanuto et al. 2005; Dunn et al. 2008a,b) and four reported that knowledge did not change at follow-up (Dunn et al. 1992; Levit et al.1996; West 2000; Skidmore & Urquhart 2001; only two of these, however, reported no statistically significant difference). There did not seem to be any difference with respect to the nature of the training between those studies where knowledge decreased and those where it was maintained. In all but one study, which tested skills (Dunn et al. 1992; Kaczorowski et al. 1998; West 2000; Skidmore & Urquhart 2001; Curran et al. 2004), a significant decrease in skills at follow-up testing occurred. The study where skills were maintained was small (six participants) and skills were tested only six weeks after the training (West 2000).

Paediatric (Appendix 3, Table A5) There were five articles in this category (two reporting accredited training programmes). The nature of training was variable: in two studies this was unknown, in one it was self-study and in others it was lectures and simulation with mannequins. The period of follow-up testing ranged from 2 to 21 months. All studies reported knowledge testing (three with an MCQ), three demonstrating a decrease in knowledge at follow-up (Spaite et al. 2000; Su et al. 2000; Wolfram et al. 2003) and one demonstrating no change (assessment was by telephone questionnaire and no p value was reported; (Durojaiye and O'Meara 2002). Two reported testing skills at follow-up but did not report any assessment data (Nadel et al. 2000; Su et al. 2000).

Adults (Appendix 3, Table A6) There were 39 articles in this category. The nature of the training was varied and included lectures, simulation with mannequins and videos (in 18, this was part of an accredited programme). The training was delivered over a period of time ranging from 15 minutes to two-and-a-half days. The period between the training and testing at follow-up ranged from 1 to 60 months. Twenty-seven studies reported testing knowledge at a later date (20 with an MCQ, the others with a variety of written assessments). Sixteen of these studies reported significant deterioration in knowledge at follow-up testing (Gass & Curry 1983; Fossel et al. 1983; Stross 1983; Curry & Gas 1987; Ali et al. 1996a,b; Broomfield 1996; O'Steen et al. 1996; Leith 1997; Wenzel et al. 1997; Blumenfeld et al. 1998; Young & King 2000; Ali et al. 2002; Azcona et al. 2002; Boonmak et al. 2004; Tippett 2004; Semeraro et al. 2006) and seven reported no deterioration in knowledge at follow-up testing (Stross 1983; Coleman et al. 1991; O'Donnell & Skinner 1993; Holden et al. 1996; Hammond et al. 2000; Aboutanos et al. 2007; Cooper et al. 2007). With respect to the nature of the training, those groups who received a refresher or booster session (in two randomised trials) maintained knowledge better than those who did not (Stross 1983; O'Donnell & Skinner 1993). There were no other clear differences between those retaining and those deteriorating in their knowledge with respect to the nature of their training. Twenty-eight studies reported a deterioration in skills at follow-up testing (Gass & Curry 1983; Fossel et al. 1983; Stross 1983; Mancini & Kaye 1985; Curry & Gas 1987; Bradley et al. 1988; Plank & Steinke 1989; Yakel 1989; Ten Eyck 1993; Fabius et al. 1994; McKee et al. 1994; Ali et al. 1996a,b; Broomfield 1996; Erickson et al. 1996; Holden et al. 1996; O'Steen et al. 1996; Leith 1997; Wenzel et al. 1997; Hammond et al. 2000; Kovacs et al. 2000; Young & King 2000; Ali et al. 2002; Heidenreich et al. 2004; Semeraro et al. 2006; Beckers et al. 2007; Cooper et al. 2007; Spooner et al. 2007; Smith et al. 2008), whereas only nine reported maintenance of skills at follow-up (Coleman et al. 1991; O'Donnell & Skinner 1993; McKee et al. 1994; Kovacs et al. 2000; Ander et al. 2004; Boonmak et al. 2004; Heidenreich et al. 2004; De Regge et al. 2005; Wayne et al. 2005). In the studies where skills were maintained, two (Coleman et al. 1991; Boonmak et al. 2004) reported retesting only a short time period after the SRT (three months), three studies (Ander et al. 2004; Heidenreich et al. 2004; De Regge et al. 2005) reported maintenance of isolated discrete skills within a resuscitation scenario (other skills having deteriorated) and three (O'Donnell & Skinner 1993; Kovacs et al. 2000; Wayne et al. 2005) had as part of their SRT, repeated testing and refresher sessions (all in the context of randomised trials).

Summary of findings from Kirkpatrick 2C studies

It seems that knowledge can be maintained for several months after SRT, however, there is no specific aspect of training that can be identified, which facilitates this. There were no clear differences in outcomes between accredited and nonaccredited training programmes. Skills generally deteriorate from at least three months after SRT. Factors, which may prevent this occurring are, providing refresher or booster sessions after training and possibly identifying discrete actions to be assessed within simulation during training and at follow-up. Skills were all assessed at follow-up using simulation in mannequins and

not in real clinical situations making it impossible to know whether the deterioration or maintenance of skills identified was being reflected in clinical practice. Any association with behavioural change and a change in clinical performance in participants in those studies where their retention of skills and/or knowledge was reported is, therefore, unknown. In the context of this review, Kirkpatrick level 3, therefore, relates to retention of knowledge and skills and their application in a simulated environment. There is a need for work to be carried out to explore any association between behavioural change as evidenced by a simulated environment and behavioural change in a 'real-life' setting. To our knowledge, investigating and identifying behavioural change in individuals in such a setting has not been systematically investigated.

Kirkpatrick 3: Evidence of transfer of learning to clinical practice

There were no studies in this category.

Kirkpatrick 4 – Evidence of benefit to patients, families and communities after SRT

Neonates (Appendix 3, Table A7). There were seven studies in this category all following accredited programmes, which included lectures and simulation training. These studies reported outcomes following the introduction of SRT programmes within individual institutions, often over a period of years. Four studies reported a significant impact on patient outcome, (Zhu et al. 1997; Patel et al. 2001; Patel and Plotnowski 2002; Duran et al. 2008a,b) three reporting an improved resuscitation (Apgar) score in babies and one reporting a reduction in neonatal mortality (Zhu et al. 1997). Two studies reported improvement in clinical management with respect to the organisation of clinical resuscitations and interventions during resuscitation (improvement in delivery room preparation and assessment of the baby (Ryan et al. 1999) and reduction in hypothermia and inappropriate use of the drug Naloxone (Singh et al. 2006)).

Paediatrics (Appendix 3, Table A8). There were two studies in this category. Neither followed an accredited training programme. One study involved weekly simulation scenarios and one involved supervised practice. Neither of these studies reported any impact on patient outcome. One study reported an improvement in clinical management (Lorek et al. 1994) and one reported deterioration in clinical management (Ito et al. 2009). The latter study had weekly simulation scenarios as part of the training.

Adults (Appendix 3, Table A9). There were 13 articles in this category. Programmes, where stated, included lectures and simulation (only two did not follow an accredited programme). The majority of studies compared outcomes following the introduction of training into an institution; however, three studies (Dane et al. 2000; Moretti et al. 2007; Woodall et al. 2007) compared outcomes between groups of individuals who had received training with those who did not within the same institution. Seven studies reported a significant improvement in patient outcome, all of them showing a statistically significant reduction in mortality as well as in some improvement in other patient outcomes (Camp et al. 1997; Dane et al. 2000; Aneola et al. 2004; Van Olden et al. 2004; Moretti et al. 2007; Woodall et al. 2007; Spearpoint et al. 2009). Six studies reported a significant improvement in clinical management (less errors occurring or improved management at specific tasks; Vestrup et al. 1988; Makker et al. 1995, Camp et al. 1997; Aneola et al. 2004; Van Olden et al. 2004; Woodall et al. 2007).

Summary of findings from Kirkpatrick 4

Most of the studies reporting outcomes at Kirkpatrick 4 level were carried out over many years – with a period before SRT being introduced (typically 2–3 years) being compared with one after its introduction. From these, there is overwhelming evidence from the reported studies that the introduction of SRT within an institution has a direct positive impact on mortality and also on clinical management. The majority of SRT that were delivered were accredited programmes, which include a mixture of lectures and simulation. There were no clear differences in outcomes between accredited and non accredited training programmes.

