THE EFFECTIVENESS OF EMERGENCY OBSTETRIC CARE TRAINING IN KENYA

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

By

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November 2014

Liverpool School of Tropical Medicine

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Abbreviations

ACNM	American College of Nurse Midwives
ANC	Antenatal Care
AMDD	Averting Maternal Deaths and Disability
ALARM	Advances in Labour and Risk Management
ALSO	Advanced Life Support in Obstetrics
APLS	Advanced Paediatric Life Support
AVD	Assisted Vaginal Delivery
BEmOC	Basic Emergency Obstetric and New-born Care
C/S	Caesarean section
CEmOC	Comprehensive Emergency Obstetric and New-born Care
CME	Continuous Medical Education
DOCFR	Direct Obstetric Case Fatality Rate
EmOC	Emergency Obstetric Care
ERPOC	Evacuation of Retained Products of Conception
EmONC	Emergency Obstetric and New-born Care
ESMOE	Essential Steps in Managing Obstetric Emergencies
ESS-EMCH	Essential Surgical Skills-Emergency Maternal and Child Health
ETAT	Emergency Triage and Treatment
FBO	Faith Based Organisations
FSBR	Fresh Stillbirth Rate
GOK	Government of Kenya
HBB	Helping Babies Breathe
HMS-BAB	Helping Mothers Survive-Bleeding After Birth
KNBS	Kenya National Bureau of Statistics
LMIC	Low and Middle Income Countries
LSS-EONC	Life Saving Skills Emergency Obstetric and New-born Care
M&E	Monitoring and Evaluation
MCH	Maternal and Child Health
MeSH	Medical Subject Heading
MDG	Millennium Development Goals
MMR	Maternal Mortality Ratio

MOET	Management of Obstetric Emergencies and Trauma
MoH	Ministry of Health
MOMS	Ministry of Medical Services
MOPHS	Ministry of Public Health and Sanitation
MVA	Manual Vacuum Aspiration
NCAPD	National Coordinating Agency for Population and Development
NGOs	Non-Governmental Organisations
PNC	Postnatal Care
RCOG	Royal College of Obstetricians and Gynaecologists
SBA	Skilled Birth Attendant
SBME	Simulation Based Medical Education
SBR	Stillbirth Rate
TBA	Traditional Birth Attendant
U5MR	Under five years mortality rate
UN	United Nations
UNFPA	United Nations Fund for Population Activities
UNICEF	United National Children Endowment Fund
WHO	World Health Organisation

Acknowledgements

I will like to acknowledge the support, guidance and patience of my supervisors Professors Nynke van den Broek and James Neilson; it has been a rewarding learning experience.

The PhD journey is not without casualty! I will like to appreciate my family; Uchechukwu Nicole, Phillip Awele and Chantal Ogweye for their sacrifice, patience, understanding and support, without which this work will not have been completed.

Thanks to my colleagues at work for support and understanding during the writing up phase. Special thanks and appreciation to Emma and Sally, for helping with proof reading.

I will remain indebted to my research assistants Judith Maua and Elizabeth Washika.

Special thanks to ACDEB, your encouragement came at a critical time and it lives on in my memory.

Thanks to Government of Kenya for permitting this study to take place and for using its results to change policy on EmONC training in Kenya.

Finally to all study participants, I will forever be grateful for your time.

Abstract

Background and introduction

Maternal deaths are highest in low resource countries, skilled attendance at birth (SBA) and the availability of emergency obstetric care (EmOC) are key strategies to improve maternal health and achieve the millennium development goal number 5. In-service emergency obstetric and newborn care (EmONC) training has been used for many years to improve the quality of skilled attendance at birth and availability of EmOC, however few packages have been properly described and evaluated. There is no published comprehensive evaluation of EmONC in-service training packages in low resourced countries.

An evaluation of the effectiveness of an EmONC training intervention in 10 comprehensive EmOC Kenya hospitals was carried out from 2010-2011.

Methods

A systematic review was performed based on grading of recommendations assessments development and evaluation (GRADE) guidelines to identify the various EmONC training packages in low and middle income countries, identify literature on the effectiveness of these packages or effectiveness of various components of EmONC training globally.

The components of the intervention were training in EmONC, provision of EmOC equipment and supportive supervision. The objective of the intervention was to improve the recognition and treatment of emergency obstetric and newborn complications at all study sites by trained maternity care providers (MCP).

A before/after study design and an adapted four level Kirkpatrick framework (level 1: reaction to training, level 2: learning, level 3: behaviour/practice, level 4: EmOC availability, health outcomes and 'up-skilling') was used to evaluate the effectiveness of the training package. Mixed research methods (quantitative and qualitative approaches) were used to collect data 3 months before the intervention and at 3 monthly intervals after up to 12 months after the intervention.

Quantitative data were analysed using SPSS version 20 and qualitative data was analysed using Nvivo 9. Descriptive statistics and analysis using t-tests were performed for quantitative data (significance in mean difference at 95% confidence) while framework analysis was used for qualitative data.

Results

20 EmONC in-service training programmes implemented in low and middle-income countries were identified. The content of 85% (17) of the programmes identified included EmOC signal functions and 7 programmes were 7 days or more in duration. 50% (10) of the EmONC training packages identified had training reports of which only two studies were evaluated at Kirkpatrick level 3 (behaviour) and there was no evaluation at level 4 (health outcomes) identified.

Over 70% of all identified maternity care providers from all 10 hospitals were trained. 83% (328) of the 400 health care workers trained were midwives, 6% (26) were medical doctors, 2% (8) were clinical officers and 3% (11) were obstetricians. At 12 months post training the proportion of MCP trained in each hospital was at least 83% except for Nakuru PGH (23%) and Mbagathi GH (50%).

Kirkpatrick level 1: About 95% (380) participants responded to level 1 assessment questionnaire. Trainees reacted positively to all lectures (n=11, mean score was 9.38/100, SD: 0.12) and breakout sessions (n=25, mean score was 9.33/10, SD: 0.14).

Kirkpatrick level 2: There was a statistically significant difference between the pre and post training knowledge scores in all modules except preventing obstructed labour 0.10 CI (0.06-0.26) p=0.201. The mean difference between pre and post-test skill scores was statistically significant 3.5 CI (3.3-3.8) P<0.001, n=284.

Kirkpatrick level 3: 153 data sources (FGDs, paired interviews, KIIs) were collected over 12 months and analysed. 49% (184) and 129 (34.5%) of health care workers and managers participated. They reported a positive impact of the intervention on communication and teamwork, pre-service midwifery education, reduced treatment time, improved knowledge, skills, improved confidence to perform EmOC, organisation of care and supportive supervision.

Availability of EmOC equipment post training and supportive supervisors were factors that facilitated change in practice post training. Barriers to availability of EmOC identified were poor staff deployment and retention policy post training, lack of equipment to perform EmONC, lack of support from obstetricians, senior midwives and nurse/midwifery administrators, lack of training for all MCP (including medical interns, medical officers and staff from lower level health care facilities) and lack of clarity on the scope of practice for nurses/midwives.

Kirkpatrick level 4: 16, 764 and 17, 404 deliveries were conducted at baseline and at 12 months post intervention respectively.

There was 66.8% increase in obstetric complications recorded and managed at 12 months post training compared to baseline.

Health outcome indicators: There was an expected increasing trend for number of complications recorded and treated, availability of SBA and EmOC. There was also an expected decreasing trend in the proportion of newborns admitted to NBU for birth asphyxia, direct obstetric case fatality rate (DOCFR) and stillbirth rate (SBR). There was no change in caesarean section (C/S) rate or Fresh stillbirth rate (FSBR).

For the health outcome indicators (DOCFR, SBR, FSBR), when PGH Nakuru was excluded from the analysis, a non-statistically significant reduction but greater effect at 12 months compared to baseline was observed for complications recorded and treated (87.9% vs. 66.8%), DOCFR (47% vs. 35%), SBR (66% vs. 34%) and FSBR (14 vs. 10%).

There was 34%, 48%, and 35% mean reduction in the SBR, proportion of newborns admitted to newborn care unit and DOCFR at 12 months post intervention compared to baseline respectively.

"Up-skilling" indicators: There was a 53.8%, 80%, 100% mean increase in the proportion of all breech vaginal deliveries, proportion of all vacuum extractions performed and proportion of vacuum extractions performed by non-physician clinicians, at 12 months post intervention compared to baseline.

Assisted vaginal delivery by vacuum extraction was the least available EmOC signal function (SF) and medical doctors only performed this SF at baseline. At 12 months post intervention, non-physician clinicians performed this as well, in all study sites.

Overall the EmONC training intervention resulted in improved 'up-skilling' of maternity care providers, a trend towards improved availability of SBA and EmOC and improved health outcomes.

Implications for policy and practice

The results of this study are important for designing and implementing evidence based EmONC programmes in resource poor countries. None medical doctors can be 'up-skilled', the recognition and management of obstetric and newborn emergencies and the availability of quality EmOC can be improved using similar packages and implementation methods in other resource poor settings.

Future research

Evaluation designs that include control groups are needed. Studies to assess the relative importance of supportive supervision for behaviour change after training, the knowledge and skills retention with time post training in resource limited settings should be undertaken.

Chapter 1: Introduction and Background

An introduction to the thesis: the background to maternal and newborn mortality, definitions of key terms, strategies to improve maternal and newborn health, the problem statement, the purpose of this research, a brief overview of other chapters, and background to the research setting are presented in this chapter.

1.1. Introduction

It has been estimated that 289, 000 maternal deaths occurred worldwide in 2013, most of them occurring in sub-Saharan Africa (62%) and Southern Asia (24%) (United Nations 2014b, World Health Organization et al. 2014). A woman in the developing regions of the world has a lifetime risk of maternal death of 1 in 160 compared to 1 in 3700 for women in the developed regions of the world (World Health Organization et al. 2014).

About 73% of global maternal deaths are due to direct obstetric causes[1]. The three most common causes are haemorrhage 27.1% (uncertainty interval-UI: 19.9 -36.2), hypertensive disorders 14% (UI: 11.1 -17.4) and pregnancy related sepsis 10.7% (UI: 5.9 -18.6) (Say et al. 2014). Single medical/surgical interventions to treat these conditions are known but information on what constitutes the most effective use of such evidence-based knowledge in country specific contexts alongside other interventions is often lacking (Campbell, Graham 2006, Kerber et al. 2007). Obstetric complications require prompt action by skilled health care providers/birth attendants for favourable outcomes, therefore delays in seeking care, reaching health care facilities capable of providing quality emergency obstetric care (EmOC) can contribute significantly to poor maternal health outcomes (Thaddeus, Maine 1994). Poor quality of maternal and new-born care is associated with poor implementation of evidence based interventions, closely linked with lack of resources, leadership, skills and end-user factors (cultural, literacy, socioeconomic status and nutrition)

[1] **Direct obstetric deaths** are "those resulting from obstetric complications of the pregnancy state (pregnancy, labour and the puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above" (World Health Organization 2012)

(Nyamtema, Urassa & van Roosmalen 2011, Thaddeus, Maine 1994).

A technical consultation of global maternal health experts determined that about 15% of pregnant women will require EmOC and this should be provided by skilled health workers in EmOC health care facilities (WHO et al. 2009).

Newborn morbidity and mortality is closely associated with events during pregnancy and labour. The high rate of neonatal deaths[2] and stillbirths[3] are considered to be the result of poor maternal health, sub-optimal care during pregnancy and childbirth, and lack of newborn care (World Health Organization 2006).

46% (1.2 million) of the estimated 2.6 million stillbirths that occur globally are intrapartum deaths (occur during labour), 99% occur in low and middle-income countries (Yakoob et al. 2011, Lawn et al. 2011). The top three causes of newborn deaths are birth asphyxia (27%), newborn sepsis (28%) and prematurity (29%) (United Nations Inter-agency Group for Child Mortality Estimation 2013).

Four million babies die in the neonatal period, 75% of these occur in the first week of life and the greatest risk of death is in the first day of life (Lawn et al. 2011, Singhal et al. 2012).

It has been estimated that 44% of all under-5 (U5) mortality occurs in the neonatal period and 38% of global U5 deaths in sub-Saharan Africa occur in the first month of life. The global neonatal mortality rate fell from 33 per 1000 live births in 1990 to 21 per 1000 live births in 2012. Current neonatal mortality rate in developed regions of the world is only 4/1, 000 live births compared to 23/1, 000 live births in developing regions of the world. Sub-Saharan Africa has the highest neonatal mortality rate 32 deaths per 1,000 live births (United Nations Inter-agency Group for Child Mortality Estimation 2013).

World leaders gathered at the United Nations (UN) headquarters in New York in September 2000 to make major commitments by agreeing goals and set targets to reduce world poverty, eliminate hunger and improve health (United Nations 2000). Two key millennium development goals (MDGs) and their respective targets, related to women and children are; i) the improvement of maternal health (MDG 5) by reducing the maternal mortality ratio (MMR) by 75% and ii) improvement of child mortality (MDG 4) through under-five mortality reduction by two-thirds between 1990 and 2015 (United Nations 2000, United Nations 2009).

[2] **Neonatal deaths** are newborn deaths within 28 days of life while **early neonatal death** are those deaths occurring within 7 days of life.
[3] **Stillbirth** refers to the death of a baby during pregnancy after the period of viability (WHO indicates 28 complete weeks but there are country specific dates based on how early a fetus can be kept alive if delivered prematurely) (Nguyen, Wilcox 2005).

Less than 2 years before the target deadline, reports indicate some progress for MDG 4 but poor progress for MDG 5 in sub-Saharan Africa (SSA) (United Nations 2012, Lozano et al. 2011, World Health Organization et al. 2014) Under five mortality has reduced by 35% from 97 to 63 deaths/1000 live births between 1990 and 2013. Also MMR decreased globally by 45% from 380/ 100, 000 live births to 220/100, 000 live births and in SSA MMR decreased by 49% from 990/100, 000 live births to 510/ 100, 000 live births. The MMR in developing regions (230) was 14 times higher than in developed regions (16) (United Nations 2012, World Health Organization et al. 2014).

Key strategies to improve maternal health that have been identified are skilled attendance at birth (SBA), provision of Emergency Obstetric Care (EmOC) and family planning (Bullough et al. 2005, Campbell, Graham 2006). In addition the World Health Report 2005 emphasized the need to complement evidence based technical approaches to improve maternal health with systems that enhance continuum of care to ensure universal access and financial protection (World Health Organisation 2005).

1.2. Skilled birth attendance

A skilled birth attendant (SBA) "is an accredited health professional-such as a midwife, doctor or nurse-who has been educated and trained to proficiency in skills needed to manage normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and new-born (WHO 2004)

Skilled birth attendants will function optimally if they have the required competencies and work within an "enabling environment". This "enabling environment includes drugs, supplies, appropriate policies and a functional referral system (Graham, Bell & Bullough 2001, Adegoke, Van Den Broek 2009). **Skilled birth attendance** refers to a skilled birth attendant working in an "enabling environment" (Graham, Bell & Bullough 2001).

Skilled birth attendants attended only 69% births globally in 2012 (World Health Organization 2014) and the lowest proportion of deliveries attended by SBAs was in southern Asia (51%) and sub-Saharan Africa (53%). There has been only a slight increase in the proportion of births attended by skilled birth attendants in sub-Saharan Africa from 40% in 1990 to 53% in 2013 (United Nations 2014b).

There is a critical shortage of health care workers in Africa, the WHO reported that 36 of the 57 countries facing chronic human resource shortages in the health sector are in sub-Saharan Africa (World Health Orgaization 2006) and that only 2.5 and 9.1/ 10, 000 population of physicians and nursing/midwifery personal respectively are in Africa compared to 33.3 physicians and 84.5

nurses/midwives per 10, 000 population in the European region. This shortage of skilled birth attendants is even more severe in rural compared to urban areas (Adegoke, Hofman & Van Den Broek 2010, Adegoke, Van Den Broek 2009, Utz et al. 2013, World Health Organisation 2012b) Sixty million births occur outside health care facilities and very few of these are attended by SBAs. In addition HCP who aim to provide SBA are usually not backed up by functional health systems that can efficiently respond to life threatening obstetric and newborn emergencies (Wall et al. 2010).

Three approaches are being used to address the shortage of SBAs i) increase in numbers of SBAs being trained (pre-service), ii) training of midlevel health care workers who can take up some SBA tasks (task shifting) iii) Improving the competency of SBAs to provide EmOC (in-service training)

A common strategy used by governments in the SSA region to increase the number of health care providers for maternal and newborn health has been the training of mid-level health care workers (MLPs) (Dogba, Fournier 2009, Scheffler et al. 2008, Gerein, Green & Pearson 2006, Högberg 2010, World Health Organisation 2010, World Health Organisation 2005). The WHO in 2010 defined mid-level provider (also known as non-clinician physician), as a "health provider who is trained, authorized and regulated to work autonomously, and who receives pre-service training at a higher education institution for at least 2-3 years, and whose scope of practice includes (but is not restricted to) being able to diagnose, manage and treat illness, disease and impairments (including perform surgery, where appropriately trained), prescribe medicines, as well as engage in preventive and promotive care"(World Health Organisation 2010).

This strategy increases the numbers health care workers within a short time because they can usually be trained within shorter periods of time compared to medical doctors or nurse/midwives (Adegoke, Hofman & Van Den Broek 2010, World Health Organisation 2010, Utz et al. 2013a).

Also the MLPs are more easily retained in rural areas, thereby reducing the inequitable distribution of health care providers in the regions of the world with the greatest burden of maternal/newborn morbidity/mortality (World Health Organisation 2010). However MLPs may not have the required competencies or have a limited scope of practice or may not be supported to provide emergency obstetric and newborn care (Adegoke, Hofman & Van Den Broek 2010, Utz et al. 2013a). These MLP therefore require training or 'up-skilling' through a process of **'task shifting'**, in order to improve access to effective maternal and newborn health interventions. Task shifting has been described as a process of delegation whereby tasks are moved, where appropriate, to less specialized health workers. This relatively new strategy being promoted by the WHO to optimize the delivery of key, evidence-based interventions is likely to increase the access to quality EmOC care. Task

shifting/sharing has also been used to been used to describe the uptake and performance by nurses/midwives of task usually performed by medical doctors (World Health Organisation 2010)

Health care workers are expected to provide quality maternity services to minimize the risk of adverse maternal and newborn outcomes by minimizing delays through prompt evidence based actions at the point of contact with pregnant or recently pregnant women (Thaddeus, Maine 1994). Avoidable errors in the management of obstetric and newborn complications result in poor quality of EmOC. This is determined by the availability or lack of competent skilled birth attendants, drugs, supplies, policies, and infrastructure and functional/responsive health systems.

Skilled health care workers can primarily prevent newborn complications through effective antenatal and intrapartum care and also provide secondary prevention through prompt identification and management of complications. These actions are likely to reduce neonatal mortality rates significantly (Lawn et al. 2011, Lee et al. 2011a, Ersdal, Singhal 2013)

The close link between maternal and newborn health, the scarcity of SBAs provides an opportunity for comprehensive care provision through integrated service delivery throughout the life cycle (adolescence, pregnancy, childbirth, the postnatal period and childbirth). Health care workers can provide this continuity of care by implementing packages of health care interventions within the continuum of care from household, community, outpatients/outreach services (reproductive health, antenatal care, postnatal care and child health services) and clinical care services (reproductive health, obstetric care and care of sick newborn babies and children)(Kerber et al. 2007).

1.3. Emergency Obstetric Care

A collective package of medical interventions required to treat or manage the seven major obstetric complications (haemorrhage, prolonged or obstructed labour, post-partum sepsis, complications of abortion, pre-eclampsia or eclampsia, ectopic pregnancy and ruptured uterus) is known as Emergency Obstetric Care (EmOC) (WHO 1997). A new indicator and signal function from the perspective of the newborn was introduced in 2009. The new signal function on neonatal resuscitation was ‘perform basic neonatal resuscitation with bag and mask’ and the new indicator was on ‘intrapartum and very early neonatal death rate’ (WHO et al. 2009). More recently new signal functions to measure the ability of health facilities to provide routine care, emergency obstetric and newborn care have been described. These functions are defined at 4 dimensions, one general and three for obstetric and newborn care: a) general requirements for health care facilities such as 24/7 service availability, sufficient numbers of SBAs, functional referral systems and infrastructure, b) Routine care for all mothers and babies, c) basic EmOC for mothers and babies

with complications and d) Comprehensive EmOC in addition to EmOC (Gabrysch et al. 2012).

Emergency obstetric care is defined at health care facility level, basic and comprehensive emergency obstetric care levels (EmOC and CEmOC) See **Table 1** below for signal functions that should be available at both levels.

Table 1: Signal functions used to identify EmOC and CEmOC health care facilities (WHO et al. 2009)

S/No.	EmOC health care level	CEmOC health care level
1.	Administer parenteral antibiotics	Perform signal functions 1-7, plus
2.	Administer uterotonic drugs (1st line drug: Oxytocin, Second line drug: Ergometrine and 3rd line drug Misoprostol)	**8**. Perform surgery (e.g. caesarean section)
3.	Administer parenteral anticonvulsants for pre-eclampsia and eclampsia (for example magnesium sulphate)	**9.** Perform blood transfusion
4.	Manually remove placenta	
5.	Remove retained products (e.g. manual vacuum extraction, dilation and curettage)	
6.	Perform assisted vaginal delivery (e.g. vacuum extraction, forceps delivery)	
7.	Perform basic neonatal resuscitation (e.g. with bag and mask)	

Basic emergency obstetric care (EmOC) health care facilities are defined as those health care facilities that have all seven EmOC signal functions), while comprehensive emergency obstetric care (CEmOC) facilities are those that provide nine signal functions, including all EmOC signal functions (WHO et al. 2009).

The availability of EmOC with a minimum acceptable level of five health care facilities (One of which should be a comprehensive EmOC health care facility) providing all EmOC signal functions in the three months preceding the assessment, is one of the eight indicators for monitoring the availability and utilization of EmOC (WHO et al. 2009). The other EmOC indicators are presented in the **Table 2.**

Table 2: Indicators and acceptable levels for monitoring the availability and utilization of EmOC (WHO, 2009)

S/No.	Indicator	Acceptable level
1.	Availability of emergency obstetric care: basic and comprehensive care facilities	There are at least five emergency obstetric care facilities (including at least one comprehensive facility) for every 500, 000 population
2.	Geographical distribution of EmOC facilities	All subnational areas have at least five emergency obstetric care facilities (including at least one comprehensive facility) for every 500 000 population
3.	Proportion of all births in EmOC facilities	(Minimum acceptable level to be set locally)
4.	Met need for EmOC: proportion of women with major direct obstetric complications who are treated in such facilities	100% of women estimated to have major direct obstetric complications are treated in emergency obstetric care facilities
5.	Caesarean sections as a proportion of all births	The estimated proportion of births by caesarean section in the population is not less than 5% or more than 15%
6.	Direct Obstetric case fatality rate	The case fatality rate among women with direct Obstetric complications in emergency obstetric care Facilities is less than 1%
7.	Intrapartum and very early neonatal death rate	Standard to be determined
8.	Proportion of maternal deaths due to indirect causes in emergency obstetric care facilities	No standard can be set

1.4. Evaluation of Maternal and Newborn Health Programmes

Maternal mortality is a rare event and designing experimental studies to investigate the impact of EmOC on maternal mortality is only possible for large-scale studies. Such studies will have to cover

large geographical areas or need to be conducted over long periods of time and involve a large number of pregnant women for the results to reach statistical significance.

A recent systematic review on the impact of maternal health programs in resource-limited countries, reported that 52-65% of 54 programs had multiple interventions. The most frequent interventions were refurbishment of existing health care facilities, improved supply of equipment, drugs and supplies, training of health care providers in emergency obstetric and newborn care (EmONC) and their deployment to EmOC health care facilities. The impact was a 55% and 40% statistically significant reduction in MMR and case fatality rate (CFR) respectively. There were also significantly increased deliveries and caesarean section rates in 71-75% health care facilities covered under these programs (Nyamtema, Urassa & van Roosmalen 2011). The World Health Report 2005 identified lack of investment or poor investment in health systems as one of the significant reasons for lack of progress in MDG 4 and 5, fragmented health systems that do not promote continuity of care, and, insufficient professionalization of services (World Health Organisation 2005).

Paxton et al (2005) performed a systematic review of evidence for the effectiveness of emergency obstetric care (EmOC) interventions in reducing maternal mortality using population based studies with MM as the outcome variable. Eight studies identified were ranked for quality and strength of recommendation based on the US Preventative Services Task Force system (Paxton et al. 2005).

Two of three studies that had moderate quality and strong evidence were quasi-experimental (the interventions were EmOC training and effective referral systems) and the third was a maternal mortality trend analysis (showing precipitous declines in MMR in Western Europe and United States following the introduction of blood transfusion and antibiotics) (Ronsmans, Graham 2006).

The Ecological study by Bulato et al (2002) used multiple regression analysis to show EmOC and post abortion care services had the strongest association with reduced MMR (Bulatao, Ross 2002). A similar study by Ronsmans et al (2003) across 16 sites in 8 West African countries, showed a strong negative correlation between MMR and proportion of births attended by SBA (in hospitals) and caesarean sections (Ronsmans et al. 2003).

More recent evidence based on a systematic review and meta-analysis of the effect of community-based skilled attendance at birth (based on two before and after studies of 'moderate' quality), showed a 23% significant reduction in stillbirths (RR=0.77; 95% CI: 0. 69-0.85) (Yakoob et al. 2011). This finding was supported by a Delphi process were experts concluded that EmOC had the potential to avert between 45% and 75% of stillbirths, if EmOC or CEmOC services were provided (Yakoob et al. 2011).

The ability to provide skilled birth attendance and EmOC are related, medical doctors and midwives ideally provide EmOC at health care facilities. All skilled birth attendants should have the skills and competencies to manage normal pregnancy, provide Basic EmOC functions (identify and treat obstetric and newborn complications) at primary care level, while medical doctors/obstetricians are expected to have more advanced SBA competencies such as surgery for obstetric indications and blood transfusion at referral or hospital level, that ideally provide comprehensive EmOC functions- Figure 1 (WHO 2004, Adegoke et al. 2011).

EmOC health facilities provide the backup required by those SBAs providing services in the community (Paxton et al. 2005). Experts agree that both strategies are complimentary but have to be implemented as a set of plans and courses of actions to bring about appreciable reductions in maternal mortality (Campbell, Graham 2006).

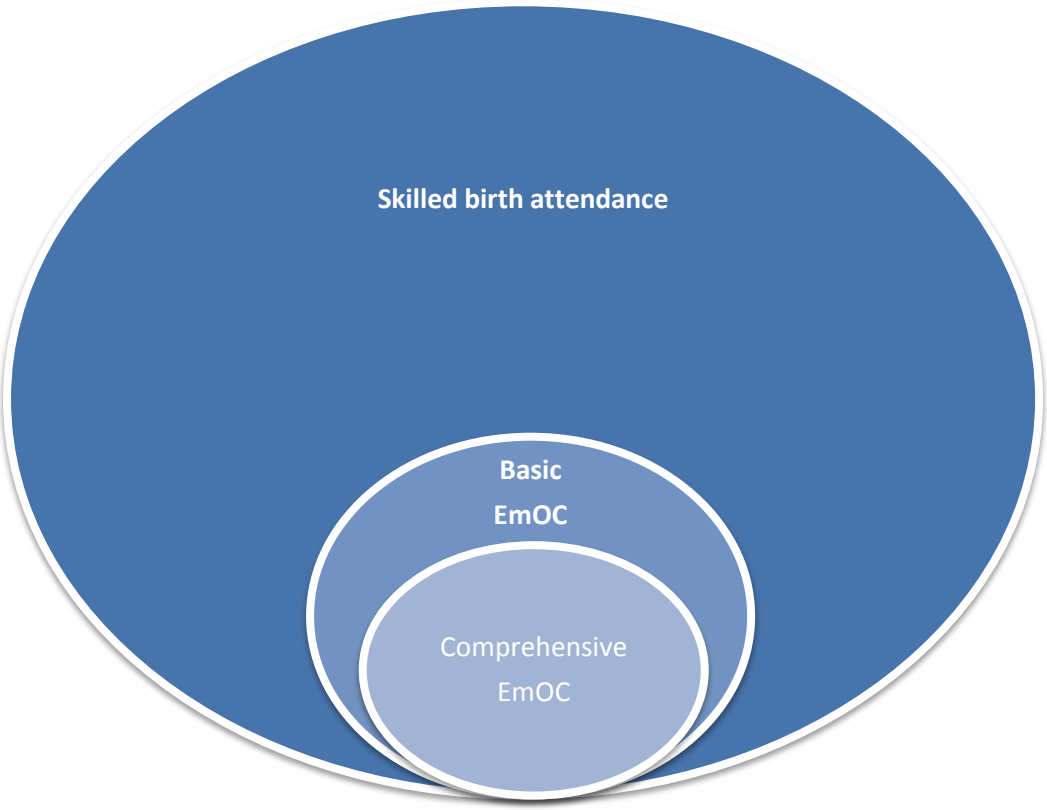


Figure 1: Schematic representation of the relationship between skilled birth attendants/attendance, BEmOC and CEmOC

A number of surveys have shown that the majority of health care facilities in developing regions of the world are unable to provide the emergency obstetric care services that are required (Ameh et al. 2012a, Echoka et al. 2013, WHO et al. 2009).

In depth assessments of availability and coverage of EmOC have shown that in many cases structures are in place, equipment and consumables are available, but, staff lack competency and skills and are therefore unable to provide all the signal functions of EmOC and essential new-born care (Adegoke, Hofman & Van Den Broek 2010). In other instances the lack of knowledge and skills to provide EmOC is compounded by non-utilization of simple but proven health technologies/equipment (Harvey et al. 2007, Tsu, Coffey 2009).

Appropriate training of health care workers, as well as addressing issues of staff deployment, retention, and supervision is key issues that need to be addressed in order to scale up skilled attendance at birth (Koblinsky et al. 2006).

The lack of knowledge and skills by health care workers who are expected to provide EmOC suggest deficiencies in pre-service training content or/and training methodology.

In-service training programmes for EmONC were introduced in the mid-80ies to address the skills and knowledge gap of health care workers in sub-Saharan Africa (Van Lonkhuijzen et al. 2010, Penny, Murray 2000). These trainings were 2-3 weeks in duration and usually poorly evaluated.

Simulation based medical education (SBME) with deliberate practice[4] has been shown to be superior to traditional clinical medical education (McGaghie et al. 2011a). There is increasing evidence that medical education with the key features of mastery learning[5] with deliberate practice, can lead to better health for individuals and populations (McGaghie et al. 2011b).

There is some evidence that short competency based EmONC training programmes based on adult teaching techniques are more effective in improving professional practice than longer didactic based training (Van Lonkhuijzen et al. 2010, Penny, Murray 2000, Forsetlund et al. 2009). Several shorter in-service training programmes with larger SBME component have been developed for well-resourced settings and have in some cases been modified for implementation in lower resource settings (Sibanda et al. 2009, Sorensen et al. 2010, Johanson et al. 2002b).

Although it can be argued that regular in-service EmONC training is required to ensure that

[4] Deliberate practice embodies strong and consistent educational interventions grounded in information processing and behavioural theories of skill acquisition and maintenance (McGaghie et al. 2011b).

[5] Mastery learning is an especially stringent form of competency-based education where learners acquire essential knowledge and skills measured rigorously against fixed achievement standards without regard to the time needed to reach the outcome (McGaghie et al. 2011b).

maternity care providers remain confident and competent in providing EmOC, evidence is required to convince policy makers regarding what is the best EmOC training approach to implement (Zachariah et al. 2009, Calvert et al. 2013). Policy makers are likely to be influenced by evaluation conducted within 'real life' settings using information generated within the health system. Key evidence required to facilitate change in policy includes the acceptance of the training methodology and its usefulness by health care workers, demonstrable improvement in knowledge, skills, confidence and practice by these workers, and finally improvement in maternal and newborn health care outcomes.

New approaches to the evaluation of effectiveness of implementation programmes in real life settings include operational research (or implementation research).

Operational research provides the opportunity to ask more far-reaching questions about the effectiveness of programmes or health systems. Operational research is the use of systematic research techniques for program decision-making to achieve a specific outcome (Zachariah et al. 2009, Zachariah et al. 2012, Harries, Zachariah & Maher 2013). Operational research provides policy-makers & managers with evidence that they can use to improve program operations (Harries, Zachariah & Maher 2013).

Operational research has the advantage of improving the quality of available data, it can be less expensive compared to prospective or controlled trials, it is less threatening to local staff who readily appreciate its relevance to the health system (Zachariah et al. 2009, Harries, Zachariah & Maher 2013) Operational research relies on routinely collected quantitative data, this may have varying quality but potentially improves with programme implementation (Harries, Zachariah & Maher 2013).

1.5. Problem statement

There is an urgency to improve the availability and quality of emergency obstetric care and skilled attendance at birth as key strategies to reduce maternal and new-born morbidity and mortality in order to complement efforts to meet the MDGs 4 and 5 targets. A number of countries currently support in-service training as a component of this strategy, however evidence on effectiveness is lacking.

Short competency based in-service training programmes have not been properly described or evaluated in a developing country context although often a component of maternal health intervention programmes (Black, Brocklehurst 2003, Van Lonkhuijzen et al. 2010, Nyamtema, Urassa & van Roosmalen 2011). Evaluation has been at the level of the health care providers, very few

studies have evaluated the impact of training on change in practice and health outcomes (Van Lonkhuijzen et al. 2010, Calvert et al. 2013).

1.6. Purpose of research

For the purpose of this thesis I will perform a systematic review to identify which EmONC training packages are implemented in low and middle income countries (LMIC), review the literature on evaluation of EmONC training programmes **(Chapter 2)** and evaluate the effectiveness of the Liverpool School of Tropical Medicine (LSTM)/Royal College of Obstetricians and Gynaecologists (RCOG) Life Saving Skills Essential (Emergency) Obstetric and New-born Care (LSS-EONC)[6] training package in Kenya.

Maternity care providers from a sample of EmOC health care facilities in Kenya will be trained and provided with essential EmOC equipment to improve the availability and quality of EmOC. The training evaluation will be based on the framework described by Donald Kirkpatrick (Kirkpatrick 1996b) and will be conducted at four levels using both quantitative and qualitative research methods, before and after the implementation of the intervention. Data will be collected at maternity care provider level to assess acceptance of the training intervention, change in confidence, and perception of its usefulness, change in knowledge, skills and practice post training and at health care facility level to assess change in availability of skilled attendance at birth, emergency obstetric care and health outcomes. This operational research will use routinely collected health care facility data to evaluate the effect of the training intervention on maternity care provider practice, maternal and newborn health outcomes.

A detailed description of the intervention, the evaluation approach, data collection tools, analysis plan and limitations of the research methods is presented in **Chapter 3** of this thesis. The results of the evaluation are presented in three chapters: **Chapter 4** will present reaction to training and change in knowledge/skills findings (level 1 and 2 quantitative/qualitative results respectively) and **Chapter 5** will present change in behaviour/practice findings (level 3 qualitative findings) and **Chapter 6** will present change in health outcomes, availability of EmOC and skilled attendance at birth (level 4 quantitative results)

[6] EmONC will be used to denote emergency obstetric care training

1.7. Background of study location: Kenya

Kenya was the setting for this research is a low income (World Bank Gross National Income ranking 88), east African country bordered by Ethiopia to its north, Somalia (northeast), Sudan (northwest), Uganda and Lake Victoria (west) and Tanzania (south) **Figure 2** (World Bank 2012).