Discussion

This review has described and analysed the evidence available for the efficacy of SRT on acquisition of knowledge and skills, their retention and the effect of SRT on patient care and outcome. This is the first systematic review of the literature investigating these issues. The following section summarises our conclusions regarding this in relation to the review aims and suggests a number of practice points to guide improvement in training resuscitation practice.

After attending SRT programmes do the participants have a sustained retention of resuscitation knowledge and skills after their initial acquisition?

It is clear that immediately after the vast majority of SRT programmes, knowledge and skills assessed by written examination and simulation are significantly improved (all studies where this was reported showed this to be the case). After some SRT, knowledge, assessed by written examination, may be maintained for 3 to 12 months after the initial training. There were no differences with respect to the education provided or assessments used in studies where knowledge had deteriorated compared with those where it was retained. Although it is possible that knowledge retention (given that knowledge is necessary to enable an individual to use their skills in resuscitation) may result in an improvement in clinical resuscitation practice, there is no evidence available that demonstrates this. However, the ability to demonstrate appropriate resuscitation practice in a simulated scenario is more likely than not to deteriorate after SRT as early as three months after training. Therefore even if knowledge retention did improve clinical resuscitation practice, it seems not to

result in maintenance of appropriate practical skills in a simulated scenario.

There is no evidence available to assess whether ability in resuscitation procedures in *clinical practice* changes after SRT in individuals, what the time frame for this change (if it occurs) may be and whether there is any correlation with loss of ability in a simulated environment. Further work needs to be done to investigate this (see subsequent sessions).

Much of the training offered in SRTs consist of lectures with simulation with a mannequin and is thus very similar across accredited training programmes and even in those studies that reported nonaccredited programmes. As previously discussed, educationally this SRT training approach seems to be optimal as it offers experiential learning (Kolb 1984) through practical simulation experiences aimed at supporting experiential and reflective learning (Issenberg et al. 1999) and incorporates many facets within the simulation scenarios, which facilitate learning (Issenberg et al. 2005) although learning was not sustained. There were no characteristics of individual training programmes identified that influenced the retention of knowledge and skills at a later date. Deliberate practice, reported to encourage 'mastery' (Ericsson KA 2006; McGaghie WC 2011) does not seem to have been specifically or consistently used in the SRTs reviewed. Incorporating this into SRTs may involve more time and a higher instructor – candidate ratio to ensure that all participants have achieved mastery.

Support for participants after attending SRTs may also be an important focus in order to try and ensure change in clinical practice and maintenance of skills. Some studies reviewed here suggested that factors, which may ameliorate deterioration in knowledge and particularly skills might be the provision of regular booster or refresher sessions and focusing on discrete skills as part of a task during training and at follow-up (O'Donnell & Skinner 1993; Kovacs et al. 2000; Ander et al. 2004; Heidenreich et al. 2004; De Regge et al. 2006; Wayne et al. 2006). As well as further simulation sessions, other work has suggested that 'reinforcement' in the clinical area to strengthen behaviour will also improve competence (Burns 2000).

Is there an impact on outcomes for patients and/or their healthcare organisation?

It is clear from data in this review that the introduction of SRTs within institutions, where no previous training existed, has a positive effect on patient outcome and leads to improvement in clinical management. In particular, mortality rates are reduced. There is clearly a 'group' or institutional effect of introducing these courses. However, the relative benefits for subgroups of different disciplines of healthcare practitioners is unclear. Given that there was no training before the introduction of SRTs into the institutions who reported improvement, it is likely that resuscitation practice within these institutions was at a low baseline thus making improvement more likely to occur. There is no evidence available to assess whether further improvement might occur in institutions where all staff are trained (i.e. a higher baseline of resuscitation practice) and extra training offered before mandatory updates.

Value for money and practicalities of training

Current mandatory training programmes take place at their most frequent annually, sometimes every two to three years. This review suggests that further, earlier intervention with participants might be appropriate. This not only has cost, but human resource implications. It would not be practical to offer three monthly cycles of booster resuscitation sessions at institutions – rather it might be more feasible to embed aspects of deliberate practice (including resuscitation drills) at staff induction sessions and into daily work.

If institutions are to organise and run their own in-house SRT programmes it is important that they ensure that they incorporate appropriate educational approaches into these.

Further research

Investigation of later clinical performance in individual participants in relation to skills learnt on SRT programmes and whether deteriorations in skills after SRT as assessed by simulation correlates with deterioration of skills in clinical practice are areas that have not been researched. This may be quite difficult to do, possibly involving routine videoing of resuscitation. There are ethical and consent issues surrounding this practice and, at present, there is no validated assessment tool for this. There are also concerns that videos may be used in litigation cases (O'Donnell et al. 2008).The effects of embedding aspects of deliberate practice into routine work and the use of resuscitation drills require further work and the timing and frequency of booster sessions has yet to be determined.

Where staff of all disciplines in a healthcare institution are trained in resuscitation, there is a need for research, which investigates whether the learning that takes place on subsequent resuscitation courses results in improvement in resuscitation management.

Strengths, weaknesses and limitations of the review

This review has systematically obtained literature pertaining to SRTs and their impact. Results have been reported by speciality (adult, paediatric and neonatal), thus, facilitating the readers understanding of the evidence available within each speciality.

The systematic review only considered articles from the English language literature to avoid the long potential time delay that obtaining translations may have entailed. This is often standard practice for systematic reviews, making it possible that articles with relevant data (in another language), which could have contributed to the results may have been overlooked. There is, however, no evidence of a systematic bias from the use of language restrictions in systematic reviews (Morrison A et al. 2009). The nature of the published body of evidence ruled-out a formal meta-analysis for this review. Heterogeneity of research designs and unstandardized outcome measures made a quantitative synthesis of the research evidence impossible. By the nature of qualitative analysis of themes, the quality of the final data collection and analysis depends on the integrity and unbiased approach of the researchers. Bias is possible if the researchers approach the subject with preconceived notions which may affect

the findings. In order to minimise this, validation of the analysis was carried out by triangulation of the findings with others members of the review group.

Conclusions

(1) SRTs result in an improvement in knowledge and skills in those that attend them.
(2) Deterioration in skills and to a lesser extent knowledge is highly likely as early as three months following SRTs.
(3) There is a small amount of evidence that booster or refresher sessions may improve an individual's ability to retain resuscitation skills after initial training. However, the timing and frequency of these in different disciplines has yet to be determined.
(4) Ensuring clinical staff of all disciplines in a healthcare institution, where no previous training existed, are trained in resuscitation will improve the clinical management and mortality rates after resuscitation attempts.
(5) Where staff of all disciplines in a healthcare institution are trained in resuscitation, there is a need for research, which investigates whether the learning that takes place on subsequent resuscitation courses results attended by individuals from these institutions results in further behavioural change in the clinical area (that is a change in clinical practice) thus further improving resuscitation management.
(6) There is an urgent need for research to determine whether deteriorations in skills after SRT as assessed by simulation correlates with deterioration of skills in clinical practice.