Kenya was politically administered by a strong central government working directly with province administration authorities (with districts and sub-districts); following the implementation of the new Kenya constitution in 2013 the eight provinces (Nairobi, Western, Nyanza, Central, Rift valley, North Eastern, Eastern and Coast) have been replaced by 47 counties. This change is also associated with devolution of power to counties rather than through a very powerful central government. This is intended to stimulate development of more rural areas, reduce poverty, to improve health and socio-economic conditions of the population (Government of Kenya 2010).

Kenya has a projected population of 39.4 million and about 60% (25 million) of the population is younger than 15 years, the life expectancy at birth is 58.9 years, total fertility rate is 4.6%, crude birth and death rates are 34.8% (2009) and 11.7% (1999) respectively (Kenya National Bureau of Statistics, ICF Macro 2010).

Figure 2: Map of Kenya by province

Source: (Kenya National Bureau of Statistics, ICF Macro 2010)

It was estimated that 5, 500 Kenyan women died in 2010, the life time risk of death at birth is 1 in 55 and the MMR is 488/100, 000 (World Health Organisation 2012a, Kenya National Bureau of Statistics, ICF Macro 2010). The annualised decline in MMR was 1.3% between 1990 and 2011; this was much lower than the 5.5% required to achieve the MDG 5a target (Lozano et al. 2011). Only 44% of births are attended by a skilled birth attendant and 43% of births occur in health care facilities (KDHS 2009).

It was also estimated that Kenya had 106, 700 under 5 deaths in 2011. The early neonatal death and under-5 deaths per 1000 live births in Kenya were 19.0 (17.1-21.3) and 69.7 (61.5-79.0) respectively (Lozano et al. 2011). The annualised rate of decline for U5MR was only 1.8%, far less than the 4.4% required to reduce U5 mortality rate by two thirds from 1990 figures.

Overall Kenya has not made much progress in achieving MDG 4 and 5 targets. A summary of MDG 4 and 5 indicators/achievements for Kenya (2013) is presented in **Table 3**.

Table 3: MDG and 5 indicators/achievements for Kenya

(World Health Organization 2014, United Nations 2014b, United Nations 2014a)

MDG			1990 estimate	Current estimate (2012/13)
Goal	**Target**	**Indicator**		
Goal 4: Reduce child mortality	Reduce by two-thirds between 1990 and 2015 the under-five mortality rate	4.1. Under-five mortality rate/1000	98.2	73
		4.2. Infant mortality rate/1000	63.6	48.7
		4.3. Proportion of 1 year old children immunised against measles	78%	93%
Goal 5: Improve maternal health	**Target 5A:** Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio	5.1.Maternal mortality ratio/100, 00 live births	490	488
		5.2.Proportion of birth attended by skilled health personnel	45.4%	43.8%
	Target 5B: Achieve, 2015, universal access	5.3.Contraceptive prevalence rate	32.7%	45.5%

MDG			1990 estimate	Current estimate (2012/13)
Goal	Target	Indicator		
	to reproductive health	5.4.Adolescent birth rate/1000 women	118	106.3
		5.5.Antenatal coverage rate (At least 1 visit and at least 4 visits)	ANC 1: 94.9%, ANC 4: 63.9%	ANC 1: 96%, ANC 4: 47%
		5.6.Unmet need for family planning	35.3%	26%

1.7.1. Kenya Health Care System

Both public and private sector (Private for profit, Non-Governmental Organisations (NGOs) and Faith Based Organisations (FBO) provide health care in Kenya. There are over 4700 health care facilities in the country, 51% of which are public health care facilities, which provide care for most of the population.

Care is provided at 6 levels of care, the highest level of care is provided at level 6 also known as National referral hospitals **(Table 4).**

Table 4: Public health care facilities: Level of care, type of care and number of facilities

Source: (Ministry of Health Kenya 2011)

Level of health care	Type of care provided	Type of health care facility	Number of Health care facilities
1	Primary health care, first contact for patients, ensures wide coverage of preventive health services	Dispensary	4220
2	Provide ambulatory health services and preventive/curative services adapted to local community needs	Health centre	1007
3	Provide curative health services	Sub-district General Hospital	134
4	Provide curative health services	*District General Hospital	130
5	Specialised care, oversight of health	Province General Hospital,	9

Level of health care	Type of care provided	Type of health care facility	Number of Health care facilities
	care policy at district level, control and coordination of district level health care	Level 5 hospital	
6	Sophisticated diagnostic, therapeutic and rehabilitative services	National hospital	2

* Three District General Hospitals were upgraded to level five statuses in the last 5 years.

1.7.2. Human resources for health in Kenya

Kenya like many other countries has severe shortage in physicians, nurses and midwifery personal. The WHO report in 2013 stated that Kenya had 1.8 and 7.9 physicians and nursing/midwifery personnel /10, 000 population respectively compared to the African average of 2.5 and 9.1 physicians and nursing/midwifery personnel/10, 000 respectively. Whereas the situation is similar to Southeast Asia (5.5 and 9.9 physicians and nursing/midwifery personnel /100,000 respectively), there is a huge disparity compared to Europe (33.3 and 84.5 physicians and nursing/midwifery personnel /100,000 respectively). Usually medical doctors, nurses and midwives provide maternity services at hospitals (level 3-5); clinical officers provide services at level 1 and 2 health care facilities (Adegoke et al. 2012).

Some clinical officers receive additional training in reproductive health or anaesthesia. (Kenya Medical College 2012) Clinical officers with additional training can provide care (Caesarean section or anaesthesia) at level 3 or 4 hospitals (Clinical Officers Council Kenya 2014). Specialist medical doctors including obstetricians are only available at level 5, 6 and a few level 4 hospitals.

1.7.3. Health service provision in Kenya

The Kenya national health service provision survey reported that in 2010 few government owned hospitals provide comprehensive maternity services (National Coordinating Agency for Population and Development (NCAPD) [Kenya], Ministry of Medical Services (MOMS) [Kenya], Ministry of Public Health and Sanitation (MOPHS) [Kenya], Kenya National Bureau of Statistics (KNBS) [Kenya], ICF Macro 2011). The survey involved 695 health care facilities nationwide, randomly selected from the Kenya health care facility master list of 2010. 7% (51) were hospitals, 50% (344) were government owned and a quarter of them located in Rift valley region (174). The survey reported that Antenatal care, normal delivery and caesarean section services were provided by only 50% (26) of government

managed hospitals surveyed. Over 80% of the health care facilities had antibiotics, oxytocics and parenteral anticonvulsants, and newborn respiratory support (Infant-sized Ambu bag, external heat sources, laryngoscopes, endotracheal tubes, oxygen source, and nasogastric tube) was reported to be available in 72% of health care facilities. Only 8 EmOC signal functions were assessed (newborn resuscitation with bag and mask was not assessed). Assisted vaginal delivery was the least (13%) available[7] EmOC signal function in all hospitals (**Figure 3**).

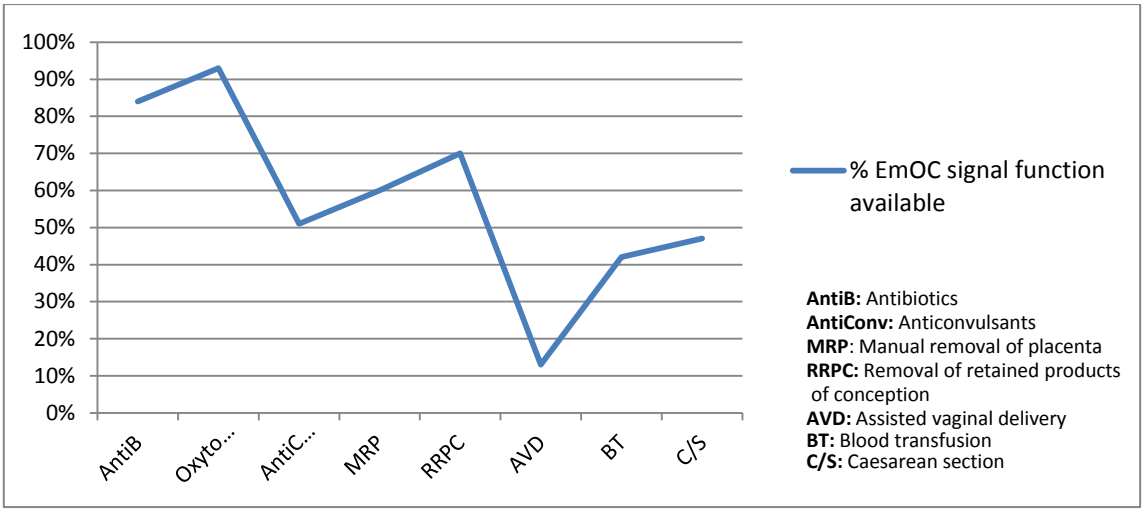


Figure 3: Proportion of EmOC signal function available in hospitals in Kenya (n=51)

93% of government managed health care facilities had up-to-date delivery registers but only 48% had adequate documentation of monitoring of delivery.

The survey also assessed the knowledge of health care providers with regard to normal labour and delivery care, and two aspects of emergency obstetric care (post-partum haemorrhage and obstructed labour). Of the 881 health care providers assessed, correct answers to all related questions were provided by only 3% on appropriate labour and delivery practices, 7% on PPH prevention and treatment, and 5% could make a correct diagnosis of obstructed labour (Kenya MoHPS).

Only 48% of health care workers had participated in any form of in-service in the 12 months preceding the survey. Less than 20% (those on duty in the included health care facilities on the day of data collection) had received any form of Emergency Obstetric Care training in the 12 months

[7] "The availability of EmOC services is measured by the number of facilities that perform the complete set of signal functions in relation to the size of the population" (WHO et al. 2009)

preceding the survey. 92% of staff in government hospitals reported having at least one personal (one-to-one) supervision session 6 months before the survey.

1.8. Summary

There is a high burden of maternal and neonatal mortality in less developed countries of the world. The MDG 4 and 5 have specific targets to drive the implementation of key strategies to improve maternal and newborn health. These strategies include skilled birth attendance, EmOC and improved access to reproductive health (ANC and family planning). Well-trained SBAs are required to provide quality EmOC, within an enabling environment (drugs, supplies, policy and functional referral systems). Although there is a recognised critical shortage of health care workers, most existing maternity care providers may not have the knowledge and skills to respond adequately to emergency obstetric and newborn complications. There is some evidence that training in EmOC is a very important component of maternal health programs that result in reduced maternal morbidity/mortality (Paxton et al. 2005, WHO et al. 2009). In-service EmONC training packages could therefore be essential for improving maternal and newborn health. However currently it is not clear which packages are available in low and middle-income countries. There are several short competency based EmONC training packages implemented in well-resourced countries, some of which have been adapted for use in developing country settings. It is also not known what the specific effective components of EmONC training packages are.

A recent survey of health services in Kenya reported that availability of maternity care services in Kenya hospitals is sub-optimal, knowledge of maternity care providers is very low, less than a fifth of HCP had any in-service training in the year preceding the survey, most staff reported having had some form of supervision, essential drugs for EmOC are largely available and 93% maternity registers in government hospitals were up-to-date.

This research will identify which EmONC training packages are available and suitable for LMICs, review the effectiveness of EmONC training packages and conduct a comprehensive evaluation, based on Kirkpatrick's training evaluation framework of the RCOG/LSTM short competency based EmONC training package in Kenya.

The next chapter will be a systematic review of the literature to identify in-service EmONC training programmes in LMICs and review the evidence for effectiveness of EmONC training.

Chapter 2: Literature Review

This chapter presents a description of EmONC training programmes in low and middle-income countries, assesses the extent of EmONC training evaluation based on Kirkpatrick's four level framework for evaluating training, presents results of evaluation of EmONC training and highlights key components of effective EmONC training in low and middle income countries (resource limited settings) as identified in the literature.

2.1. Introduction

Building the capacity of health care providers through 'in-service' or 'on the job' training has become a common approach to ensure that health providers have the necessary skills and knowledge to manage obstetric and newborn complications (Nyamtema, Urassa & van Roosmalen 2011, Penny, Murray 2000). In addition regular in-service training and re-orientation is recommended and is in some cases mandatory, to ensure health care providers continue to be accredited by their respective professional associations.

However, delivery of this type of training has been fragmented, a variety of training packages and teaching methodology is used, and the content of available training packages is often not described in much detail (Penny, Murray 2000, Van Lonkhuijzen et al. 2010, Black, Brocklehurst 2003). To ensure optimal use of scarce resources, it is important to determine the effectiveness of in-service EmONC training as well as what the most effective components of the available in-service EmONC training packages are. Such evidence will be useful to stakeholders striving to improve maternal and newborn health in resource-limited settings.

In this chapter I will

1) Identify and describe EmONC training packages available in resource limited settings, including the lead organisation for each training package and the countries in which these training packages have been or being implemented.
2) Present and discuss the findings of studies that have assessed the effectiveness of EmONC training programmes in both low resourced and high resourced settings.
3) Identify key components of effective EmONC training programmes.

2.2. Training evaluation framework

Kirkpatrick (1996) has extensively studied and described the methodology that is most appropriate for evaluating training programmes **(Box 1).** Evaluation is the "determination of the effectiveness of a training programme" (Kirkpatrick 1996b). Kirkpatrick indicated that training evaluation itself should be considered the last of ten steps that are required for effective training programmes. Evaluation of this training is important to improve future training programmes and provide evidence on their effectiveness thereby justifying their use (Kirkpatrick, Kirkpatrick 2007).

1. Determining ideas
2. Setting objectives
3. Determining subject content
4. Selecting participants
5. Determining the best schedule
6. Selecting appropriate facilities
7. Selecting appropriate instructors
8. Selecting and preparing audio visuals
9. Coordinating the programme
10. Evaluating the programme

Box 1: Kirkpatrick's 10 steps for effective training programmes

Kirkpatrick described four logical steps or levels in order to achieve the goal of evaluation **(Table 5 and detailed description in Chapter 3: Methodology):**

i. **Reaction (Level 1):** To determine how well participants like the programme. It can be a measure of the acceptability of the training programme. A positive reaction to training is indicative of interest and enthusiasm, both prerequisites to maximum learning.

ii. **Learning (Level 2):** Trainees may accept a training programme but this may not be translated into improvement in their knowledge and skills. Evaluation at Level 2 is to determine what knowledge and skills were learned as a result of the training.

iii. **Behaviour (Level 3)**: An improvement in knowledge and skills immediately after training does not guarantee a change in behaviour after attending training. Evaluation at level 3 is to determine what job changes resulted from the training.

iv. **Results (Level 4):** Job changes following training may not lead to quantifiable or 'tangible' results. These results depend on the objectives of the training programme and the expectations of the stakeholders (who commission the training or are administratively responsible for the staff being trained). These stakeholders consider evaluation at level four most important. Kirkpatrick stated that evaluation at level 4 is to determine the tangible costs of the training in terms of reduced cost, improved quality, improved customer satisfaction, improved quantity and productivity etc.

For this review Kirkpatrick's levels were adapted to include indicators for MNH outcomes such as direct obstetric case fatality rate, stillbirth rate and fresh stillbirth rates, SBA and EmOC availability. **(Table 5)**

Table 5: Adapted Kirkpatrick training evaluation framework

Kirkpatrick's four levels	Adapted evaluation framework
Level 1: **Reaction**	Participants reaction to training
Level 2: **Learning**	Change in knowledge and skills
Level 3: **Behaviour**	Change in behaviour (Clinical practice)
Level 4: **Results**	Change in maternal and newborn health outcomes, SBA and EmOC availability

2.3. Development of PICO (population, intervention, comparator/control and outcome) and PEO (population and their problems, Exposure and outcomes/themes) framework

The adapted Kirkpatrick framework for evaluation of effect of EmONC training was used to guide the formulation of PICO (Population, intervention, comparator/control and outcome) and PEO (Population and their problems, Exposure and outcomes/themes) questions for this literature review.

The PICO and PEO research question format were used to formulate suitable questions in line with the review objectives and are the most widely used formats for developing quantitative and qualitative research questions respectively (Moyer 2008). Both approaches were used to ensure that a comprehensive search strategy was developed to identify precise answers to the research questions from large databases (Boudin et al. 2010)- **Table 6.**

Table 6: PICO questions developed and associated Kirkpatrick level used to guide systematic review of effect of training in Emergency Obstetric Care

Kirkpatrick level	PICO/PEO questions
1,2	**1. Which cadres of health care provider have been trained in EmONC?** a. What is the reaction of health care providers who participate in EmONC training? b. Do different cadres of staff demonstrate different reactions to training in EmONC? c. Is there a different level of change in confidence, competency (skills, knowledge) for different cadres of staff? (Nurse-midwife, medical doctor, mid-cadre staff, obstetrician gynaecologist)
1,2, 4	**2. What are the essential components of an EmONC training package, which will result in improved competence of health care providers?** a. What is the optimal length of training- are short courses (less than 1 day/more than 1 day but less than 7days) more effective than long courses (more than 7 days long)? b. Is EmONC training cost effective? c. Where is training best conducted; in a specialised training centre or hospital setting or other setting? d. Which is the most effective training method? Is simulation training or a mixed methods approach (didactic and simulations) more effective than didactic teaching alone to improve knowledge and skills of health care providers? e. Is there a measurable difference in knowledge and/or skills among health care providers who have been trained in EmONC? (Directly before and after training, at 3, 6 and 12 months after training) f. How often does training need to be repeated to ensure competency in EmOC is maintained among health care providers?
1,2, 3	**3. Does EmONC training improve communication and teamwork?** a. Does EmONC training in multidisciplinary groups (compared to single discipline group) lead to improved communication and teamwork among health care providers? b. Is additional stand-alone team training more effective in improving

Kirkpatrick level	PICO/PEO questions
	communication and teamwork among health care providers than multidisciplinary EmONC only?
3, 4	**4. Does EmONC training result in change in clinical practice?** a. Do health care providers demonstrate a measurable change in behaviour after EmONC training compared to before training? b. Do health care providers trained in EmONC feel more confident in providing the EmONC signal functions after training compared to before training? c. Is there a change in the provision of EmONC signal function demonstrated by health care providers after EmONC training? (In the short term (3-6 months) and long term (1 year or more) d. What are the facilitators and barriers to change in practice after health care providers are trained in EmONC?
3, 4	**5. Is the availability of EmOC increased in health facilities after EmONC training of health care providers?** a. In health facilities where providers have been trained in EmONC is there a change in the availability of EmOC signal functions? b. In health facilities where providers have been trained in EmONC is there an increased uptake of services? (For normal deliveries, for emergency obstetric and newborn care)
3, 4	**6. Does EmONC training result in improved quality of care?** a. Is there a change in the quality of care provided by health care providers after training? b. Among women who come to the health facility for care, is there a perceived change in the quality of services in health facilities where health care providers have been trained? c. Is there evidence of an increased number of evidence-based practices provided in health facilities where health care providers have been trained? (e.g. use of the partograph, active management of labour, new-born resuscitation with bag and mask, no routine suctioning of babies at birth, no routine episiotomy, providing informed consent)
4	**7. Does EmONC training of health care providers improve maternal and neonatal health outcomes?** a. Is there change in the number of women recognised to need EmOC and provided with EmOC b. Is there change in the number of babies recognised to need resuscitation and receive resuscitation? c. Is there a decrease in the number of stillbirths in facilities where health

Kirkpatrick level	PICO/PEO questions
	care providers have received EmONC training? d. Is there a decrease in the number of maternal deaths resulting from obstetric complications in facilities where health care providers have received EmONC training? e. Is there a decrease in maternal morbidity for specific obstetric complications in facilities where health care providers have received EmONC training? (e.g. reduction in number of fits in eclamptic patients, reduction in the number of caesarean hysterectomies for rupture of uterus as a result of obstructed labour) f. Is there a decrease in newborn morbidity in facilities where health care providers have received EmONC training/r (e.g. reduction in number of babies admitted for birth asphyxia to the new-born care unit, reduction in the number of babies who have hypothermia)

2.4. Search Strategy

Search words

A search strategy was developed using medical subject headings under 3 main categories and using terms related to the main concepts; a) emergency, b) who is being trained and c) training or simulation. Relevant synonyms were then used to expand the search with each concept.

Terms used were those related to emergency, midwifery or obstetric training or simulation and assessment or evaluation. The medical search terms included 3 major headings **(Box 2)**

The literature was searched to include all published information relevant to the objectives of the review set out in the introduction **(section 2.1)** and **Table 6** (PICO and PEO questions). The search was for the period 1st January 1980 to 30th June 2014, articles describing training were restricted to World Bank low and middle income countries while articles reporting on evaluation of training were included from all countries.

Search of peer reviewed and grey literature

A computerised database search for all reports, training manuals and peer reviewed articles of the following databases: PUBMED, EMBASE, COCHRANE library, SCOPUS, IMEMR (Eastern Mediterranean Index Medicus), ERIC, CINHAL, International trial register, Clinical trials.gov and the University of Liverpool library database (DISCOVER) was conducted. 'DISCOVER' is the University library's electronic and print collections, with access to Theses, historical collections and 11 major databases (including EBSCO host, Medline, ProQuest, Scopus and web of science). DISCOVER also

gives access to publishers of major medical journals (and e-books) like JSTOR, Oxford, SAGE, Science Direct, Springer link, Taylor and Francis online and Wiley online library.

The websites of key international organizations known to be involved with in-service EmONC training (WHO, UNFPA, UNICEF, AMDD, JPHIEGO, PATHFINDER, Population council, ICM, FIGO and RCOG) were searched for relevant reports and web based publications. The reference lists of all relevant publications were reviewed for relevant articles not identified in the initial search. Finally, researchers and organisations were contacted by email for unpublished work that was relevant to the review.

(Emergency OR essential OR complicat* OR "Lifesaving" OR). m.p. AND Obstetric* OR midwi* OR Prenatal OR perinatal OR postnatal OR postpartum OR maternal).mp. OR (Infant, newborn OR pregnancy).sh. AND (Simulat* OR scenario* OR drill* OR virtual OR educat* OR meeting OR workshop OR train* OR competenc* OR Skill* OR"hands on" OR).m.p.

1. **Terms related to Emergency:**

(Emergency OR essential OR complicat* OR "Lifesaving" OR). m.p.

AND

2. **Terms related to who is being trained,** who is conducting the training, duration of the training and when the training was conducted:

Obstetric* OR midwi* OR Prenatal OR neonatal OR Newborn OR perinatal OR postnatal OR postpartum OR maternal).m.p. OR (Infant, newborn OR pregnancy).sh. OR multi-disciplinary .m.p.

AND

3. **Terms related to training or simulation**
(Simulat* OR scenario* OR drill* OR virtual OR educat* OR meeting OR workshop

Box 2: Terms and MeSH headings used in search strategy

The multipurpose (m.p.) limiter was used to restrict the search of the key word to the Title, Original Title, Abstract, Subject Heading and Registry Ward fields while subject heading (s.h.) was used to ensure that the search only retrieves records with the exact subject heading

2.5. Screening

The primary researcher and an academic colleague screened each title and abstract independently, thereafter the full version of all relevant publications was submitted to a full review. When there was disagreement regarding the relevance of a publication, a senior researcher (first supervisor) reviewed the full paper and made a decision to include or exclude.

2.6. Inclusion and exclusion criteria

Publications were included if they were in the English language and described evaluation of in-service training programmes or courses in (or including any of the components of) Emergency Obstetric Care. Publications were excluded if they were conference abstracts, evaluation of family planning training, study protocols, evaluation of training of Traditional birth attendants (TBAs) and evaluation of training with no component of EmOC.

Quantitative studies were graded using the Oxford system of grading of evidence while qualitative studies were evaluated based on the methodology described by Patton Quinn (Oxford centre for evidence 2013, Patton 2002).

2.7. Studies identified for inclusion in review

The primary search produced 448 records; of these 18 were noted to be duplicates. After screening of titles and abstracts 152 potentially eligible publications were identified. After full review of each paper or report 83 not meeting the inclusion criteria were excluded leaving 69 included in the review (**Figure 4**).

2.8. Synthesis of findings

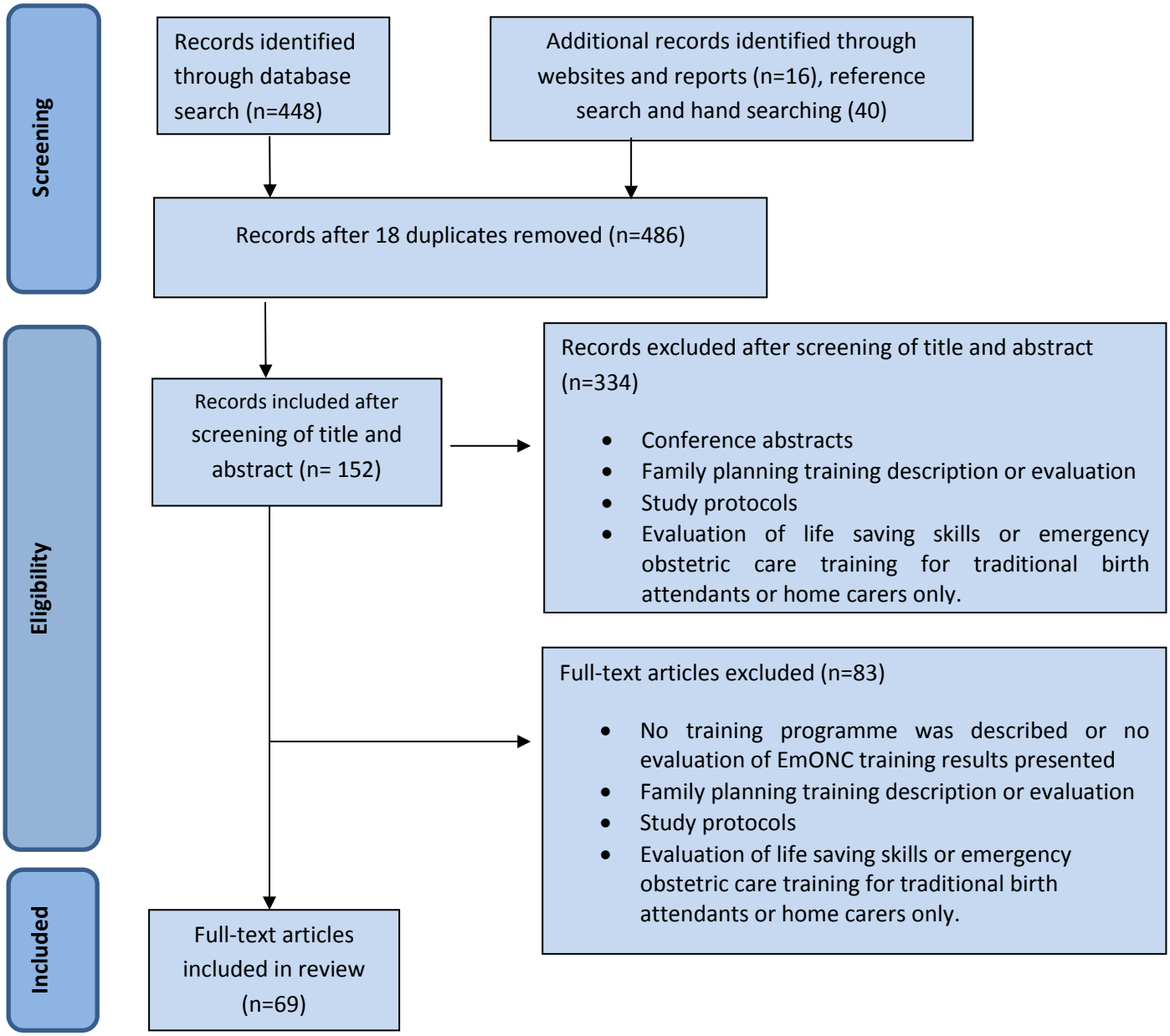
A description of EmONC training packages implemented in LMIC, indicating the name of the training package, the lead implementing organization providing the package, training duration, training content, cadre of health care workers trained and the main training methods used is presented in **Table 8**.

All relevant information related to evaluation of EmONC training was extracted from included studies. The extracted data is presented in tabular form and includes the publication reference, location of the training evaluated, objective of evaluation/, content of training, number of participants included, study design and evaluation approach, PICO/PEO question addressed by the

evaluation, summary of results and evidence grade of the study (**Table 9**). The grade assigned to each study provided an indication of the quality of the study.

A narrative synthesis approach was used due to the considerable heterogeneity of the included studies in terms of methodology, participants, type of EmONC training, type of evaluation conducted and outcome measures used (Popay et al. 2006).

Figure 4: Flow diagram of systematic review of EmONC training evaluation



2.9. Results

Sixty-nine papers were identified, of which 59 reported on evaluation of training in Emergency Obstetric Care in both developed and developing countries. There were 10 systematic reviews (Van Lonkhuijzen et al. 2010, Merién et al. 2010, Nyamtema, Urassa & van Roosmalen 2011, Opiyo, English 2010, Rabøl, Østergaard & Mogensen 2010, Meaney et al. 2010, Yang et al. 2012, Cooper et al. 2011, Black, Brocklehurst 2003, Calvert et al. 2013), 54 peer reviewed journal articles and 5 reports identified. Studies carried out in resource limited settings were included in 2 systematic reviews (Van Lonkhuijzen et al. 2010, Nyamtema, Urassa & van Roosmalen 2011), 5 reports and 29 peer reviewed journal articles **(Table 9).**

There were 18 (30.5%) of studies each evaluated in Africa and Europe, 11 (18.6%) in Asia and 1 in Mexico that were identified **(Figure 5).**

Figure 5: Geographical distribution of EmONC training evaluation studies published in English language

The results of this review are presented in two sub-sections, the first is on results of EmONC training packages identified in LMICs while the second is thematic areas of evidence of effectiveness of EmONC training based on the PICO/PEO questions **(Table 6).**

2.9.1. Training packages in Emergency Obstetric Care

Twenty different in-service EmONC training packages identified in this review, have been implemented in low/middle income countries **(Table 8)** and for half (11), studies evaluating effectiveness were identified (**Table 9**).

Seven EmONC training packages identified were more than 7 days in duration (Taylor 2010, Blackwell-Smyth, Breen & Hinshaw 2004, Osei et al. 2005, Gill, Ahmed 2004). The duration of training ranged from 40 minutes covering only one component of obstetric care (shoulder dystocia) to 24 weeks in Bangladesh for the training of medical doctors to provide Comprehensive EmOC including Caesarean Section (Crofts et al. 2007a, Gill, Ahmed 2004). Seventeen (81%) of all evaluated EmONC trainings identified in this research had all EmOC content as defined by the UN (WHO et al. 2009), five other EmONC training programmes addressed single aspects of EmOC such as newborn resuscitation or interventions associated with use of parenteral oxytocics to manage or reduce postpartum haemorrhage (Msemo et al. 2013, Singhal et al. 2012, Nelissen et al. 2014, Ersdal et al. 2013, Opiyo et al. 2008). Six trainings were tailored for specific health care worker cadres and 16 were multidisciplinary, involving mostly medical doctors and nurses/midwives (in some instances paramedics). Longer trainings were associated with a clinical component, including supportive supervision and retraining based on recognised need after initial training (McDermott et al. 2001, Msemo et al. 2013, Osei et al. 2005, Taylor 2010, Xu et al. 2014)

2.9.2. Effectiveness of EmONC training packages

Study setting

55.9% (33) of the studies were in high resourced countries while 26 (44.1%) were in low resourced countries. There were 11 RCTs in high resourced countries compared to only 2 in low resourced countries **(Table 9)**.

Evaluation methodology for included studies

There was a wide range of study designs used in EmONC training evaluations, 56% (33) of all evaluations used a before/after study design. There were two RCTs, one secondary data analysis, one qualitative study, three prospective studies using logbooks, two cross-sectional studies and 24 before/after study designs conducted in low resource limited settings. While 11 RCTs, five secondary data analysis, one cross-sectional study and nine before/after study designs conducted in high-resourced countries **(Table 9).**

Table 7: Level of evaluation for studies evaluating effectiveness of EmONC training

Kirkpatrick level	Low and middle income countries n (%)	High income countries n (%)	Total (%)
Evaluation at 1 or/and 2	15 (45.5%)	13 (50%)	28 (47.5%)
Evaluation included level 3	19 (59.4%)	12 (42.3%)	31 (52.5%)
Evaluation included level 4	4 (12.5%)	5 (19.2%)	9 (15.3%)
Evaluation at level 1, 2 and 3 only	2 (6.1%)	1 (3.8%)	3 (3.4%)
Evaluation at all 4 levels	0	1 (3.8%)	1 (1.7%)
Total number of studies identified (%)	**33** (55.9%)	**26** (44.1%)	**59**

Extent of evaluation of studies identified using Kirkpatrick's framework

About half of the studies (47.5%) were evaluated at Kirkpatrick's level 1 or/and 2, 52.5% (31) involved level 3 (behaviour) evaluation and only one 2014 study conducted in China was evaluated at all four levels (Xu et al. 2014). No study identified from low resource countries that evaluated EmONC training at all four levels (including health outcomes at level 4).

Only two studies in a low resourced settings were evaluated at levels 1-3 (Ameh et al. 2012b, Child health Advocacy international 2010), the Ameh et al (2012) study reported availability of EmOC signal functions under level 4 but no health outcomes were evaluated. There were two RCTs, one secondary data analysis, one qualitative study, two prospective studies using logbooks, four cross sectional studies and 22 before/after study designs conducted in resource limited settings **(Table 7)**.

2.9.3. Narrative analysis by identified PICO/PEO question

The narrative analysis is presented by PICO/PEO question and relevant themes:

A. PICO question 1: Cadres of Health care workers trained in Emergency obstetric care

Cadre of health care providers training in EmONC

A wide range of health care provider cadre has participated in in-service EmONC training. Intern medical doctors, non-specialist and specialists medical doctors (including specialists such as obstetricians, paediatricians and anaesthetists), nurses/midwives working in formal health care settings in well-resourced countries while skilled birth attendants, mid-level health care providers

(clinical assistants, clinical officers) and in some instances non-skilled health care workers (traditional birth attendants, ambulance drivers, MCH aides, community health assistants and other paramedics) are reported to have been trained in low resource settings (Conroy et al. 2014, Nelissen et al. 2014) **(Table 9).**

Reaction to training

Several before/after design studies evaluated reaction to training (Kirkpatrick's level 1) in low resourced settings (Ameh et al. 2012a, Grady et al. 2011, Evans et al. 2014, Singhal et al. 2012, Walker et al. 2012)

In all studies some form of 5 or 10 point Likert scale was used through anonymous self-administered questionnaires completed by the participants after the training. One study compiling data from seven sub-Saharan countries (trainees n=600) reported that trainees reacted positively to the EmONC training (Grady et al. 2011) and felt the new knowledge and skills would help them provide a better quality of care, this finding was similar to that reported by Ameh et al (2012)-n=212.

In the Walker et al (2012) study, (trainees- Module 1: n=68, Module 2: n=48) were highly positive in terms of acceptability and feasibility of the training approach (Walker et al. 2012). Similar results were reported in two other studies that evaluated the Helping Babies Breathe (HBB) and Helping Mothers Survive-Bleeding After Birth (HMS-BAB) training programmes (Nelissen et al. 2014, Singhal et al. 2012). In all studies participants requested for longer duration of 'hands on' training sessions. Nelissen et al (2014) made recommendations to increase the duration of the HMS-BAB training programme from 5 hours used in their study to one full day (Nelissen et al. 2014). Partly as a result of this feedback, the final version of the 'Helping Mothers Survive haemorrhage after birth' has been increased to one full day (Evans, Johnson 2014, Evans et al. 2014). There were similar requests in the study by Grady et al (2011) and Ameh et al (2012). The 2010 systematic review of effectiveness of EmONC training programmes in low resourced countries had similar results at Kirkpatrick level 1 (Van Lonkhuijzen et al. 2010).