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Notes on contributors

BEN (NJD SHAW, MB ChB, MRCP (UK), FRCPCH, MD, MA (Clin Ed), Consultant in Neonatal and Respiratory paediatrics at Liverpool Women's Hospital and The Royal Liverpool Children's Hospital, Associate Postgraduate Dean at Mersey Deanery and Professor to the Evidence-based Practice Research Centre, Faculty of Health, Edge Hill University His special interests are acute and chronic neonatal respiratory disease, learning in the clinical setting, retention of skills, work place based assessments and educational interventions that improve clinical care. Contact reviewer, author of the background for the protocol, joint author of the review, main support for the project. Assisted with coding the abstracts and second coder for the final articles

CHIARA MOSLEY, Msc Health Sciences, BNB Higher award, ENB 405, 997, A19 (Advanced Practice, Dip He Midwifery, Dip He, Nursing, PGCE, Advanced Neonatal Nurse Practitioner, Liverpool Women's Hospital) Currently undertaking a PhD in the retention of knowledge and skills following structured neonatal resuscitation training. Lead for coding, assisted with writing draft protocol and coding the abstracts, first coder for all papers and main author of the BEME review

CHRISTOPHER DEWHURST, MB, ChB, BSC, FGCTICP, MRCPCH, Consultant neonatologist, Liverpool Women's Hospital Contributed to screening articles and to coding of articles, transferred the coding sheet into excel form and set up the reference manager system, reviewed drafts of review manuscript

STEPHEN MOLLOY, BA, Head librarian Liverpool Women's Hospital Lead for designing search terms and finding the articles for the review

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Appendix 1: Table to show search strategy

Searched		Searched		
RESUSCITATION	AND	(CLINICAL ADJ COMPETENCE).MH	AND	TRAIN$ OR COURS$ OR PROGRAM$
RESUSCITATION#.W..DE.		CLINICAL ADJ SKILLS		
CARDIOPULMONARY ADJ RESUSCITATION		RETAIN OR RETAINED OR RETENTION		
CARDIOPULMONARY-RESUSCITATION#.DE.		RETENTION-PSYCHOLOGY.MH.		
ADVANCED ADJ LIFE ADJ SUPPORT OR BASIC ADJ LIFE ADJ SUPPORT		EDUCATION-MEDICAL..MH.		
		MEDICAL ADJ EDUCATION		
		MEASURE OR MEASUREMENT		
		COGNITION.MH.		
		COMPUTER-SIMULATION.MH.		
		COMPUTER-ASSISTED-INSTRUCTION.MH.		
		PRETEST OR POSTTEST		
		TIME-FACTORS.MH.		

Appendix 2A: Coding Sheet printed computerised version

Title of BEME review

What is the impact of structured resuscitation training on healthcare practitioners, their clients and the wider service?

Administrative Data

Date Coded _____ Kirkpatrick score_____

Reference number _____ Reviewer 1._____

Reviewer 2._____

Agree with coding Y | ___ N | ___ (If N) Why? _____

Impact of intervention studied

Code the level of impact being studied in the item and summarize any results of the intervention at the appropriate level. Note: include both predetermined and unintended outcomes.

- Modified **Kirkpatrick hierarchy**

Level 1 ☐ **Participation** - covers learners' views on structured resuscitation programmes, their presentation, content, teaching

methods, and aspects of the instructional organization, materials, quality of instruction

_____

_____

Level 2a ☐ **Modification of attitudes/perceptions** – outcomes here relate to changes in the attitudes or perceptions between participant groups towards structured resuscitation programmes (e.g. do candidates feel more confident following the course).

_____

_____

Level 2b ☐ **Modification of knowledge or skills** –Is there a change in knowledge or skills following a structured resuscitation programme (i.e. does the candidate acquire skills in problem solving, practical and psychomotor skills?)

_____

_____

Level 3 ☐ **Behavioural change** – Identifies the individuals transfer of learning to the workplace or the willingness of learners to apply new knowledge and skills following attendance on a structured resuscitation programme. (Was there retention of knowledge or skills over time?)

_____

_____

Level 4a ☐ **Change in organizational practice** – looks at the wider changes in the organizational delivery of care, attributable to structured resuscitation programmes

_____

_____

Level 4b ☐ **Benefits to patient Identifies** any improvement in the health & well being of patients as a direct result of attending a structured resuscitation programmes

_____

_____

What levels have been obtained? _____

Does the abstract fulfil the objective criteria and how? (Modified Kirkpatrick Hierarchy)

Yes… Level achieved? _____

No…. Why not? _____

Article Volume No _____ Issue _____ Pages_____ Year _____

Qualitative ☐

Quantitative ☐

Search Method

Electronic search ☐ Hand search ☐

Grey literature ☐ Recommendation ☐

Aim of the study

Was the aim/objective? Implied ☐ Stated ☐ unclear (after checking) ☐

Why was the article written?

In an attempt to change practice ☐

In response to new guidelines ☐

To investigate the effects of a training programme on knowledge retention ☐

As a look at patient outcome following attendance on a resuscitation programme ☐

Was ethical approval sought and gained prior to commencing the study? Y ☐ N ☐

Research design

1. Qualitative? Y ☐ N ☐

If so what type? _____

2. Quantitative? Y ☐ N ☐

If so what type? _____

	Y	N		Y	N
Cross-Sectional	☐	☐	Case Control	☐	☐
Trials			Cohort Study		
Non-randomized	☐	☐	Prospective	☐	☐
Randomized	☐	☐	Retrospective	☐	☐

Over what period of time was the data collected? _____

Type of structured resuscitation programme (status)

Title of the training programme if stated (E.g. NLS)_____

_____

Is it a national programme? _____

Is it an in house training programme? _____

Specify the type of skills that were being taught. _____

Was this a mandatory training update? Y ☐ N ☐

Cost of the course_____ Unknown ☐

Duration of the course (please tick)

< 1 day ☐ 1 day ☐ 2 days ☐ > 2 days ☐ unknown ☐

Location of course _____

Country set in _____

Was there any e-learning involved? Y | N |

Number of instructors_____ unknown

Number of candidates in the group _____ unknown

Were the participants Drs | Nurses | Students | Other? |

If other please specify _____

Was their place of work specified? Y N if yes where did they work?

_____

Was their age specified? Y N

If yes how old were they _____

Was their gender specified Y | N |

If yes were they mostly male or female? _____

Had the attendees any knowledge of the subject before attending? Y N unknown?

|

Had they attended a similar course or been taught to the same level prior to attending? Y | N |

unknown?

Were they given any pre-course material to read prior to attending? Y N

If yes was this an official resuscitation manual? Y | N | unknown? |

Certification of course if stated

Is this a pass or fail course? Y N not known

Were all the assessments formative or summative

How much of the course was skills based? <1/3 | 1/3-2/3 | >2/3 |

How much was knowledge based? <1/3 1/3-2/3 >2/3

ASSESSMENT PROCESS

Precourse (prior to attending)	**Yes**	**No**
Were participants tested 'pre course'?		
Was there a written paper prior to instruction? (i.e. was knowledge assessed)?		
If yes did they complete the paper prior to attending?		
Was a practical exam involved prior to instruction? (i.e. were skills assessed)?		

(If Yes) What were these? _____

How many observers where there? _____

Was it done under exam conditions?

Was 360 degree review used?

Were candidates asked their confidence levels prior to attending the course? Y N

Were the pre-course assessments formative summative

Were there any skill stations **Pre course** (tick any that apply)

- Vascular access (UVC) ☐
- Cannulation ☐
- Inflation breaths ☐
- Chest compressions ☐
- Drug calculations ☐
- Needle thoracentisis ☐
- Crichoidotomy ☐
- Scenarios ☐
- Other ☐ please state _____

During the course (Inc the end)	Yes	No
Was a practical exam involved (i.e. were skills assessed)?	☐	☐

(If Yes) What was this? _____

How many observers where there? _____

Was there a written paper (i.e. was knowledge assessed)? ☐ ☐

Was 360 degree review used? ☐ ☐

Was there a behavioural change in candidates? (skills) ☐ ☐

(i.e. had learning occurred?) not known ☐

Was this implied ☐ Stated ☐

Was an improvement noted between pre-course and course test? Y ☐ N ☐

(knowledge/ written paper) e.g had learning taken place? not known ☐

Was this? Implied ☐ Stated ☐

Were the course assessments formative ☐ summative ☐ not known ☐

Were there any skill stations at the final assessment (tick any that apply)

- Vascular access (UVC) ☐
- Cannulation ☐
- Inflation breaths ☐
- Chest compressions ☐
- Drug calculations ☐
- Needle thoracentisis ☐
- Crichoidotomy ☐
- Scenarios ☐
- Other ☐ (state) _____

Post course (if reviewed after a period of time)

Did the candidates get tested at a later date? Y ☐ N ☐

If retesting was done- How many times

1 ☐ 2 ☐ 3 ☐ >3 ☐

How long after the initial exposure was this carried out?