A 2003 systematic review of evaluation of acute obstetric training in developed countries by Black and Brocklehurst found similar results as in low-income countries, at Kirkpatrick level 1. The review included four ALSO and MOET (n=1372) training packages delivered in United Kingdom and USA. Self-administered questionnaires were used to assess the participant's reaction to each training and also to assess the change in behaviour at varying intervals after the each training. There was high acceptability of the training courses by over 90% of all participants (Black, Brocklehurst 2003).

Summary:

- There was no study identified that compared participant reaction to one type of EmONC training with another or the reactions to a specific EmONC training programme by different cadre of health care providers trained.
- Short EmONC training programmes are acceptable to health care providers

B. PICO question 2: Essential components of EmONC training packages

EmONC training duration:

Two studies compared training of different lengths of EmONC training programmes, Osei et al (2005) compared a 3-week residential EmONC training (TRA, n=35) programme to a 6-9 month self-paced learning (SPL, n=40) programme (same content but with additional component of supportive supervision for the longer course) using a non-randomised pre- and post- intervention and comparison group design. The outcomes assessed were change in knowledge and skills (managing obstetric complications, normal labour and delivery, antenatal and post-natal care), quality of care provided, performance of EmOC and cost effectiveness. The longer self-paced learning training resulted in statistically significant improvement in EmOC knowledge and skills (SPL group: 49% baseline, 55% end line vs. TRA: 54% baseline and 58% end line), but the shorter residential training was more cost effective. The main difference between the two training approaches was the use of continuous supportive supervision to ensure that the health care workers applied new skills/knowledge and retained them on the job. This component accounted for the significantly higher cost of the SPL training (Osei et al. 2005).

McDermott (2001) in a cross sectional study conducted in Malaysia involving midwives deployed to villages (n=33) who received an 11 day Life-saving skills training (LSS) with components of peer review (PR) and continuous medical education (CME), compared to a 7 day LSS delivered to midwifery interns (n=28) training programme and to 47 midwives who received no LSS training (McDermott et al. 2001). Details of peer review and CME were not provided. The outcome measures were knowledge, skills and confidence in providing EmOC.

There was significant improvement in knowledge in the LSS+PR+CME group compared to the untrained group (LSS+PR/CME 65% vs. untrained 59% p=0.006). There was no statistical difference in EmOC knowledge between the midwives on the longer and shorter training (post training mean score LSS interns=62%, LSS/PR/CME= 65% p=0.24). However the midwives on the longer course had statistically significant improvement in skills compared to those on the shorter course (71% vs. 62%

p<0.009). This result is similar to that reported by Osei et al (2005), both studies had the same content of EmONC training and it will appear supervision was the main difference in skills outcome results between short and longer EmONC training programmes (McDermott et al. 2001, Osei et al. 2005).

Summary:

- Only two before and after studies in low resourced countries were identified. Both evaluated the LSS EmONC training programme.
- Longer EmONC training programmes were associated with much improved skills compared to the shorter version.
- Peer support and on the job supervision contributed to improved skills in the longer versions of the EmONC training package evaluated.

Training facilities (Location/venue, materials)

Several studies compared on-site/offsite training locations and use of low/high fidelity EmONC training equipment (Guise, Segel 2008, Crofts et al. 2006, Crofts et al. 2007b, Crofts et al. 2008).

On-site (within or close to normal place of work) training facilities appear to be more acceptable and but may not be as effective for training health care providers in EmONC compared to training in a simulation centre (located at a distance from place of work).

An observational study compared the benefits of on-site obstetric simulation training with training at a simulation centre. Trainees felt that onsite simulation was more appropriate, cost effective, convenient and maximized learning because the participants were in a familiar environment (Guise, Segel 2008).

A randomised controlled trial (n=140: obstetric teams from 6 hospitals) with four arms (a) 1-day course at local hospital, (b) 1-day course at simulation centre, (c) 2-day course with teamwork training at local hospital (d) 2-day course with teamwork training at simulation centre) to explore the effectiveness of training on a patient actor (onsite training) and on a computerised patient at an offsite simulation centre. The outcome measures were safety and communication scores; compared for teams (midwives and doctors) trained in management of eclampsia, shoulder dystocia and postpartum haemorrhage comparing a hospital setting with training in a simulation centre. The results of this RCT showed significantly higher scores in hospital-trained teams compared to those trained at the simulation centre (safety p=0.048, communication p=0.035) (Crofts et al. 2008)

Crofts et al (2007) in an RCT involving 140 medical doctors and midwives (training contents: hypertensive disorders in pregnancy, shoulder dystocia, breech, twins, cord prolapse, postpartum haemorrhage and electronic fetal monitoring) concluded that the site of training did not affect the knowledge gained after the training (Crofts et al. 2007b).

Crofts et al (2006) in a well-designed randomised control trial (RCT) reported that the use of both low and high fidelity mannequins resulted in improved management of shoulder dystocia with higher successful delivery rates using a high (compared to a low) fidelity mannequin. (94% vs. 72% Odds Ratio 6.53: 95% CI 2.05 20.81; p=0.002) (Crofts et al. 2006).

Summary:

- Onsite training improves communication within obstetric teams and patient safety but is not more effective than offsite training in terms of knowledge improvement post training.
- Onsite training is more acceptable to health care providers compared to offsite training. Low and high fidelity mannequins are equally effective in improving management of shoulder dystocia.

Training methods

Several RCTs and systematic reviews report that short interactive in-service training using a combination of didactic and simulation based teaching methods results in sustained improvement of knowledge, skills, teamwork, and confidence of health care providers (Crofts et al. 2006, Crofts et al. 2007b, Crofts et al. 2008, Ellis et al. 2008, Cooper et al. 2011, Fisher et al. 2010, Daniels et al. 2010, Black, Brocklehurst 2003) .

In a randomised controlled study in the USA where participants were resident doctors and midwives (n=32) were trained in shoulder dystocia and eclampsia to determine whether simulation based training was more effective than didactic based training, there was no significant difference in knowledge between the Didactic group (Did) and the Simulation trained group (Sim), however the Sim group performed significantly better in the skills (performance based) evaluation (Shoulder dystocia: Sim = 11.75, Did=6.88, P = 0.002, Eclampsia: Sim =13.25, Did =11.38, P =0.032 (Daniels et al. 2010).

A systematic review (24 papers included: 6 interrupted time series, 9 cohort studies, 7 RCTs and 2 systematic reviews) on simulation based learning in midwifery education concluded that this had

benefits over didactic teaching and was associated with improved teamwork, confidence and competence (Cooper et al. 2011).

A quasi experimental study comparing the effectiveness of lecture based training (LBT), lecture and skills based training (LAS) and simulation based training (SBT) concluded that a combination of lecture and short simulation based training appeared to give the best short term improvement in team performance (improved knowledge and confidence). Knowledge and skills retention was better sustained in the SBT group compared to the LBT at 3 months, although this did not reach statistically significant levels (Birch et al. 2007).

Macgure et al (2011) performed a meta-analytic comparative evidence review to assess the effectiveness of traditional clinical education toward skills acquisition goals and compare this with simulation-based medical education (SBME) with deliberate practice (DP). SBME engages learners in lifelike experiences with varying fidelity designed to mimic real clinical encounters. DP embodies strong and consistent educational interventions grounded in information processing and behavioural theories of skills acquisition and maintenance (McGaghie et al. 2011b).

McGaghie and colleagues Identified 3,742 articles of which 14 met their inclusion criteria. The result was that the overall effect size for the 14 studies evaluating the comparative effectiveness of SBME compared with traditional clinical medical education was 0.71 (95% confidence interval, 0.65-0.76; $P < 0.001$). The study concluded that SBME with DP is superior to traditional clinical medical education in achieving specific clinical skill acquisition goals. They recommended that SBME should be introduced thoughtfully and evaluated rigorously at training sites (McGaghie et al. 2011a).

Summary:

- A combination of lecture and short simulation based training appeared to give the best short term improvement in team performance (improved knowledge and confidence)

Effect of EmONC training on knowledge and skills

Several before and after studies, two RCTs and one systematic review have shown improvements in knowledge and skills immediately after EmONC training (Van Lonkhuijzen et al. 2010, Child health Advocacy international 2007, Child health Advocacy international 2010, Nelissen et al. 2014, Evans et al. 2014, Calvert et al. 2013, Ersdal et al. 2013). Multiple-choice questions and skills tests (simulated scenarios or tests using mannequins to demonstrate skills) are usually administered to trainers at

the start of a training course and repeated at the end. Few studies conducted such assessments at regularly intervals after the training, to assess the extent of skills/knowledge retention.

Grady et al (2011), reported statistically significant improvements in knowledge and skills following multicounty EmONC training (n=600) (Grady et al. 2011). These results were similar to other RCTs, before and after studies reported from Armenia, Bangladesh, Mexico, Pakistan, Tanzania, India, Malawi, Zanzibar, Kenya and Somaliland. However Conroy et al (2014) in a cross sectional study to assess the baseline retention of previous neonatal resuscitation training in Sierra Leone (n=42) using observation of real cases and simulation using newborn resuscitation mannequins, found out that 6 or 14% of the health care workers identified the need for/commenced resuscitation, most (86%) of the HCP were graded as providing inadequate resuscitation. It was unclear from the study what the nature of the resuscitation training was or how long before the study the health care workers were trained. 17 or 40.5% of the participants in this study were community health workers, community health assistants, maternal and child health aides and traditional birth attendants, these categories of health care workers may have very low levels of knowledge and skills to build upon within a short in-service training programme, this may explain the results (Conroy et al. 2014).

Although Nelissen et al (2014) demonstrated significant improvement in knowledge after the HMS-BAB training in Tanzania; there were no significant improvements in skills after the training for both participants and locally trained trainers. The more recent evaluation of the same training in India, Malawi and Zanzibar (n=155) showed significant improvements in both knowledge and skills (Evans et al. 2014, Nelissen et al. 2014). This may be due to improvements made in the training methodology (increased duration of training to allow for more hands on training) after the Nelissen et al study (Evans, Johnson 2014).

In South Africa (n= 68) the knowledge and skills of medical interns trained in EmOC was significantly improved compared to pre-training scores and scores of medical interns after completing the standard obstetrics rotation only (Frank, Lombaard & Pattinson 2009). These results were similar to that of another study evaluating knowledge after EmOC training for final year medical students in Rwanda (n=65) (Homaifar et al. 2013).

Summary:

- Health care provider knowledge and skills improves significantly immediately after EmONC training compared to before.

Frequency of retraining after initial EmONC training

Five studies reported on the level of knowledge, skills, clinical practice, level of comfort and confidence after EmOC training over time (Crofts et al. 2007b, Black, Brocklehurst 2003, Harris, Yates & Crosby 1995, Yang et al. 2012, Crofts et al. 2007a)

In a RCT, a group of midwives and doctors were assessed (n=122) at 3 weeks, 6 and 12 months following 40 minute in-service training in the management of shoulder dystocia. This study showed a reduction in competency at 6 and 12 months compared to assessment at 3 weeks post training but competency was still well above pre-training levels. They concluded that annual training was sufficient for those already proficient in management of shoulder dystocia while more frequent training was needed for staff initially lacking competency (Crofts et al. 2007a).

A systematic review of EmOC in-service training in developed countries (44 papers, including only 4 that reported on training evaluation-n=1372) concluded that health care providers showed improved comfort and confidence post training that was sustained at 4, 6, 10, 12 months post training (Black, Brocklehurst 2003).

Similarly, improved knowledge and care practice up to 1 year post training was reported in a cohort study conducted in the USA (Harris, Yates & Crosby 1995).

One systematic review of retention of knowledge and skills for advanced life support included 3 RCTs, 5 quasi-experimental studies and 4 descriptive studies and concluded that skills and knowledge decay by 6 months to 1 year after training. Skills decay faster than knowledge and that clinical experience either prior to the training or gained after the training was noted to have a positive impact on knowledge and skills retention (Yang et al. 2012).

Another RCT reported mean knowledge assessment scores at 6 (97.6+/-23; n=107) and 12 (98.8+/-21.6; n=98) months had remained higher than those measured before training (79.6+/-21.9, n=140; both P<0.001) but were slightly lower than those immediately after the training (101+/-21.3, n=133; p<0.001) (Crofts et al. 2013).

Summary:

- All studies that have evaluated knowledge and skills retention after EmONC training have been in high resourced settings.
- Knowledge and skills can be retained for up to 1 year post training and HCP report comfort and confidence in providing EmOC up to 1 year post training.
- Skills decay faster than knowledge; factors that affect retention of skills and knowledge include previous relevant clinical experience and training.

C. PICO question 3: Effect of EmONC training on communication and teamwork

Multidisciplinary training, communication and teamwork

A 2010 systematic review on the effectiveness of multidisciplinary teamwork training for the reduction of adverse medical outcomes in emergency obstetric situations included four randomised controlled trails, three before/after studies and one retrospective cohort study (Merién et al. 2010). Only the retrospective study by Draycott et al reported on a medical outcome, the Apgar scores 6 or lower decreased from 86.6 to 44.6 per 10, 000 births (relative risk 0.51, 95% confidence interval 0.35-0.74, p <0.001 and hypoxic-ischaemic encephalopathy decreased from 27.3 to 13.6 per 10, 000 births (relative risks 0.50, 95% CI 0.26-0.95, p=.032) (Draycott et al. 2006).

The review concluded that simulation based multidisciplinary team training in EmONC results in improved practical skills, knowledge, communication and team performance in acute obstetric situations (Merién et al. 2010). It is suggested that the simulation component may be responsible for the development of non-technical skills including teamwork (Cooper et al. 2011, Birch et al. 2007).

One RCT (n=1, 307), that was not included in the 2010 systematic review by Merien et al, evaluated the impact of team specific training (with no obstetric skills training) on the occurrence of adverse outcomes (the proportion of deliveries at 20 weeks or more of gestation in which one or more adverse maternal or neonatal outcomes or both occurred measured as adverse outcome Index) and the interval between decision for a caesarean section and the time of C/S skin incision. Seven intervention sites (received team specific training) while the 8 control sites did not. There was no significant difference in the mean adverse outcome index between the intervention and control arm (mean score 9.4 and 9.0), although there was a significant improvement in caesarean section decision to incision time after the training (33.3 versus 21.2 minutes, p=0.03). These findings may indicate improved communication as a result of the team specific training (Nielsen et al. 2007).

Similar results were reported in another RCT (also not included in the Merien 2010 systematic review) involved four teams of six medical doctors and midwives (n=24), evaluated the effect of clinical team training on communication. Teams receiving additional team work specific training used more directed commands compared to teams which received EmONC training only suggesting that team training may add value to clinical multidisciplinary training (Siassakos et al. 2009).

One cluster control randomised trial (n=teams from 24 obstetric departments) evaluated the effect of multidisciplinary team training. The training comprised of both team work specific training and EmONC training (80% resource crew training-team work specific training and 20% EmONC clinical training) using a validated clinical teamwork scale and assessment of two obstetric clinical scenarios to assess improvement in team performance and utilization of appropriate obstetric skills post training. Obstetric teams who received the intervention performed significantly better in comparison to the non-training group (median clinical team work scale score 7.5 versus 6.0, respectively; p=0.014) (Fransen et al. 2012).

Summary:

- All studies were in high resourced countries, one systematic review concluded that multidisciplinary simulation based training was effective in improving health care provider knowledge, skills, communication, team working and patient safety. That systematic review did not include any studies comparing the benefit or not of team specific training compared to multidisciplinary obstetric simulation based training alone. One retrospective cohort study in that review reported on the positive impact of multidisciplinary EmONC training on neonatal health outcome.
- Only one RCT compared EmONC training only to EmONC training and additional team specific training on team communication. The researchers concluded that team specific training may add value to clinical multidisciplinary training.
- Only one cluster RCT study evaluated a combination of team specific training and EmONC training, this was found to improve teamwork significantly compared to the control group that received no training.
- Results from both RCTs indicate that addition of team specific training to EmONC training programmes may improve the quality of communication within obstetric teams.

D. PICO question 4: Effect of EmONC training on clinical practice

Change in clinical practice

Several studies evaluating EmONC training have assessed change in clinical practice post training.
A before-after study design was used to evaluate the impact of the WHO Effective Perinatal Care (EPC) package implemented in three maternity units (average number of deliveries per unit: before 1248, after: 72, 808/annum) and monitored over a period of 2.5 years in Ukraine. The outcome measures assessed included; interventions during labour, maternal outcomes and hypothermia in neonates, baseline data pre-intervention were collected, then at 3 other intervals. There was a significant increase in the use of partographs in two of the three units (from average 45.4% to 87.6% $p<0.0001$), significantly decrease in labour induction (from average 20.8% to 0.5% $p<0.0001$) and caesarean section rates also decreased significantly (from average 28.3% to 16% $p<0.0001$), the proportion of hypothermic babies decreased significantly from an average of 74% to 1% ($p<0.0001$) in all three maternities. The greatest change in behaviour and practice were observed in the first 3 months post training and was retained throughout the 2.5-year study period (Berglund et al. 2010).

A 15-year retrospective cohort study conducted in the Netherlands following the introduction of the Managing Obstetric Emergencies and Trauma (MOET) course to determine the incidence of perimortem caesarean section. The result was that there were significantly more peri-mortem caesarean sections (PMCS) conducted after the introduction of the course (0.36/year vs. 1.6/per year $p=0.01$) (Dijkman et al. 2010). This study did not assess any of the other skills taught during the MOET course.

In a cohort study evaluating 234 health care workers trained in Essential Surgical Skill with Emphasis on Emergency Maternal and Child Health (ESS-EMCH) in Pakistan using log books to document resuscitation attempts, Zafar and colleagues reported a response rate of 53% (63), 1123 resuscitation attempts (medical doctors 76% and nurses: 24%) and a survival rate of 89% in reported cases (Zafar et al. 2009). Logbooks were also used to evaluate the training of 217 doctors and nurses in Gambia; there were 293 resuscitation attempts documented but the logbook response rate was not reported (Cole-Ceesay et al. 2010). The logbooks were documented trainee reports of skills performed after training, these were not verified in anyway.

Qualitative findings from the evaluation of ESS-EMNCH training in Pakistan also showed change in practice (frequent use of bag and mask for neonatal resuscitation and hand washing) after the training (Child health Advocacy international 2007).

A 5 year retrospective analysis to evaluate of the effect of post abortion care (PAC) training for 434 midwives and 53 medical doctors (trained separately) in Ghana showed that after training in PAC both doctors and midwives provided this service. The percentage of midwives providing PAC was

lower than for doctors (20% vs. 80%). Factors associated with midwives' offering PAC services were in-service PAC training received, working in health care facilities where the national reproductive health standards and policy was available, and working in a private health care facilities (Clark, Mitchell & Aboagye 2010).

Opiyo et al in a RCT in Kenya also found that health care providers trained in new-born resuscitation performed the correct steps compared to the control group: trained 66% vs. control 27%; risk ratio 2.45, [95% CI 1.75–3.42], p<0.001 (Opiyo et al. 2008). They also found statistically significant reduction in the frequency of inappropriate and potentially harmful practices per resuscitation in the trained group compared to the untrained group (trained 0.53 vs. control 0.92; mean difference 0.40, (95% CI 0.13-0.66), p=0.004). This study training resulted in change in practice and improved quality of care (Opiyo et al. 2008).

Another before/after study evaluating the HBB programme in a Tanzanian hospital, reported that health care workers improved their skills based on clinical assessment using scenarios and training resuscitation models, but this was not transferred to the clinical setting based on analysis of observational data on neonatal management before (n=2745) and 7 months after (n=3116) the HBB training (Ersdal et al. 2012a, Ersdal et al. 2013).

Summary:

- Retrospective analysis of data, use of log books and before/after studies conducted in both low and high resourced countries have been used to evaluate change in behaviour and practice.
- One RCT showed that newborn resuscitation training resulted in improved practice and resulted reduced number and frequency of harmful/inappropriate practices. However a before/after study found that although knowledge and skills improved after newborn resuscitation training this was not transferred to clinical practice.
- EmONC training results in change in health care provider behaviour and practice

E. PICO question 5: Effect of EmONC training on EmOC availability

Three studies conducted (RCT, cohort study, before/after study) in LMIC, have assessed the availability of EmOC after EmONC training (Opiyo et al. 2008, Evans et al. 2009, Ameh et al. 2012a).

A randomised controlled trial conducted in Pumwani Maternity hospital Kenya (Intervention group =28, control group =55) following a one day training in new-born resuscitation, where new-born resuscitation practice was directly observed, documented that those HCW trained demonstrated a higher proportion of adequate resuscitation steps compared to the control group (trained 66% vs. control 27%: risk ratio 2.45, (95% C 1.75-3.42) p<0.001, adjusted for clustering). EmONC training improved the availability of newborn resuscitation with bag and mask EmOC signal function (Opiyo et al. 2008).

A cohort study in India evaluating the impact of a 16 week EmONC training of 17 medical doctors showed an increase in EmOC signal functions available with 10 out of 15 health care facilities providing all CEmOC signal functions after training compared to 2 out of 15 before training. In addition more trainees could perform basic EmOC skills after the training compared to before. This was a mixed methods before and study design which concluded that medical doctors could be trained to provide EmOC but the effectiveness of training was limited by low caseload post training (limiting the amount of complications seen and EmOC provided), lack of equipment such as vacuum extractors and manual vacuum aspiration equipment (Evans et al. 2009).

A before and after study conducted in Somaliland to evaluate the impact of EmONC reported an improvement in the availability of EmOC signal functions from 43% (EmOC) and 56% (CEmOC) to 100% at 3 months post training (3 hospitals and 8 maternal and child health (MCH) clinics). Reasons for non-availability of EmOC after training identified through qualitative methods were lack of drugs, supplies, medical equipment, lack of 24-hour services in some MCH clinics due to manpower shortage and supportive policy (Ameh et al. 2012a).

Summary:

- EmONC training improved the availability of EmOC after EmONC training.

F. PICO 6: EmONC training and quality of care

There is emerging evidence to suggest training in EmOC improves patient satisfaction with care.

A RCT to explore the effect of training on patient (actor) perception of care during simulated obstetric emergencies reported significantly higher scores for teams trained onsite using a patient-actor compared to teams trained at a simulation centre using a computerised patient mannequin (safety p=0.048, communication p=0.035) and higher scores for respect (p=0.077). The training resulted in improved patient safety, communications and respect by trained health care providers (Crofts et al. 2008).

EmOC training by both self-paced learning and using the traditional onsite approach resulted in improved interaction between service providers and women attending for antenatal care and improved client satisfaction regarding waiting times (Osei et al. 2005).

Summary:

- One RCT showed that simulation based EmONC training resulted in improved patient safety, communications and respect by trained health care providers.
- One before/after study showed that EmONC training resulted in improved client satisfaction.

G. PICO 7: Maternal and newborn health outcomes

There are several studies (RCT, before/after, retrospective data analysis) on the impact of EmONC training on maternal and newborn health outcomes in both low and high resourced settings.

In the before and after study to evaluate the impact of ALSO training in Tanzania, trained healthcare providers significantly improved the use of active management of the 3rd stage of labour and reduced the facility based incidence of PPH from 32.9 to 18.2% [RR 0.55 (95%CI: 0.44–0.69)], severe PPH from 9.2 to 4.3% [RR 0.47 (95%CI: 0.29–0.77)], and also decreased the number of episiotomies performed (Sorensen et al. 2011).

A large retrospective cohort study (19, 460 infants included) showed a statistically significant reduction in the numbers of babies born with 5-minute Apgar scores of < 6 from 86.6 to 44.6 per 10,000 births (P < 0.001) and neonatal hypoxic-ischaemic encephalopathy decreased from 27.3 to 13.6 per 10,000 births (P = 0.032), however there was no change in stillbirth rates following mandatory 1 day training of maternity staff in the UK (Draycott, Crofts 2006).

Berglund et al (2010) reported significant reduction in the number of hypothermic babies and admissions into the neonatal unit (average before intervention: 8.3%, average 2.5 years after: 5.4%)

but no effect on early neonatal mortality following 3 day training in Effective Perinatal Care in three Ukrainian hospitals (Berglund et al. 2010).

Opiyo et al (2008) evaluated neonatal resuscitation training in a busy Kenya hospital using RCT study design. They reported improved availability of newborn resuscitation, change in practice but no measurable reduction in newborn mortality, mortality of asphyxiated babies or a reduced number of babies admitted for asphyxia. This is probably because the study was not powered with mortality as the primary outcome (Opiyo et al. 2008). However Msemo et al (2013) in a before/after study design (Before n=8, 124, After n=78, 500) for the evaluation of the 'Helping Babies Breathe' training programme, reported significant reduction in neonatal deaths (relative risk [RR] 0.53; 95% confidence interval [CI] 0.43–0.65; P ≤ .0001) and fresh stillbirths FSB (RR with training 0.76; 95% CI 0.64–0.90; P = .001) after the training, this study was adequately powered (Msemo et al. 2013). Also the Msemo study used trained master trainers onsite to provide on the job support to trainees, this was not available in the Opiyo study.

Another before and after study (Midwives in 18 clinics trained, 71, 689 neonates enrolled over 3 months) evaluating the WHO Essential New-born Care (ENC) training for midwives in Zambia, assessed the impact of the training on early neonatal death rate and stillbirth rate. Also the study assessed the additional benefit of a new-born resuscitation training after the ENC training, the early neonatal mortality rate decreased from 11.5% to 6.8% deaths per 1000 live births after training (relative risk: 0.95% CI: 0.48-0.77; P<0.001), due to decrease in deaths from birth asphyxia and infection and there was no decrease in stillbirth rates. There was a further decrease in neonatal mortality rate after further Neonatal Resuscitation Training (Carlo et al. 2010).

Makuwani et al demonstrated improved health care facility utilization (increase in the number of deliveries from 306 to 636 per month, institutional C/S rate reduced by 17.4%, number of referrals out reduced by 80%) after EmOC training in Tanzania (Makuwani et al. 2010) using a before/after study design after EmONC interventions (EmONC training, equipment, demand creation) were implemented.

A before and after study conducted in Tanzania evaluating the EmONC training of non-physician clinicians (n=43) reported an increase in availability of EmOC, 300% increase in institutional deliveries, decreased stillbirth rate (OR: 0.4; 95%CI 0.1-0.7) and reduced obstetric referrals (OR:0.2; 95% CI:0.1-0.4) (Nyamtema et al. 2011).

Summary:

- Several indicators have been used to assess the impact of EmONC training on health outcomes: health care facility incidence of PPH, incidence of low Apgar score at 5 minutes, incidence of hypoxia ischaemic encephalopathy, stillbirth rate, early neonatal mortality rate, newborn mortality, mortality of asphyxiated babies, fresh stillbirth rate and caesarean section rate
- Indicators used to assess the impact of EmONC training on health care facility utilization were number of deliveries, caesarean section rate and number of referrals out of the health care facility
- The results show a reduction in number of babies with low Apgar scores, HIE (Draycott et al. 2006).
- Two large before and after studies showed reduction in early neonatal mortality rate (Carlo, W.A.) et al. 2010, Msemo et al. 2013).
- The reduction in stillbirth rates and fresh stillbirth rates were not consistent across studies identified
- Newborn resuscitation training evaluated in two studies, one reported reduced FSBR (Msemo et al. 2013), the other reported no reduction in SBR (FSBR was not accessed) (Carlo, W.A. et al. 2010).
- One study evaluated a full EmONC training and showed reduced stillbirth rate (Nyamtema et al. 2011)
- EmONC training results in reduced referrals out of supported health care facilities

Table 8: Emergency Obstetric and Newborn Care training packages delivered in low/middle income countries.

S/No.	Name of training package	Lead organisation	Training duration	Training content	Cadre of health care providers trained	Teaching methods used (% Didactic, simulation or clinical)
Evaluation reports identified						
1.	**Advanced Life Support in Obstetrics (ALSO)** Sudan, Egypt, Gambia, Kenya, Malawi, Rwanda, Zambia, Syria, Tanzania, Iraq, Iran, Oman, United Kingdom, Brazil, Hong Kong, Australia Nepal and Pakistan	ALSO www.also.org.uk/about.asp	2 - 3 days, 3-4 weeks in Zambia	• Major obstetric and perinatal complications. • Shoulder dystocia • Instrumental vaginal delivery • Managing malpresentations • New-born resuscitation • Estimation of blood loss, • Active management of third stage of labour, • Team work	Medical doctors (MBBS), midwives, nurses, paramedics and medical students Modified (3-4 week course for clinical officers in Zambia) (Blackwell-Smyth, Breen & Hinshaw 2004)	• Didactic 19%, • Simulation 63%
2.	**Essential Newborn Care Course** Argentina, Democratic Republic of Congo, Guatemala, India, Pakistan, Zambia	World Health Organisation http://www.who.int/maternal_child_adolescent/documents/newborncare_course/en/	9-10 days	• Routine neonatal **care**, • Newborn resuscitation, • Thermoregulation, • Breast-feeding, • "Kangaroo" [skin-to-skin] care, • Care of the small baby, and common illnesses	12-24 health care workers (Medical doctors and other health care workers with secondary education training and some level of health care training) per course. Two trainers for a group of 12-24 trainees.	• Didactic lectures (50% • Clinical sessions (50%) in a health care facility with 20-30 deliveries per day, post natal ward, a special care baby unit, paediatric outpatients clinic or a hospital with Baby Friendly Initiative status.
3.	**Essential Steps in Managing Obstetric Emergencies (ESMOE)**	Department of Health, University of Pretoria, Republic of South Africa	2 days	• Maternal resuscitation • Care of the new-born • Shock and the unconscious patient	Medical doctors (MBBS), Senior midwives and medical	Didactic and clinical practice (rel % not available)

S/No.	Name of training package	Lead organisation	Training duration	Training content	Cadre of health care providers trained	Teaching methods used (% Didactic, simulation or clinical)
	Republic of South Africa	Medical Research Council, University of Pretoria Liverpool School of Tropical council, United Kingdom. www.lstmliverpool.ac.uk		• Pre-eclampsia and eclampsia • Obstetric haemorrhage • Sepsis • Assisted delivery • Obstructed labour • Obstetric complications • Surgical skills • Complications of abortion • HIV in pregnancy	interns	
4.	**Essential Surgical Skills with Emphasis on Emergency Maternal and Child Health - (ESS-EMCH)** Sudan, Egypt, Gambia, Zambia, Pakistan, Syria, Iraq, Iran and Oman	Child Advocacy International, Pakistan Advanced Life Support Group United Kingdom	5 days	• Emergency triage and treatment (ETAT) • Complications of pregnancy, • Newborn and adult resuscitation, • Transportation of ill patients, • Care of the new-born • Paediatric emergencies • Burns, trauma • BEmOC	Paediatricians, obstetrician-gynaecologists, anaesthetists, nurses and doctors and nurses in emergency care departments (5 days)	• Didactic 32% • Simulation based 68%
5.	**Essential Surgical Skills with Emphasis on Emergency Maternal and New-born Health -(ESS-EMNH)** Pakistan, Gambia	Child Advocacy International, Pakistan Advanced Life Support Group United Kingdom	3 days	• Neonatal emergencies • Complications of pregnancy, • New-born and adult resuscitation, • Care of the new-born • Paediatric emergencies • BEmOC	Non specialist medical doctors, nurse/midwives working with mothers and babies	• Didactic 32% • Simulation based 68%
6.	**Helping babies breathe** Several countries in Africa, Asia, Pacific region, South America and USA	American Academy of Paediatrics	1 day health care provider training 2 day Training of	Simulation based newborn resuscitation training.	Midwives, medical doctors, nurses, clinical officers, assistant medical officers, health extension workers, technicians, medical or	Mainly simulation based training

S/No.	Name of training package	Lead organisation	Training duration	Training content	Cadre of health care providers trained	Teaching methods used (% Didactic, simulation or clinical)
		http://www.helpingbabiesbreathe.org/	trainers		nurses' aides	
7.	**Helping mothers survive bleeding after birth** Tajikistan, Tanzania, Uganda, Guatemala, India, Malawi, and Zanzibar	Jhpiego (The Johns Hopkins Program for International Education in Gynaecology & Obstetrics) http://www.jhpiego.org/hms/	1 day followed by "low-dose, High-frequency" training with peers in their facilities	Simulation based training to prevent and treat post-partum haemorrhage	Midwives, medical doctors, nurses, clinical officers, assistant medical officers, health extension workers, technicians, medical or nurses' aides, and ambulance attendants	Mainly simulation based training
8.	**Life Saving Skills – Essential Obstetric and New-born Care Course (LSS- EOC and NC)** Bangladesh, Malaysia, Ghana, India, Iraq, Kenya, Libya, Malawi, Nigeria, Pakistan, Tanzania, Sierra Leone, Somaliland, Swaziland, Zimbabwe	Liverpool School of Tropical Medicine (LSTM), UK www.lstmliverpool.ac.uk and recognised by: Royal College of Obstetricians, UK (RCOG), www.rcog.org.uk World Health Organization, Geneva (WHO) www.who.int	3 or 4 days	• **Resuscitation** of mother and new-born • **Early new-born care** (Prematurity, hypoglycaemia and hypothermia) • **Communication, triage and referral** • Management of **shock and the unconscious patient** • Management of **severe pre-eclampsia and eclampsia** • Prevention and treatment of **Obstetric haemorrhage** • Prevention of **obstructed labour** • Diagnosis and treatment of Pregnancy related Sepsis • Assisted vacuum delivery- **vacuum delivery**	Obstetrician-gynaecologists, medical doctors (MBBS), nurse-midwives, medical assistants, clinical officers health care providers considered to be skilled birth attendants in each country setting.	• Didactic 15% • Simulation 70%, • Mentoring 5% • Evaluation 10%

S/No.	Name of training package	Lead organisation	Training duration	Training content	Cadre of health care providers trained	Teaching methods used (% Didactic, simulation or clinical)
				• Other common **obstetric emergencies** (Breech delivery, Cord prolapse, Twin delivery and Retained placenta)		
9.	**Life Saving Skills Program** Ghana, Nigeria, Uganda, Indonesia, Vietnam, Eritrea, Tajikistan, Malawi, Zambia, Ethiopia, Tanzania, and Honduras	American College of Nurses and Midwives http://www.midwife.org/Life-Saving-Skills-LSS	15 days	• Infection prevention practices, • Management of pregnancy induced hypertension, • Anaemia and post-partum haemorrhage, • Use of the partograph, infant resuscitation, • Post abortion care, family planning counselling and methods	Midwives	Didactic and clinical practice (rel % not available)
10.	**Managing Obstetric Emergencies and Trauma Course (MOET)** Armenia, Bangladesh	Advanced Life Support Group, UK http://www.alsg.org/uk/MOET	3 days	• Adult Life Support, • Management of trauma, obstetric, • Neonatal emergencies • Anaesthetic emergencies	Obstetrician-gynaecologists	Didactic and clinical practice (rel % not available)
11.	**Practical Obstetric Multi-Professional Training course (PROMPT)** Bahamas, Egypt, Fiji, Trinidad and Tobago, Zimbabwe	PROMPT Maternity Foundation, UK http://www.promptmaternity.org/	Varies, minimum 40 minutes.	• Emergency obstetric care drills	Midwives, resident doctors and obstetrician-gynaecologists	Didactic and simulation (rel % not available)
12.	**PRONTO** Mexico, Guatemala, Kenya	Pronto International http://prontointernational.org	22.5 hours over 2 modules 3 months apart	• Team work, • Communication, • Strategic planning, • Obstetric haemorrhage, Neonatal resuscitation, • Pre-eclampsia and eclampsia	General practitioners, medical interns, obstetricians, anaesthetist, midwives, obstetric nurses, paediatricians and general surgeons.	Predominantly simulation based. Relative proportion of simulation to didactic sessions not provided.