< 1 month ☐ 1-3 months ☐ 4- 6 months ☐ 6 months -1 year ☐

Were the assessments formative ☐ summative ☐

Yes No

Was a practical exam involved (ie were skills assessed)? | | |

(If Yes) What was this?_____

How many observers where there? _____

Was there a written paper(ie was knowledge assessed)? | | |

Were there any skill stations **post-course** (tick any that apply)

- Vascular access (UVC)
- Cannulation
- Inflation breaths
- Chest compressions
- Drug calculations
- Needle thoracentisis
- Crichoidotomy
- Scenarios
- Other (state)_____

Was 360 degree review used? Y N

Were questionnaires used for self evaluation? Y N

Was there evidence of loss of confidence? Y N

Was there any evidence that knowledge had been maintained at the same level as the end of the course?

Y N

Was there any evidence that skills were maintained at the same level as the end of the course?

Y N

Did the candidates feel that they have lost their skills? Y N

Did the candidates feel that they have lost their knowledge? Y N

Was there evidence of organisational change? Y N

Was there evidence of alteration of clinical outcome? Y N

Conclusions

Did the recommendations of the study:-

Suggest that further studies were required? Y N

Make recommendations for change? Y N

Suggest further training was required? Y N

Suggest that the training should be offered more frequently? Y N

Quality (statistical analysis)

Was the study design appropriate? Y N unsure

Were statistical tests were used to evaluate the results Y | N |

Please list _____

Were these appropriate? Y N unsure

Were the results of the main aim of the study statistically significant? Y | N |

Comment on the evaluation methods if appropriate

_____

Appendix 2B: Initial assessment of quality

Criteria		Yes (2/good)	Partial (1/fair)	No (0/poor)	N/A
Study aims					
1.	Is the hypothesis/aim/objective of the study clearly & sufficiently described?	Easily identified in introduction/method. Specifies: purpose, subjects/target population, and specific interventions/associations under investigation.	Vague/incomplete reporting or some info has to be gathered from parts of the paper other than intro/background/objective section.	Question or objective not reported/incomprehensible.	
Study design & sample characteristics					
2.	Is the study design well described and appropriate? *(If study question not given, infer from conclusions).*	Design easily identified, well described and appropriate.	Design and/or study question not clearly described, or design only partially addresses study question.	Design does not answer study question or design is poorly described.	
3.	Is the method of intervention group selection described and appropriate?	Described and appropriate.	Selection methods not completely described, but no obvious inappropriateness. Or selection strategy likely introduces bias but not enough to seriously distort results.	No information/inappropriate information provided or selection bias, which likely distorts results.	
4.	Are the characteristics of intervention group clearly described (i.e. age range, occupation)?	Sufficient relevant demographic information. Reproducible criteria used to categorise participants clearly defined.	Poorly defined criteria or incomplete demographic information.	No baseline/demographic info provided.	
5.	Have the characteristics of participants lost to follow-up been described?	Losses adequately reported & not likely to affect results.	Losses not well reported, but small & not likely to affect results.	No information or losses large and likely to affect results.	No participants lost to follow-up.
6.	Are educational intervention(s) clearly described?	Defined and reproducible.	Partially defined, but insufficient detail to reproduce design.	Not described.	
7.	Is method of delivery of educational intervention and subsequent follow-up clearly defined?	Sufficient relevant descriptive information. Reproducible criteria used to replicate intervention defined.	Poorly defined criteria or incomplete descriptive information.	No criteria/descriptive info provided.	
Data analysis and results					
8.	Are the main outcomes to be measured clearly described in the introduction/method?	Defined and measured according to reproducible criteria.	Definition leaves room for subjectivity, or not sure (i.e. not reported in detail, but probably acceptable). Or precise definition(s) are missing, but no evidence of major problems. Or instrument/mode of assessment(s) not reported.	Main outcomes first mentioned in results section. Or measures not defined/inconsistent/poorly defined.	
9.	If possible, was an attempt made to blind those measuring the main outcomes of the intervention?	Assessor blind to intervention/study group.	Inadequate blinding: i.e. assessor may have been aware of group participant assigned to.	No attempt made to blind assessor.	Not possible/appropriate – e.g. observational/before & after study.

10.	Are population characteristics (if measured & described) controlled for and adequately described?	Appropriate control at design/analysis stage or randomised study with comparable baseline characteristics.	Incomplete control/ description. Or not considered but unlikely to seriously influence results.	Not controlled for and likely to seriously influence results.	
11.	Are the outcomes chosen to evaluate the intervention appropriate?	Appropriate outcomes selected and reported.	Some outcomes not relevant to assessing appropriateness of intervention.	Outcome measures do not evaluate intervention or poorly reported/not defined/ inconsistent.	
12.	Are the main findings clearly described?	Simple outcome data (e.g. mean/prevalence) reported for all major findings.	Incomplete or inappropriate descriptive statistics.	No/inadequate descriptive statistics.	
13.	Are methods of analysis adequately described and appropriate?	Described and appropriate.	Not reported but probably appropriate or some tests appropriate, some not.	Methods not described and cannot be determined.	
14.	Are estimates of variance reported for the main results?	Appropriate estimates provided (SD/SE, confidence intervals).	Undefined or estimates provided for some but not all outcomes.	No information.	
15.	In trials/cohort studies, do analyses adjust for different lengths of follow-up, or in case-control studies, is the time between intervention and outcome the same for cases/ controls?	Different lengths of follow-up adjusted for (e.g. survival analysis) and adequately described.	Different lengths of follow-up probably adjusted for but not adequately described.	Differences in follow-up ignored.	Cross-sectional design or same length of follow-up.
Conclusions					
16.	Are the conclusions supported by the results?	All conclusions supported by data.	Some of the major conclusions are supported by the data; some are not. Or speculative interpretations are not indicated as such.	None/few of major conclusions supported by the data.	

Appendix 2C: Final quality assessment criteria

Methodology

1. Randomised control trials

Individuals are randomly allocated to a control group and another group who receive a specific intervention- groups are identical for significant variables.

2. Cohort study

Groups are selected based upon their exposure to something and followed up for a specific outcome.

3. Case control studies

Cases with the condition/subject of interest are matched with 'controls' without

4. Cross sectional surveys/studies

Interview/questions are of a sample of the population of interest at a certain point in time

5. Case study report

A report based upon a single patient

Quality score

4. Results from this are clear with good methodology.
3. Results are unclear with good methodology
2. Results are clear but with poor methodology
1. Results are unclear and specific to the individual study.

Appendix 3

Table A1. Kirkpatrick 2A and 2B neonates.

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence assessed (if so how)	Significant improvement in confidence at the end of the training
Cavalieri et al. 2009	No	50 min Lecture then self study or Simulation (RCT)	Yes - after lecture and again after self study/simulation	MCQ	Yes after lecture ($p < 0.0001$) No after self study/ simulation	No	N/A	N/A	No	N/A
Engelsen et al. 2009	No	8 hours Lectures simulation	Yes	MCQ	Yes (mean score precourse 9.5 vs. post course 14.2) ($p = 0.001$)	No	N/A	N/A	Yes, assessed in evaluation form at the end of the course	72% felt more confident at the end
Trevisanuto et al. 2005	Yes NRP	2 courses 2 day Lectures Simulation	Yes	MCQ	Yes Both courses (62% to 86% and 64% to 94%) $p \leq 0.01$	No	N/A	N/A	No	N/A

Notes: MCQ: multiple choice questionnaire, NRP: Neonatal Resuscitation Programme, N/A: – Not applicable, RCT – randomised controlled trial.

Table A2. Kirkpatrick 2A and 2B paediatrics.