S/No.	Name of training package	Lead organisation	Training duration	Training content	Cadre of health care providers trained	Teaching methods used (% Didactic, simulation or clinical)
No evaluation reports identified						
13.	**Advances in Labour and Risk Management (ALARM)** East and Central Africa-Uganda, Western Kenya	ALARM International Programme Society of Obstetricians and Gynaecologists of Canada (SOGC) http://sogc.org/events/advances-in-labour-and-risk-management/welcome/ http://sogc.org/aogu/index0a07.html?contentID=46	2-5 days (2 days in Canada 5 days in Africa)	• Post-partum hemorrhage, • Obstructed labour, • Sepsis, • Abortion complications, • Pre-eclampsia/eclampsia complications	General Physicians, obstetrician-gynaecologists, nurses, midwives	• Didactic (35%), • Simulation/work shop (35%), • Mentoring and evaluation (30%)
14.	**Basic Essential Surgical Skills-Emergency Maternal and Child Health (ESS-EMCH) Life Support course** Pakistan	Child Advocacy International, Pakistan (Developed from Advanced Paediatric Life Support (APLS) and Management of Obstetric Emergencies and Trauma (MOET))	1 day	• Structured approach to emergencies • Resuscitation of newborn • Breathing difficulties, • Airway, ventilation, basic life support • Trauma, spinal immobilization after trauma • Infection control • Intraosseous needle insertion	Doctors, nurses, paramedics and birth attendants, ambulance Drivers	• Didactic 45% • Simulation 55%
15.	**Emergency Obstetric Care (EmOC)** India	The Federation of Obstetric and Gynaecological Societies of India (FOGSI) www.fogsi.org	16 weeks	• CEmOC	Medical doctors (MBBS)	• Didactic 37.5%, • Clinical practice 62.5%
16.	**Emergency Obstetric Care** Sub-Saharan Africa, Asia, Pacific and Caribbean regions	Averting Maternal Deaths and Disability Program (AMDD) www.amddprogram.org Columbia University	25 days	• EmOC • Surgical procedures • Anaesthetic procedures • ANC • Breast feeding • PNC	Medical doctors (MBBS) and midwives	• Didactic 25% • Simulation 49% • Clinical practice 26%

S/No.	Name of training package	Lead organisation	Training duration	Training content	Cadre of health care providers trained	Teaching methods used (% Didactic, simulation or clinical)
		JHPIEGO (The Johns Hopkins Program for International Education in Gynaecology & Obstetrics) www.jhpiego.org				
17.	**Emergency Obstetric Care training** Bangladesh	Ministry of Health and Family Welfare, Bangladesh www.mohfw.gov.bd	24 weeks	• Como • Anaesthetic techniques	Medical doctors (MBBS)	Didactic and clinical practice (rel % not available)
18.	**Pacific Emergency Obstetric Care Course** Pacific Island countries	Pacific Society for Reproductive Health, New Zealand www.psrh.org.nz	1 or 2 days	• BEmOC	Frontline clinicians providing obstetric and newborn care	Didactic and clinical practice (rel % not available)
19.	**Prevention, Recognition, and Management of Postpartum Haemorrhage** Burundi, Egypt, Ethiopia, Ghana, India, Kenya, Mozambique, Nigeria, Pakistan, Peru, South Africa, and Vietnam	Pathfinder International, USA www.pathfind.org	5 days	• Active management of the third stage of labor (AMTSL) • Recognizing and treating excessive postpartum hemorrhage • Use, of the non-pneumatic anti-shock garment (NASG).	Community based healthcare providers, health care workers considered to be skilled birth attendants, ambulance drivers, anaesthetists	Didactic and clinical practice (rel % not available)
20.	**Comprehensive Emergency Obstetric Care Training** Training of Medical Officers in pregnancy care and management of common obstetric complications India	Ministry of Health and Family Welfare, Government of India http://mohfw.nic.in	10 days	• BEmOC • Essential newborn care • Anaemia in pregnancy ANC • Breast feeding • Infection	Medical Officers (MB.BS) trained in batches of four	• Didactic 40-50% • Clinical 50-60%

2.10. Summary

a. 20 EmONC training packages implemented in low resource poor settings, of which only half have been evaluated were identified.
b. Only seven EmONC training identified in this study were conducted in seven or more days. 5 trainings were tailored for specific health care worker cadres and 15 were multidisciplinary, involving mostly medical doctors and nurses/midwives (in some instances paramedics).
c. 85% (17) of all EmONC training packages implemented in low resourced countries identified had content covering all UN defined EmOC signal functions. The longer the training, the more likely that it will have a clinical, supportive supervision and update/reminder/retraining component.
d. More short training packages, with one or more components of EmOC only (for example eclampsia, or shoulder dystocia) were delivered in well-resourced compared to low resourced countries.
e. Fifty-nine papers reporting evaluation of EmONC training in resource limited (33) and high - resourced (26) countries were identified. 10 other papers were systematic reviews of EmONC training.
f. There were two RCTs, one secondary data analysis, one qualitative study, three prospective studies using logbooks, three cross sectional studies and 23 before/after study designs conducted in low resource limited settings. While there were 11 RCTs, four secondary data analysis, three cross sectional studies and eight before/after study designs conducted in high-resourced countries identified.
g. 47.5% (28) of all evaluations used a before/after study design. And 19% (13) were randomised/cluster-randomised studies.
h. Evaluation has been **mostly at Kirkpatrick' level 1, 2 or 3**. There were only two studies conducted in low resourced countries that were evaluated at all 3 levels and **none at Kirkpatrick's level 4**.
i. In both low and high resourced settings, there was **strong positive reaction (Kirkpatrick level 1)** to EmONC training, health care providers in low resourced settings request more time for trainings. HCPs with considerable pre-service obstetric training/experience reported more confidence to provide EmOC after the training.
j. There was only one study that compared EmONC training of various **durations**. There was statistically significant difference in the skills of health care providers trained with the longer 11-day package compared with the seven-day package. The main difference in training

approach was the use of clinical supervisors/trainers on site for the longer EmONC training package.

k. Two RCTs and one before/after study evaluated the effectiveness of EmONC training **onsite compared to offsite** (simulation centre). Onsite training improves communication within obstetric teams and patient safety but is not more effective than offsite training in terms of knowledge improvement post training. Onsite training is more acceptable to health care providers compared to offsite training.

l. Low and high fidelity mannequins are equally effective in improving management of shoulder dystocia.

m. Several RCTs report that short interactive in-service training using **a combination of didactic and simulation based teaching methods** results in sustained improvement of knowledge, skills teamwork, and confidence of health maternity care providers.

n. Two RCTs assessed knowledge retention after training, showed that **Knowledge and skills scores were lower at 6 and 12 months post training** compared to immediately after training immediately post training scores but significantly higher than pre-training scores. One of the RCTs (training on shoulder dystocia management only) recommended **annual retraining for health care workers** who were already proficient in management of shoulder dystocia and more frequent training for those who were not. Both studies were in high-resourced settings.

o. One systematic review on skills and knowledge retention of advanced life support training concluded that skills and knowledge **decay by 6 months to 1 year after training**, skills decay faster than knowledge and that **clinical experience** either prior to the training and after the training has a positive impact on knowledge and skills retention.

p. One systematic review concluded that simulation based **multidisciplinary team** training in EmOC results in **improved practical skills, knowledge, communication and team performance**. However two other studies (one RCT and one cluster randomised trail) not included in that systematic review concluded that **specific team training in addition to EmONC training** improved the quality of communication of obstetric teams. All studies were conducted in high resourced settings.

q. There were no randomised controlled studies that evaluated change in practice but several before after studies showed change in practice after training in use of partographs, reduced C/S rates, improved new-born care, increase peri-mortem C/S, increased resuscitation attempts and increase in the number of post abortion care services provided by both medical doctors and midwives.

r. There was only one RCT that evaluated increase in EmOC signal functions. The training was newborn resuscitation and there was increase in the availability of newborn resuscitation with bag and mask after the training. This study was conducted in a low resource setting. Two studies (cohort, before after study design) have shown increase in the availability of EmOC signal functions up to 6 months after training.

s. There is evidence that **EmONC training improves patient perception of improved quality** of care. This is based on one RCT and observational study conducted in a high resourced and low resourced setting respectively.

t. A before and after study conducted in a low resource setting evaluated the impact of EmOC training, showed that it **significantly reduced** the incidence of facility based post-partum haemorrhage, severe PPH and decrease the number of episiotomies performed.

u. There are **mixed results** on the effectiveness of newborn resuscitation on newborn health outcomes. A RCT carried out in low resource setting did not show any improvements in new-born health outcomes but two before-after studies in a similar setting, showed significant reduction in early neonatal mortality and neonatal mortality rates. However results on stillbirth rates (and fresh stillbirths) were not consistent. These results were similar to those reported after a large retrospective cohort study in a high-resourced setting showed significant reductions in 5 minute Apgar scores and hypoxic-ischaemic encephalopathy but no change in stillbirth rates.

The next chapter will present methodology used for the evaluation of EmONC training in Kenya based on the 4 levels of evaluation of training described by Kirkpatrick (Kirkpatrick 1996b)

Table 9: Summary tables-Studies included in review providing information on evaluation of effectiveness of training in Emergency Obstetric and Newborn Care (EmONC)

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
Systematic reviews								
1. (Black, Brocklehurst 2003)	BJOG: An International Journal of Obstetrics and Gynaecology, vol. 110, no. 9, pp. 837-841	Description of in-service emergency obstetric training packages and evaluation of training (developed country setting only)	MOET and ALSO training packages	MOET-UK: 30, ALSO-USA: 1012 ALSO-USA: 275 ALSO-USA: 55 Midwives, obstetric trainees, consultants in obstetrics and anaesthesia, family physicians	**Systematic review** 4 studies included; before and after comparison of reaction, comfort and confidence responding to obstetric emergencies	1, 2, 4	Improved comfort and confidence sustained at 10 and 12 months in 2 studies. There was no study comparing one type of training with another	2b
2. (Calvert et al. 2013)	Australian and New Zealand Journal of Obstetrics and Gynaecology 2013; 53: 509-516	To identify the evidence for the clinical impact of simulation training in obstetrics emergency training	Obstetric emergency training	Skilled health care workers	**Review:** 92 articles included of which 59 were commentary or review articles 20 had non-clinical evidence of the impact of training 13 had Clinical evidence of the impact of training Kirkpatrick's level of training evaluation was used.	7	Most studies were evaluated at KL1, 2 or 3, 4 studies were evaluated at level 4 only and 1 study was evaluated at levels 1-3. There was evidence of positive impact of obstetric training in eclampsia, shoulder dystocia, post-partum haemorrhage, maternal collapse, cord prolapse and teamwork training however this is mostly at participant's level rather than clinical outcome level.	3a

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
3. (Cooper et al. 2011)	Women and Birth, DOI: 10.1016/j.wombi.2011.03.004	Examine the evidence for simulation based learning in midwifery education	Evidence from obstetrics, neonatology, technical and non-technical skills (teamwork) training was included where it informed the development of midwifery curricula	Not specified	**Systematic review** 24 papers included. All were quantitative studies: 6 interrupted time series, 9 cohort studies, 7 RCTs, 2 systematic reviews	2	Benefits of simulation compared to didactic based learning are apparent. This approach also aids the development of non-technical skills, confidence and competence.	1b
4. (Merién et al. 2010)	Obstetrics and Gynaecology, vol. 115, no. 5, pp. 1021-1031	Effectiveness of multidisciplinary teamwork training in a simulation setting for the reduction of medical adverse outcomes in obstetric emergency situations	Teamwork training programs with simulation models for labour ward staff in acute obstetric emergencies.	Not specified	**Systematic review** 86 studies included; 8 studies evaluated the effectiveness of team training (4 RCTs and 4 cohort studies)	3	Teamwork training in a simulation setting resulted in improvement of knowledge, practical skills, communication, and team performance in acute obstetric situations	1a/2b
5. (Nyamtema, Urassa & van Roosmalen 2011)	BMC Pregnancy and Childbirth, vol. 11, pp. 94-102	Impact of maternal health interventions in resource limited countries.	Multiple intervention programmes which included: training in EmONC, deployment of health care providers, refurbishment of health facilities, infrastructure, improved supply of drugs, equipment and consumables for obstetric care.	Not specified	**Systematic review** 58 papers included; 35 of 54 multiple intervention programmes reviewed included EmOC training, placement and motivation of health care providers. Effect of EmOC training alone not assessed	7	Programs integrating multiple interventions were likely to have significant positive impacts on maternal outcomes. Births and caesarean section rates in EmOC facilities increased by 71-75%, case fatality rates and maternal mortality ratios reduced significantly by 40% and 50% respectively	1a/2a
6. (Opiyo, English 2010)	Cochrane database of systematic reviews (Online), vol. 4	Effectiveness of in-service training of health professionals on management and care of the seriously ill new-born or child in low and middle-income	New-born in-service training packages – new-born resuscitation training	Not specified	**Systematic review** 2 studies included (1 RCT)	2, 5, 6, 7	Improvement in performance of adequate initial resuscitation steps (risk ratio 2.45, 95% CI 1.75, 3.42, p < 0.001) and reduction in the frequency of inappropriate and potentially harmful practices (mean difference 0.40, 95% CI 0.13, 0.66, P	1a

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
		settings					= 0.004).	
7. (Rabøl, Østergaard & Mogensen 2010)	Quality and Safety in Health Care, vol. 19, no. 6, e27	Outcome of classroom-based multi-professional team training for hospital staff.	Team training	Not specified	**Systematic review** 18 studies included; 15 studies were uncontrolled, 17 studies had a moderate or high risk of bias	4	Participant reaction, learning and behaviour change as well as effect on clinical processes was positive in all studies, but for some only partially. Results at patient level were limited. More than half of the studies ended evaluation within 6 months.	1a/2a
8. (Meaney et al. 2010)	Human Resources for Health 2011, 9:28	Systematic review to evaluate whether the inclusion of any specific resuscitation training educational strategy in developing countries improved outcomes	Resuscitation training	Not specified	**Systematic review** 44 papers included: 15 of good quality, 17 of fair quality and 12 of poor quality. Also there was only 1 RCT, 4 none randomised cross over studies, 21 retrospective controlled studies, 10 non-controlled studies and 2 descriptive studies.	3, 6 and 7	38/44 supported the use of resuscitation training programs in developing countries. Increased patient survival after resuscitation with absolute risk reduction ranging 0%-34%. There was no consistent-testing method for educational outcomes across studies and few studies examined educational outcomes and health outcomes (1). 15 studies assessed self- efficacy and 8 studies assessed student satisfaction. 15 studies assessed patient survival, 14 of which were either newborn or trauma resuscitation or only 1 was adult resuscitation.	1a/2a
9. (Van Lonkhuijzen et al. 2010)	BJOG: An International Journal of Obstetrics and Gynaecology, vol. 117, no. 7, pp. 777-787	To assess the effectiveness of training programmes aimed at improving emergency obstetric care in low-resource environments	Training programmes aimed at improving emergency obstetric care in low-resource environments	Not specified	**Systematic review** 38 papers included. There was large variation the study designs, training content and method of evaluation. Frequently poor study design and non-validated measurement tools used	3, 4, 5, 6, 7	Positive reaction, increased knowledge and skills, and improved behaviour after training. Health outcomes infrequently reported.	Reaction to training 2-4 Change in knowledge and skills 2a-3 Change in behaviour

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
								2a-4
10. (Yang et al. 2012)	Resuscitation 83 (2012) 1055–1060	To evaluate the retention of adult advanced life support (ALS) knowledge and skills following completion of an ALS course in healthcare providers.	Adult life support training	Nurses, physicians, anaesthesiologists, newly graduated doctors (n =10-325)	**Systematic review:** Data from included articles were analysed using a structured approach and organized outcomes by evaluation method, and knowledge and skills retention. 336 articles retrieved, 11 papers were included 3 RCTs, 5 repeated measure quasi-experimental study, 3 descriptive observational studies and 1 descriptive correlational study. 10 study designs were of fair quality and 1 was poor.	4	Most studies used multiple-choice questionnaires to evaluate knowledge retention and cardiac arrest simulation or other skills tests to evaluate skills retention. All studies reported variable rates of knowledge or skills deterioration over time, from 6 weeks to 2 years after training. Two studies noted retention of knowledge at 18 months and up to 2 years, and one reported skills retention at 3 months. Clinical experience, either prior to or after the courses, has a positive impact on retention of knowledge and skills. Conclusion: ALS knowledge and skills decay by 6 months to 1 year after training and that skills decay faster than knowledge.	1a/2a
Low and middle income countries								
1. (Ameh et al. 2012a) **Somaliland**	International Journal of Gynaecology and Obstetrics 117 (2012) 283–287	To evaluate in-service training in "Life Saving Skills – Emergency Obstetric and New-born Care"	3-day training designed to cover the 5 major causes of Maternal deaths: haemorrhage, sepsis, eclampsia, obstructed labour and complications of abortion; newborn resuscitation and early	222 healthcare providers	A before and after study was conducted using quantitative and qualitative methods to evaluate trainee reaction and change in knowledge, skills, and behaviour, in addition to functionality of healthcare facilities, during and immediately after	1,2, 4	The HCPs reported improved confidence in providing EmOC. Basic and comprehensive EmOC healthcare facilities provided 100% of expected signal functions compared with 43% and 56%, respectively, at baseline with trained midwives performing skills	2c