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Dobson et al. 2003	No	Six hours lectures simulation	No	Not tested	Not tested	No	Not tested	Not tested	Yes – Likert scale	Yes in all 13 areas tested ($p \leq 0.002$)
Donoghue et al. 2009	No	Simulation – Hi fidelity vs low (RCT)	No	Not tested	Not tested	Yes	Simulation with two different manikins	Both groups improved scores but P value not stated (High fidelity group improved more than low fidelity) (P= 0.007)	No	N/A
Girard. et al 2006	Yes PALS	Web based course vs. traditional PALS	Yes	MCQ	Not stated	Yes	Video of performance		Not stated	Yes
Quan et al. 2001	Yes PALS	Two days Not stated	Yes	Written case scenarios	No	Yes	Video simulation	Yes P= < 0.05 and < 0.01 depending upon skill	Yes questionnaire	Scores improved from 3.77 to 4.28 in one group and 3.57 to 4.24 in other group (p value not stated but 95% confidence intervals indicate significant) Mean confidence score increased from 1.9 to 6.2 (p value not stated but 95% confidence intervals indicate significant)
Wallman et al 2002	Yes PALS	Not stated	Yes	MCQ	Yes – proportion passing exam increased from 62% to 84% ($p \leq 0.001$)	No	N/A	N/A	No	N/A

Notes: MCQ – multiple choice questionnaires, PALS- Paediatric Advanced Life Support, RCT – randomised controlled trial

Table A3. Kirkpatrick 2A and 2B adults.

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Aboutanos et al. 2007	No	Lectures simulation	Yes	MCQ	Score increased from 72% to 79% ($p = 0.032$)	Yes	OSCE	Not known – no precourse score	No	N/A
Ali et al. 1995	Yes ATLS	Not stated (RCT of course vs not course)	Yes	MCQ	Improved compared with control group ($p < 0.01$)	Yes	OSCE	Improved compared with control group ($p < 0.01$)	No	N/A
Ali et al. 1998a,b	Yes ATLS	Not stated (RCT of course vs not course)	Yes	MCQ	Improved compared with control group and precourse scores (no p value)	Yes	OSCE	Improved compared with control group and precourse scores ($p < 0.05$)	No	N/A
Ali et al. 1998	No PHTLS	Not stated	yes	MCQ	Improved compared with control group and precourse scores ($p < 0.05$)	Yes	Simulation	Improved compared with control group and precourse scores ($p < 0.05$)	No	N/A
Bliger et al. 1997	Yes AHA	Model telephone simulation (RCT – phone vs no phone)	No	N/A	N/A	Yes	Use of phone	Improved in group taught with model phone ($p < 0.01$)	No	N/A
Clmrin et al. 2005	No	Lectures simulation	No	N/A	N/A	Yes	Simulation	Improved from score of 11.2 precourse to 15.6 postcourse ($p < 0.001$)	No	N/A
Azoona et al. 2002	Yes ATLS	Not stated	Yes	MCQ	Improved from 0% to 100% pass	Yes	Simulation	Improved from 5/16 to 16/16 passed	No	N/A
Dauphin et al. 2007	Yes ALSO	2 days Lectures simulation	Yes	MCQ	Improved from mean score of 55% precourse to mean 88% postcourse ($p < 0.01$)	No	N/A	N/A	Yes questionnaires	Eight of nine felt more confident
Dunning et al. 2006	No	Lectures simulation	No	N/A	N/A	Yes	Simulation	Improved times in most tasks (all $p < 0.05$)	No	N/A
Featherstone et al. 2005	Yes ALERT	Not stated	No	N/A	N/A	No	N/A	N/A	Yes questionnaires	Confidence improved in many areas ($p < 0.01$)

Gadkey et al. 1993	Yes ATLS	Lectures simulation	Yes	MCQ	Improved from mean score of 28.3% pre-course to mean 34.6% post-course $p = 0.0001$	No	N/A	N/A	No	N/A
Greig et al. 1998	Yes BLS	Not stated	No	N/A	N/A	Yes	Simulation	Yes (six weeks later) – p value not stated	No	No
Davis et al. 2005	No	Lectures, simulation, debriefing	No	N/A	N/A	Yes – as a team	Simulation	Improved survival and task completion after training ($p < 0.002$)	No	N/A
Hoadley 2009	Yes ACLS	Lectures simulation	Yes	MCQ	Improved score from mean pre-course of 80% to post-course mean of 89% ($p < 0.001$)	Yes	Simulation	Not known	Yes	N/K
Jensen et al. 2009	Yes ALS	Lectures simulation RCT	Yes	MCQ	Improved scores of means of 73 and 70% pre-course to 86 and 83 % post-course (no p value reported)	Yes	Simulation	Yes (combined score with MCQ)	No	N/A
Mayo et al. 2004	No	Two groups – one received training the other not simulation	No	N/A	N/A	Yes	Simulation	Improved in most areas in group receiving training ($p < 0.001$)	No	N/A
Monsieurs et al. 2005	No	Not stated RCT two different bagging systems	No	N/A	N/A	Yes	Simulation	Not stated – automatic bagging system better than manual $p = 0.0001$)	No	N/A
Marshall et al. 2001	Yes ATLS	Not stated	No	Not stated	N/A	Yes	Simulation	Skills improved in all areas post-course ($p < 0.002$)	Yes survey	Increased from mean score of 5.8 to 8.1 ($p < 0.01$)
Murphy & Fitzsimons 2004	Yes LS	Not stated	No	N/A	N/A	No	N/A	N/A	Yes – qualitative	Improved (qualitative data)
Owen et al. 2006	No	Simulation	Yes	MCQ	Yes $p = 0.001$	Yes	simulation	Improved (p value not stated)	Yes – questionnaire	$p \leq 0.001$
Rosenthal et al. 2006	No	Simulation	No	N/A	N/A	Yes	Simulation	Improved in nearly all areas (at 6 weeks after/from pre-course pre-course score ($p < 0.0001$)	No	N/A

(continued)

Table 3. Continued.

Author	Accredited training programme	Nature of the training	Tested knowledge at the end of the training	How was knowledge tested	Knowledge significantly improved at the end of the training	Tested skills at the end of the training	How were skills tested	Skills significantly improved at the end of the training	Confidence tested at the end of the training (if so how)	Significant improvement in confidence at the end of the training
Tippet 2004	Yes ATLS	Not stated	Yes	Short answers	Improved from mean 61% to mean 83% ($p = 0.008$)	No	N/A	N/A	No	N/A
Wayne et al. 2005	No	Simulation RCT	No	N/A	N/A	Yes	Simulation	Improved scores – 38% higher than controls with no training ($p < 0.0001$)	No	N/A

Notes: ACLS – Advanced Cardiac Life Support, AHA – American Heart Association, ALERT – Acute Life-Threatening Events: Recognition and treatment, ALSO – Advanced Life Support for Obstetrics, ATLS – Advanced Trauma Life Support, BLS – Basic Life Support, MCQ – multiple choice questionnaire, N/A – not applicable, OSCE – Objective Structured Clinical Examination, PHTLS – Prehospital Trauma Life support.

Table A4. Kirkpatrick 2C neonates.

Author	AP	Nature of the training	No of participants Followed up (D=doctors, N=nurses, S=students O=other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	*p*	Skill change	Notes	*p*
					K	S						
Curran et al. 2004	No	Computer manikin	60 (D)	Four and eight months (one group with booster)	Yes MCQ	Yes Simulation	R then NC	RCT – Decreased knowledge at four months in both groups then remained same at eight months	<0.0001 then Not SIGNIF	R	RCT – Both groups at eight months	<0.0001
Dunn et al. 1992	No	One day Lectures Demo	166 (N)	Six months	Yes MCQ	Yes Simulation	NC	Mean MCQ score from 91% to 86%	Not SIGNIF	R	All passed after training – All failed at follow-up	N/K
Duran et al. 2008a,b	Yes NRP	Lectures Simulation	42 (D)	6 and 12 months	Yes MCQ	No	R	Mean MCQ score from 94.5% to 59.2% after 6 months and 93.2% to 58.3% after 12 months	N/K	N/A		N/A
Kuczorowski et al. 1999	Yes NRP	Video Practical	44 (D)	6–8 months	Yes MCQ	Yes Simulation	R	RCT – All passed after training –at follow-up 26 (96%) passed in control group and two other groups who had booster	N/K	R	All passed after training – all failed at follow-up	N/K
Levitt et al. 1998	Yes NRP	N/K	10 (D)	6–9 months	Yes MCQ	No	NC	Mean MCQ score from 86.4% to 75.4%	Not SIGNIF	N/A		N/A
Skidmore & Urquhart 2001	No	Lectures Simulation	62 (D and N)	6 months 12 months	Yes MCQ	Yes Simulation	NC		N/K	R	After six months (but not back to pretraining score)	N/K
Trevisanuto et al. 2005	Yes NRP	2 days Lectures Simulation	25 (D)	6 months	Yes MCQ	No	R	Mean MCQ score from 94.1% to 62.7%	<0.0001	N/A	N/A	N/A
West 2000	No	Two hours N/K	6 (N)	6 weeks	Yes MCQ	Yes Simulation	NC		N/K	NC		N/K

Notes: AP – Accredited programme, Knowledge change:, I – Increased, NC – No change, *p* – *p* value, MCQ – Multiple-Choice Questionnaires, Not SIGNIF – not significant, N/A – Not applicable, N/K – Not known, NRP – Neonatal Resuscitation Programme, R – Reduced.

Table A5. Kirkpatrick 2C paediatrics.

Author	AP	Nature of the training	No of participants Followed up (D = doctors, N = nurses, S = students, O = other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	*p*	Skill change	Notes	*p*
					K	S						
Durojaiye and O'Meara 2002	Yes PLS	N/K	23 (D)	2 weeks and 2 and 4 months	Yes phone questions	No	NC		N/K	N/A		N/A
Nadel et al. 2000	No	Eight hours Lectures Simulation video – Then booster in one group	57 (D)	Approx 12 months	Yes MCQ	Yes Simulation video	N/K	Did not report change in knowledge but group who received booster did better than control group	N/K	N/K	Did not report change in skills over time but group who received booster did better than control group	N/K
Spinte et al. 2000	No	Self-study	11 (O)	Four months	Yes 'test'	No	R	Mean score in test fell from 13.04 to 11.59	<0.01	N/A		N/A
Su et al. 2000	No	16 hours Lectures Simulation Subgroups had simulation or knowledge exam at 6 months	43 (O)	12 months	YesMCQ	Yes simulation	R	Scores in reduced between 19.7% and 22.3% at follow-up – no difference between groups randomised to have test at six months and controls	<0.05	N/K		N/K
Wolfrum et al. 2003	Yes PALS	N/K	99 (O)	Mean 21 months	Yes MCQ	No	R	25% passed exam at follow-up	N/K	N/A		N/A

Notes: AP – Accredited programme, Knowledge and Skill change: I – Increased, NC – No change, MCQ – Multiple-Choice Questionnaires, N/A – Not applicable, N/K – Not known, *p* – *p* value, PALS – Paediatric Advanced Life Support, PLS – Paediatric Life Support, R – Reduced.

Table A6. Kirkpatrick 2C adults.

Author	AP	Nature of the training	No of participants Followed up (D = doctors, N = nurses, S = students O = other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	p	Skill change	Notes	p
					K	S						
Aboutanos et al. 2007	No	Lectures simulation	12 (D)	Two years	Yes MCQ	No	I	Mean score increased from 65% to 77%	<0.05	N/A		N/A
Ali et al. 2002	Yes ATLS	Lecture Simulation	144 (D)	Six months, 2, 4, 6 and 8 years	Yes MCQ	Yes OSCE Simulation	R	High and low trauma-exposed groups reduced scores from 83.9% to 74.8% and 81.9% to 74.6%, respectively, at six months. After this, no group passed MCQ	N/K	R		N/K
Ali et al. 1996a,b	Yes ATLS	N/K	60 (D)	Six months, 2,4 and 6 years	Yes MCQ	Yes OSCE	R	Scores after ATLS 85.3 – 87.7% in four groups. At six months = 77.8% (50%) pass, at two years 70.6% (0 passes), at four years 69.4% (0 passes), at six years 68.9% (0 passes)	N/K	R	Score after ATLS 16.6. Score at six months = 16.8, at two years = 13.9, at four years 12.0, at six years 11.9	N/K
Ander et al. 2004	No	Four hour lectures two hours and Simulation	40 (D)	Six and 12 months	No	Yes Simulation	N/A		N/A	I	Two of three skills improved at follow-up	N/K
Azzona et al. 2002	Yes ATLS	Not stated	59 (D)	Less than two years (38) and more than two years (21)	Yews MCQ	No	R	8/38 and 2/21 passed at follow-up	N/K	N/A		N/A

(continued)

Table A6. Continued.

Author	AP	Nature of the training	No of participants Followed up (D = doctors, N = nurses, S = students O = other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	p	Skill change	Notes	p
					K	S						
Beckers et al. 2007	No	15-minute lecture	59 (S)	Six months	No	Yes Simulation	N/A		N/A	R	Time to first shock elongated from mean of 56.5 seconds post-training to 59.9 seconds at follow-up (but not back to pre-training level)	<0.01
Blumenfeld et al. 1998	Yes ATLS	N/K	220 (D)	Three to 60 months	Yes MCQ	No	R	Mean score 84% post-course and 66% at follow-up. 50% participants scored above 80% by 180 weeks	N/K	N/A		N/A
Boonmak et al. 2004	No	One-hour lecture, one-hour Simulation	30 (N)	Three months	Yes MCQ	Yes Simulation	R	Mean score fell from 75.4% to 60.5% at follow-up (back to pre-training levels)	N/K	N/C	(Mean skill score after training 79.7, at follow-up 75.7)	Not SIGNIF
Bradley et al. 1988	No	10-hour and four-hour lectures and Simulation	51 (O)	18 months (after Six month test at follow-up)	Yes MCQ And written	Yes Simulation	?R	RCT Proportion of failures may have increased in both groups at follow-up – no formal analysis	N/K	?R	Proportion of failures may have increased at follow-up – no formal analysis	N/K
Broomfield 1998	Yes ENB	Three hours Lectures Simulation	19 (N)	10 weeks	Yes MCQ	Yes Simulation	R	Mean score 23.9 postcourse and 19.4 at follow-up (higher than pretraining)	<0.0001	R	Mean score 7.2 postcourse and 5.1 at follow-up (higher than premining)	<0.0001
Coleman et al. 1991	No	Four hours of either lectures, discussion, handouts and simulation or e-learning	49 (S)	Three months	Yes MCQ	Yes Simulation	NC	Maintained scores in both groups	Not SIGNIF	NC	Maintained scores in both groups	Not SIGNIF
Cooper et al. 2007	Yes ILS	One-day lectures Simulation	29 (D, N, O)	Six months	Yes MCQ	Yes Simulation	N/C	Mean score 82% postcourse and 80% at follow-up	Not SIGNIF	R	Mean score 99% postcourse and 86% at follow-up (higher than premining)	0.02

Curry and Gas 1987	No	N/K		86 (D and N)	Six and 12 months	Yes MOQ	Yes Simulation	R	Doctors mean score 89.6% post-course, 84% at 6 months and 83.4% at 12 months Nurses mean score 92.3% post-course, 82% at 6 months and 79.4% at 12 months (Both back to pre-training levels)	N/K	R	Both for doctors and nurses – numerical data not reported (Both back to pre-training levels)	N/K
Curry and Gas 1983	Yes CPR	N/K		128(N) 13(D) 128(N) 6(D)	Six months 12 months	Yes MOQ	Yes Simulation	R	D and N had decreased after six months – back to pre-training levels by 12 months	<0.05	R	D skills decreased after six months. N by 12 months – both back to pre-training by 12 months	<0.01
De Regge et al 2006	No	Simulation		Two groups of 16 (N)	Three and six months	No	Yes Simulation	N/A		N/A	N/C	Two groups with different resuscitation bags – Efficiency of ventilation stayed the same in both	Not SIGNIF
Erickson et al. 1996	No	30-minute lectures and Simulation		11 (D, N, O)	Two months	No	In clinical area	N/A		N/A	R	Airway and trauma skills decreased at follow-up (to pre-training levels)	N/K
Fabius et al. 1994	No	Computer demo and Simulation		54 (N, O)	Six months	No		N/A		N/A	?R	RCT – two groups – N/K 1 person in each group 'passed' at follow-up compared with six and 34, respectively, immediately post-training	
Fossel et al. 1983	No	Simulation		41 (S)	One year and two years	Yes MOQ	Yes Simulation	R	Score lower at one and two years compared with those followed up at 2-3 weeks after training	<0.001	R	CPR performance lower at one and two years compared with those followed at 2-3 weeks after training	<0.05
Hammond et al 2000	Yes ALS	Two days Lectures Simulation		40 (N)	18 months	Yes MOQ	Yes Simulation	N/C	Mean score 81.7% post course, 83.8% at follow-up	Not SIGNIF	R	75% person passed at follow-up	N/K

(continued)

Table A6. Continued.

Author	AP	Nature of the training	No of participants Followed up (D = doctors, N = nurses, S = students O = other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	p	Skill change	Notes	p
					K	S						
Heidenreich et al. 2004	Yes AHA course	25 minutes Instruction Video Simulation	28 (S)	Six and 18 months	No	Yes Simulation	N/A		N/A	R and N/C	In standard CPR – reduction percentage correct chest compressions from 54 to 35 then 32. In uninterrupted chest compressions stayed the same	< 0.02
Holden et al. 1996	No	N/K	55 (N)	Six months	Yes MCQ	Yes Simulation	N/C	Number achieving more than 50% correct answers did not deteriorate	N/K	?	R 21 (38%) passed skills test at six months	N/K
Jensen et al. 2009	Yes ALS	Lectures simulation	Two groups (immediately and 6 months after qualification)	Six months	Yes composite	Yes composite with MCQ	N/K		N/A	N/K	Mean scores reduced from 86% and 83% post course to 82% and 78% at follow-up	N/K
Kovacs et al. 2000	No	One-hour lecture, five hours simulation and half-an-hour/week for three weeks	84 (S)	16, 25, and 40 weeks	No	Yes Simulation	N/A		N/A	N/C And R	RCT – groups with practice and feedback maintained skills. Control group and group receiving feedback alone deteriorated by 16 weeks (Mean score 45.2 to 34 and 45.2 to 35.4, respectively)	< 0.05 in D groups
Leith 1997	No	'Defibrillation training'	10 and 10 (N)	Six and 12 months	Yes write exam	Yes Simulation	R	Mean score reduced from 89% post course to 78% at 6 months and 70% at 12 months	N/K	R	Pass rate of practical test decreased from 70% to 0% at 6 and 12 months	N/K

Mancini & Kaye 1985	Yes AHA	N/K	33 (D)	Mean eight and 22 months	Yes Assessment and action	Yes Simulation	?R	Less than 100% of candidates responded correctly in all aspects except for assessing unresponsiveness (presume all needed to be correct immediately post-training)	N/K	?R	Less than 100% of candidates performed correctly in all aspects except for ventilating (presume all needed to be correct immediately post-training)	N/K		
McKee et al. 1994	No	Lectures Simulation	60 (N)	One week, one, three and six months	No	Yes Simulation	N/A		N/A	R and N/C	Delay to defibrillation increased – resuscitation score deteriorated then improved to post training score at 6 months	< 0.05 and Not SIGNIF		
O'Donnell & Skinner 1993	No	20-minute lecture and Simulation	44 K 60 S	Six months	Yes Questionnaire	Yes Simulation	N/C and R	N/C in the 2 groups with refresher sessions and D in group with no refresher prior to follow-up	Not SIGNIF and < 0.05	I	Group with monthly refresher sessions improved in 'pass rate' for performing cardiac massage from 39 to 69%	< 0.05		
O'Steen et al. 1996	Yes ACLS	N/K	40 (N)	Mean 344 days (0–1034)	Yes MCQ	Yes Simulation	R	After 12 months – no further deterioration after	< 0.05	R	After 12 months – no further deterioration after	< 0.05		
Plank & Steinke 1989	No	Two hours Lecture and simulation vs video	36(N)	6–8 weeks	Yes MCQ	Yes simulation	N/K	Pass score not stated	N/A	R	26 failed at follow-up	Not stated		
Semeraro et al. 2006	Yes ALS	Lectures Simulation	47 (D)	Six months	Yes MCQ	Yes Simulation	R	Mean score 85.9% post-course and 79.5% at follow-up	< 0.001	R	All passed post-course and 30 passed at follow-up	< 0.001		
Smith et al. 2008	Yes ACLS BLS	N/K	133 (N)	Three, six, nine and 12 months	Yes MCQ	Yes Simulation	N/K	Results not reported	N/K	R	Four groups – all deteriorated – some to pretraining	N/K		
Spooner et al. 2007	Yes BLS	eight hours Lectures simulatio	RCT standard vs feedback mannequin	66 (S)	Six weeks	No	Yes simulation	N/A		N/A	R	Fail rate increased from 16% and 25% to 10% and 38%, respectively	N/K	
Stross 1983	Yes ACLS	N/K	132 (D)	One year	Yes ECG recognition and mock arrest	Yes Simulation	N/C and R	RCT. All three groups maintained ECG recognition but deteriorated in mock arrest – the two groups receiving booster sessions performed better at follow-up	N/K	R	39% performed successful ventilation and 47% external cardiac massage compared with all having passed ACLS course	N/K		

(continued)

Table A6. Continued.

Author	AP	Nature of the training	No of participants Followed up (D = doctors, N = nurses, S = students O = other)	When tested at follow-up	Components of ability tested		Knowledge change	Notes	*p*	Skill change	Notes	*p*
					K	S						
Ten Eyck 1993	No	Four hours lectures and Simulation	48 (O)	Six months	No	Yes simulation	N/A		N/A	R	Five failed resuscitations and others did not perform other required aspects of simulation	N/K
Tippett 2004	Yes ATNC	21/2 days Lectures simulation	14 (N)	Three months	Yes Short answers	No	R	Mean score 83% postcourse and 73% at follow-up (back to pre-course levels)	<0.05	N/A		N/A
Wayne et al. 2006	No	4 × 2 hours teaching and HI fidelity Simulation	38 (D)	Six and 14 months	No	Yes Simulation	N/A		N/A	N/C	In context of RCT previously over six months which involved three lots of testing	Not SIGNIF
Wenzel et al. 1997	No	Two hours Instruction Simulation	113 (S)	Six months	Yes MCQ	Yes Simulation	R	Mean score 6.4 postcourse and 6.2 at follow-up	<0.05	R	Five of nine skills deteriorated significantly	< 0.0001
Yakel 1989	Yes 2 BLS courses	45 minutes or eight hours Lectures Simulation	81 then 86 (N)	Four months and eight months	No	Yes Simulation	N/A		N/A	R	Mean score 55 postcourse and 38 at 4 months. Improved to 42 at 8 months ($p < 0.001$) – four month test acted as booster (remedial training given). Longer course did better at follow-up ($p < 0.05$)	N/K
Young and King 2000	No	N/K	10 (N)	Six and 12 weeks	Yes Oral questions	Yes Simulation	R	Five failed at six weeks, five failed at 12 weeks	N/K	R	Five failed at six weeks, six failed at 12 weeks	N/K

Notes: AP – Accredited programme, ACLS – Advanced Cardiac Life Support, AHA – American Heart Association, ALS – Advanced Life Support, ATLS – Advanced Trauma Life Support, BLS – Basic Life Support, CPR – Cardio-pulmonary Resuscitation, ILS – Immediate Life Support, Knowledge and Skill change D – Decreased, MCQ – Multiple-Choice Questionnaires, N/A – Not applicable, N/C – No change, N/K – Not known, Not SIGNIF – not significant, *p* – *p* value, R – Reduced.

Table A7. Kirkpatrick 4 neonates.

Author	Accredited programme	Nature of the training	Period studied	Significant impact on patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Boo 2009	Yes NRP	Lectures Simulation	Five years preminring and 8 years posttraining	Not stated	Numerical decline in perinatal and neonatal mortality but no *p* values	? Less mortality	Not stated	Not stated
Duran et al. 2008a,b	Yes NRP	Not stated	Over three-year period including pre and post implementation of training	Yes	After training: significant increase in one minute Apgar score (5.43–6.5 – $p=0.01$) Babies with ischaemic changes on CT reduced from 91% to 62% ($p=0.02$) Reduction in inpatient stay from 12 to 6.1 days $p \leq 0.05$	No statistically significant difference	Not stated	Not stated
Patel et al. 2001	Yes NRP	Not stated	Before training (1985–1988), during transition (1989–1990) and after training (1991–1995)	Yes	Fewer babies with low one and five minutes Apgar scores post-training $p \leq 0.001$	Not stated	Not stated	Not stated
Patel & Piotrowski 2002	Yes Neonatal resuscitation programme (NRP)	Not stated	Before NRP – 1985–1988, after 1991–1995.	Yes	Higher one minute Apgar score (7–10) (24% pre vs 31% post NRP – $p=0.001$) and higher five minute (83% vs 85% – $p<0.001$). More changed from low one minute to high five minute after NRP (39% to 49% – $p<0.001$)	Not stated	Not stated	Not stated
Ryan et al. 1999	Yes NRP	Lectures Simulation	51 deliveries before and 51 deliveries after the training (1994–1995)	Not stated	Not stated	Not stated	Yes	Improvement in delivery room preparation ($p=0.01$), management ($p=0.01$) assessment ($p=0.02$) and interventions ($p=0.02$)

(continued)

Table 7. Continued.

Author	Accredited programme	Nature of the training	Period studied	Significant impact on patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Singh et al. 2006	Yes NLS	Lectures simulation	Data collected pre-course in 1990-1994 and post-course in 1997 and 2003	Not stated	Not stated	Not stated	Yes for pair of findings	Inappropriate use of naloxone fell from 76% to 10% ($p = 0.0001$). Total use of naloxone fell from 13% to 0.5%, incidence of hypothermia fell from 9% to 2.3% (both not statistically significant)
Zhu et al. 1997	Yes NRP	Not stated	Premraining 1992, postraining 1993 to 1995	Yes	3 × reduction in neonatal mortality (9.9 to 3.4 per 1000) $p < 0.001$	Yes		

Notes: NLS – Neonatal life support, NRP – Neonatal Resuscitation Programme.

Table A8. Kirkpatrick 4 paediatrics.

Author	Accredited programme	Nature of the training	Period studied	Significant impact on patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Lo et al. 2009	No	Simulation. Weekly scenarios	23 weekly training sessions of approximately 30 minutes	Not documented	N/A	Not documented	No	Median time for chest re-opening significantly longer- $p = 0.002$. Longer to give medication $p = 0.002$
Lasek et al. 1994	No (PALS for emergency medicine in Sizeli)	Lectures as before but with additional supervised practice from 1988	Patients 0–18 years from January 1990 to December 1991 compared with data from January 1983 to June 1985	Not documented	N/A	Not documented	Yes	< 18-month-old improved intubation $p = 0.000008$ and vascular access $p = 0.000003$. Older child improved vascular access $p < 0.05$

Notes: N/A – not applicable, PALS – Paediatric Life Support.

Table A9. Kirkpatrick 4 adults.

Author	Accredited programme	Nature of the training	Period studied	Significant improvement in patient outcome	Nature of the impact on patients (data)	Significant increase in survival rates (data)	Significant improvement in clinical management	Nature of the improvement (data)
Arreola et al. 2004	Yes PHTLS, BLS and ALS (some in house)	Not stated	Three ambulance services October to December 1994, pretraining and January to June 1995 posttraining. January to September 2000 pretraining and October 2000 to June 2001 posttraining	Yes	Not stated	Improvement in survival in those patients transported in one intervention centre ($p = 0.04$)	Yes	Improved airway management in the two intervention centres ($p < 0.001$) Improved spinal immobilisation in one intervention centre $p < 0.001$ Some improved iv fluid administration in two intervention centres ($p < 0.001$)
Camp et al. 1997	ACLS	Not stated	1980 to 1984 pretraining and from 1985 to 1990 posttraining	Yes	Increased 'death events' reversed by intervention increased from 2% to 11% ($p < 0.001$) posttraining	Yes	Yes	Increased intervention at 'death events' posttraining (from 5% to 37% – $p < 0.001$)
Curry and Gas 1987	No	Not stated	1981–1985 – one hospital received training – the other did not	No		No	No	No difference in death rates between trained and untrained staff
Dane et al. 2000	Yes ACLS	Not stated	1996 and 1997 Compared resuscitation outcome of nurses ACLS trained with those not	Yes	4× more likely to survive when treated by trained nurses (38% to 10%) $p = 0.02$	Yes	Not stated	Not stated
Makker et al. 1995	Yes ACLS	Not stated	1991 – 225 cardiac arrests	No		No	Yes	Certified doctors made less errors in first semester after training (5.9%) compared with second semester (14.7%) ($p = 0.05$)
Moretti et al. 2007	Yes ACLS	Two-day course Lectures Simulation	January 1998 to March 2001 Compared resuscitation outcome of personnel ACLS trained with those not	Yes	Increase in return of spontaneous circulation with trained versus non-trained (49/113 vs 16/59 $p = 0.04$)	Better survival in ACLS trained group: at 30 days (27% versus 6% – $p = 0.02$) and 1 year (22% vs 0% $p = 0.002$)	Not stated	Not stated

Murphy & Fitzsimons 2004	Yes ILS	Not stated	1999–2000 and 2001–2002	Not stated	Not stated	Not stated	No	No difference in personnel who inserted mask or defibrillated
Seidelin & Bridges 1993	No	Six hours simulation	Six month period Aug 1987 to January 1987 compared with 1985	No		No	No	
Speerpoint et al. 2009	Yes ILS	One day Lectures simulation	January 2002 to December 2007 – training ongoing during this period	Yes	Increase in survival to return of spontaneous circulation $p \leq 0.005$	Reduced deaths at cardiac arrest over time period ($p < 0.0002$) Survival to discharge after emergency call increased to 39% (2007) from 28% (2004) $p < 0.005$	Not stated	Not stated
Van Olden et al. 2004	Yes ATLS	Not stated	May 1996 to September 1997 precourse and December 1997 to April 1999 postcourse	Yes	Significant reduction in mortality 24.2% to 0% in first 60 minutes following resuscitation	Yes	Not stated	Not stated
Van Olden et al. 2004	Yes ATLS	Not stated	Compared period pretraining (June 1996 to November 1997) to posttraining (January 1998 to July 1999)	Not stated	Not stated	Not stated	Yes	10 (of 14) procedures were performed better posttraining and management scores increased from 4.2 pretraining to 5.8 posttraining ($p < 0.0001$)
Vestrup et al. 1988	Yes ATLS	Not stated	Compared periods of pretraining (April 1983 to March 1984) to post training (April 1985 to 1986)	Not stated	Not stated	Not significantly different	yes	Significant increase in rectal examinations for trauma patients $p = 0.03$
Woodall et al. 2007	Yes ACLS	Lectures clinical placement	January 2000 to December 2002 Compared resuscitation outcome of paramedics ACLS trained with those not	Yes	Pulse on admission more likely in ACLS trained (21%) compared with nontrained (8.5%) $p = 0.0001$	Yes Increased survival to discharge in ACLS trained (6.7%) versus nontrained (4.66%) $p = 0.03$	Yes	Quicker mean time to first shock in ACLS trained (9.44 minutes) vs nontrained (10.07 minutes)

Notes: ACLS – Advanced Cardiac Life Support, ATLS – Advanced Trauma Life Support, ILS – Immediate Life Support, BLS – Basic Life Support, PHTLS – Pre-Hospital Trauma Life Support Course