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
			newborn care, all 9-signal functions of EmOC.		training, and at 3 and 6 months post-training. **Kirkpatrick Level 1, 2 and 3**		usually performed by medical doctors	
2. (Basnet et al. 2004) **Nepal**	International Journal of Gynecology and Obstetrics, vol. 86, no. 1, pp. 98-108	To evaluate the effectiveness of post abortion care (PAC) training	Emergency treatment of complications, Manual Vacuum Aspiration (MVA) for first trimester abortions, post procedure family planning, counselling. Medical doctors training also included use of D&C for gestation >12weeks.	24 nurses and 17 medical doctors.	Cohort study; pre- and post-training knowledge test, availability of components of PAC, number of PAC cases managed, over a 1-year period. **Kirkpatrick Level 2 and 3**	1, 4, 5	Follow up of 6 nurse-providers in 2 district hospitals; all 6 scored 85% or above for knowledge. Family planning and counselling services not previously available under medical doctor led services were available post training in the 2 hospitals. The number of PAC cases increased by 37%. The proportion of referred cases to the next level of care did not change significantly (10% vs. 11%). This was attributed to staff redeployment after training.	2c
3. (Berglund et al. 2010) **Ukraine**	Acta Obstetricia et Gynecologica Scandinavica, vol. 89, no. 2, pp. 230-237	To describe the process of change and assess compliance and effect on maternal and infant outcomes of WHO training package on Effective Perinatal Care (EPC).	Didactic, interactive 2-week training package including clinical practice and a team approach to maternity care.	Obstetricians, neonatologists, midwives, paediatric nurses, paediatricians and anaesthesiologists	Intervention study comparing outcomes **before and after** training, 3 maternities, during 2.5 years **Kirkpatrick Level 3 and 4**	2, 7	EPC procedures were successfully implemented and adherence to the protocols was excellent. For most variables, the change occurred during the first 3 months and was well sustained. **Use of partograph increased between 60 and 400%; induction and augmentation of labour decreased to < 1% and < 5%, caesarean section rate decreased** significantly in 2 maternities, proportion of hypothermic infants decreased from 60-85%% to 1% in all three maternities, **admission to Neonatal Intensive Care Unit**	2c

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
							decreased in 2 maternities. There was **no effect** on early neonatal mortality	
4. (Child health Advocacy international 2007) **Pakistan**	**Report** Published by Child health Advocacy International, Islamabad, Pakistan: Evaluation of ESS-EMCH training in Pakistan	Evaluation of ESS-EMCH training in Pakistan, to determine its impact on knowledge, attitudes and practice	Essential Surgical Skills -Emergency Maternal and Child Health (ESS-EMCH) training package	234 health care providers: 194 medical doctors and 40 nurse-midwives	Before and after comparison of knowledge and skills, postal survey post training **Kirkpatrick Level 1 and 3**	1, 2, 4	Improvement in knowledge and skills: pre course knowledge test - doctors: 63.52+/-13.32, nurses: 54.89+/-18.31. Post course knowledge test- doctors: 71.46+/-8.87, nurses; 65.47+/-7.68. (p=0.00) Qualitative survey: 54% response rate. Increased confidence, frequent use of skills, bag and mask for neonatal resuscitation and hand washing.	2c
5. (Child health Advocacy international 2010) **Pakistan**	**Report** Published by Child health Advocacy International, Islamabad, Pakistan Evaluation of Essential Surgical Skills with emphasis on Emergency Maternal and Child Health Programme by assessing doctors' practices in Pakistan	To evaluate the impact of Essential surgical skills-emergency maternal and child health ESS-EMCH training in Pakistan	Essential Surgical Skills -Emergency Maternal and Child Health (ESS-EMCH) training package	36 medical doctors in public sector hospitals of 3 districts were involved in the evaluation. 18 each in the intervention and control groups. 284 patients, 124 in each group Observational study: 7 medical doctors	Phase 1: cluster RCT Phase 2: observational study: 6 months post training, knowledge and skills assessment **Kirkpatrick Level 1, 2 and 3**	2, 4	Knowledge scores immediately after training were significantly increased (p=0.03) with non-significant change in knowledge 6 months after training (p=0.20). There was a statistically significant difference in the number of patients treated using the structured approach between the intervention; 63.7% (79) and control 37.1% (46) arms (OR 2.98, 95%CI 1.78-4.99, p=0.0001). Cluster analysis revealed similar findings for doctors: intervention-62.9% (50.4-75.3) vs. control-36.3% (26.3-46.4) (p=0.001)	1b

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							Observational study results: There was significant retention of skills 6 months after the training.	
6. (Clark, Mitchell & Aboagye 2010) **Ghana**	Journal of Midwifery & Women's Health, vol. 55, no. 2, pp. 153-161	Impact of training in Post Abortion care (PAC) on service provision.	Post Abortion Care	53 medical doctors and 434 nurse-midwives	5-year retrospective analysis of secondary data; assessment of change in behaviour and service provision. **Kirkpatrick Level 3**	2, 5	Overall, 28% of providers were offering PAC services (medical doctors 80%, nurse midwives 20%). In bivariate analysis, provision of PAC services was associated with training. Working in a facility with the National Reproductive Health Standards and Policy available or a private health care facility was associated with midwives offering PAC services.	2c
7. (Carlo et al. 2010) **Zambia**	Paediatrics 2010; 126;e1064; October 11, 2010; DOI:10.1542/PEDS. 2009-3464	To test the hypothesis that two training programs would reduce incrementally 7-day neonatal mortality rates for low risk institutional deliveries	**ENC training** Routine neonatal **care**, resuscitation, thermoregulation, breast-feeding, "kangaroo" [skin-to-skin] **care**, **care** of the small baby, and common illnesses **Neonatal resuscitation program (NRP)** Basic resuscitation knowledge, skills, bag and mask ventilation and chest compressions.	Midwives in 18 clinics	Before and after study Data collected during 3 months after implementation of each training course. **Kirkpatrick level 4**		71 689 neonates were enrolled over 3 months 7 day neonatal mortality rate decreased from 11.5% to 6.8% deaths per 1000 live births after training (relative risk: 0.95% CI: 0.48-0.77; P<0.001), due to decrease in deaths from birth asphyxia and infection. There was no decrease in stillbirth rates. There was a further decrease in neonatal mortality rate after further Neonatal Resuscitation Training. ENC training for midwives reduced 7-day neonatal mortality rates in low risk first referral level, urban community clinics.	2c

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8. (Cole-Ceesay et al. 2010) **Gambia**	Reproductive Health, vol. 7, no. 21 e1-10	To describe and evaluate interventions to improve emergency care	Training in the recognition and management of emergencies based on WHO tool kit, ALSG UK and Essential Surgical Skills with Emphasis on Emergency Maternal and Child Health (ESS-EMCH training package)	217 doctors, nurses, and nurse-midwives	Cohort study: log books used to document resuscitation attempts over 30 month period following training. **Kirkpatrick Level 3**	2, 6	A total of 293 resuscitation attempts documented in logbooks. Response rate not reported	2c
9. (Conroy et al. 2014) **Sierra Leone**	Resuscitation 85 (2014) e31-e32 Letter	Evaluation of baseline retention of previous training in neonatal resuscitation training of healthcare workers in Bo District Sierra Leone	Not described, nor interval between training and evaluation	Not clear if all those assessed were originally trained but 42 health care workers were observed: 5 Midwives, 18 Nurses, 4 Community Health Workers, 10 Maternal and Child Health Aides 3 Community Health Assistants and 2 traditional birth attendants	Cross sectional study Experienced neonatal resuscitation trainers observed health care workers and graded their performance as excellent, identified need for successfully commencing resuscitation and inadequate resuscitation. It was not clear if observation of real cases was combined with simulation using a model. **Kirkpatrick Level 1 and 2**	2, 4, 6	The score, proportion of staff with that score and the 95% confidence interval were 36 or 86% CI (72-93) of health care workers were graded as inadequate resuscitation, 6 or 14% (7-28) identified the need for and commenced resuscitation and none of the HCW was graded as excellent.	4
10. (Ersdal et al.	Resuscitation 2013 Oct; Vol. 84 (10), pp. 1422-7	To determine the effect on practical skills and **management** strategies among	One-day HBB (newborn resuscitation) training was conducted by	**Cohort total: 53** Pre HBB: 39	Before/after study design 39 providers performed two simulation scenarios;	1, 2, 4, 6	The proportion of providers who "passed" the **simulated** "routine care" and "neonatal resuscitation" scenarios increased after HBB	2c

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2013) **Tanzania**		providers using simulations seven months after HBB training, and to describe neonatal **management** in the delivery room during the corresponding time period before/after a one-day HBB training in a rural Tanzanian hospital	Tanzanian master instructors in April 2010 There was no retraining or efforts to facilitate skill transfer and sustainability of performance after training was put in place	Post HBB: 27 Post HBB rest: 13	"routine care" and "neonatal resuscitation" were performed by before (September 2009) and 27 providers after (November 2010) the HBB training. Two independent raters scored the videotaped scenarios. Overall "pass/fail" **performance** and different skills were assessed. During the study time period (September 2009-November 2010) no HBB re-trainings were conducted, Observational data on neonatal **management** before (n=2745) and 7 months after (n=3116) the HBB training was collected in the delivery room by observing all births at the hospital during the same time period. **Kirkpatrick level 2 and 3**		training, from 41 to 74% (p=0.016) and from 18 to 74% (p≤0.0001) respectively. However, the number of **babies** being suctioned and/or ventilated at birth did not change, and the use of stimulation in the delivery room decreased after HBB training. Improvements in skills observed during simulated testing were not transferred clinical practice	
11. (Evans et al. 2009) **India**	International Journal of Gynecology and Obstetrics, vol. 107, no. 3, pp. 277-282	To evaluate the impact of 16-week Comprehensive EmOC (CEmOC) training program for medical doctors.	CEmOC training	17 general medical officers	Cohort study: Before/after Primary outcome: Availability of EmOC signal functions **Kirkpatrick Level 3**	2, 4, 5, 6, 7	More trainees performed each of the basic EmOC skills after the training than before. After training, 10 of 15 facilities to which trainees returned could provide all signal	2c

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							functions for basic EmOC whereas only 2 could do so before. For comprehensive EmOC, 2 facilities with obstetricians were providing all functions before and 2 were doing so after, even though the specialists had left those facilities and services were being provided by CEmOC trainee	
12. (Evans et al. 2014) **Malawi, Zanzibar and Tanzania**	International Journal of Gynaecology and Obstetrics 2014	To validate the Helping Mothers Survive: Bleeding After Birth training module	One day health care facility based training Prevention, detection and management of post-partum training	155 skilled and semi-skilled health care workers	Before and after study **Kirkpatrick's level 1 and 2**	1, 2	The proportion of providers with passing knowledge scores increased significantly from pre- to post-training among all cadres except for those already high at baseline. On three post-training skills tests the overall proportion of individuals with a passing score ranged from 83% to 89%	2c
13. (Frank, Lombaard & Pattinson 2009) **Republic of South Africa**	South African Journal of Obstetrics and Gynaecology, vol. 15, no. 3, pp. 94-99	To assess the effect of the Essential Steps in Managing Obstetric Emergencies (ESMOE) training programme on improving knowledge and skills of interns.	3- day training in management of obstetric emergencies	68 medical interns undergoing rotation in obstetrics and gynaecology from 8 hospitals.	Before and after comparison of knowledge and skills using MCQs and OSCE methods of interns who had received in training in addition to rotation (intervention group) compared to interns who had done rotation only (control group) **Kirkpatrick Level 2**	2	Knowledge scores (mean and (range) of trained interns group were significantly higher than their pre-test scores and those of the control group (79 (58 - 93), 75 (48 - 91) and 77 (57 - 86) respectively). Similarly, the OSCE scores for skills of the intervention group were significantly higher than their pre-test scores and those of the control group (30.75 (25 - 38), 19.75 (8.5 - 27.5) and 24.5 (14.4 - 31) respectively.	2c
14. (Grady et al.	Journal of Obstetrics and Gynaecology, vol. 31, no. 1, pp. 18-23	To evaluate the effect of LSS EOC & NC training	3-day training designed to cover the 5 major causes of Maternal death	600 healthcare providers (nurse-midwives, medical doctors, clinical	Cohort study, before and after training assessment of knowledge and skills	1, 2	Knowledge (n=600) about the diagnosis and management of complications of pregnancy and	2c

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2011) **Kenya, Malawi, Somaliland, Swaziland, Zimbabwe, Tanzania, Sierra Leone**			(haemorrhage, sepsis, eclampsia, obstructed labour and complications of abortion) newborn resuscitation and early newborn care, all nine signal functions of EmOC.	officers and specialists)	**Kirkpatrick Level 1 and 2**		childbirth as well as newborn care significantly increased (p < 0.001). There was measurable improvement in skills n=238 (p<0.001), and participants expressed a high level of satisfaction with the training.	
15. (Homaifar et al. 2013) **Rwanda**	International Journal of Gynecology and Obstetrics 120 (2013) 195–199	To determine improvement in knowledge among MD6 students after completion of ALSO training; to determine retention of knowledge from completion of the ALSO course to the final assessment; and to determine individual, structural, and environmental factors that might predict competence among students with regard to provision of quality obstetric care.	ALSO course (obstetric emergencies)	65 final-year medical students	Quantitative assessments to evaluate emergency obstetrics knowledge and practical skills were administered **before, immediately after**, and 3–9 months following the training course **Kirkpatrick Level 2**	2	In total, 52 (80.0%) students demonstrated knowledge improvement after training. 57 (87.7%) students improved or maintained their scores from the post-training written test to the final assessment, and 32 (49.2%) retained practical skills. Twenty-one (32.3%) of the class demonstrated competency in both written and practical skills. According to multivariable logistic regression analysis, female gender was associated with overall competency (P=0.01), and use of the internet for academic purposes more than 3–5 times per week tended toward competency (P=0.11)	2c
16. (Johanson et al. 2002a)	BMC Medical Education, vol. 2, pp. 5-5	To evaluate the effectiveness of the MOET course in Bangladesh	3 -day training in managing obstetric emergencies and trauma (MOET)	9 obstetrician-gynaecologists	Before and after comparison of knowledge and management of an obstetric emergency scenario	1, 2	All participants showed an improvement in knowledge scores: the range of scores was narrower after- (143–175) compared to	2c

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Bangladesh					**Kirkpatrick Level 1 and 2**		before training (69–146). After training none of the candidates had un satisfactory scores for the scenario management. The overall ratings in anonymous evaluation of training were good.	
17. (Johanson et al. 2002b) **Armenia**	Journal of Obstetrics and Gynaecology Research, vol. 28, no. 4, pp. 217-223	To evaluate the effectiveness of the MOET course in Armenia	3 -day training in managing obstetric emergencies and trauma (MOET)	8 obstetrician-gynaecologists	Before and after "comparison of knowledge and management of an obstetric emergency scenario. **Kirkpatrick Level 1 and 2**	1, 2	All participants showed an improvement in knowledge scores. The range was narrower after- (167–188) compared to before-training (85–129.5). In the scenario assessment none of the participants had an unsatisfactory score. The majority of comments were complimentary and positive. All candidates enjoyed the course, 7/8 felt strongly that they learnt new procedures and 5/8 felt strongly confident to practice and teach obstetric emergencies after training.	2c
18. (Makuwani et al. 2010) **Tanzania**	East African Journal of Public Health, vol. 7, no. 2, pp. 109-113	To evaluate the impact of EmOC training and advocacy on the availability and utilisation of CEmOC	Management of prolonged and obstructed labour, obstetric haemorrhage, pre-eclampsia and eclampsia, puerperal sepsis and severe anaemia.	15 medical assistants, medical doctors and nurse- midwives	Before and after study **Kirkpatrick Level 3 and 4**	4	Increase in number of facility deliveries from 306 to 636 per month, institutional CS rate 17.4% and number of referrals out reduced by 80%	2c
19. (Mavalankar et al. 2009) **India**	International Journal of Gynecology and Obstetrics, vol. 107, no. 3, pp. 283-288	To evaluate the impact of the 18- week long Life Saving Anaesthetic Skills (LSAS) for Emergency Obstetric Care (EmOC) trained medical officers	Resuscitation in obstetric emergencies and provision of anaesthesia for obstetric procedures	51 medical doctors	14 qualitative interviews using purposive sampling **Kirkpatrick Level 1**	1, 4	Training well received but trainees wanted more practice. Being posted with a specialist anaesthesiologist and with a co-operative EmOC provider increases the likelihood that participants	

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							would provide anaesthesia. The working environment in health facilities is insufficient to tackle emergency obstetric procedures.	
20. (McDermott et al. 2001) **Indonesia**	Journal of Midwifery and Women's Health 2001 July-Aug; Vol. 46(4), pp. 217-25	To evaluate LSS in-service training programme in Indonesia. The knowledge, confidence and skills of midwives who attended a long, short intensive LSS training programme (11 day LSS+ peer review-PR/continuous medical education CME) compared 7 day LSS for midwifery interns and midwives who received no LSS training.	Based on ACNM LSS training plus Antenatal care, labour, delivery, post-partum care with focus on postpartum haemorrhage and neonatal asphyxia	Intern programme (7 day LSS training): 28 midwives LSS+PR/CME (11 days LSS training): 33 Untrained (No LSS training): 47	Cross sectional study Evaluators blinded to the participants training status **Self-reported confidence** on a scale of 0 (not confident) to 3(confident) on 50 maternal and neonatal skills **Knowledge** test consisted of 26 scenario-based questions (30-40 minutes) covering ANC, labour care, delivery and post-partum care. **Skills assessments**: Case scenarios and clinical simulations in infection prevention, use of partograph, and manual removal of placenta, bimanual uterine compression, and neonatal resuscitation. Minimum level for skills test was 70% **Kirkpatrick level 1 and 2**.	1, 2, 4	**Confidence**: LSS+PR/CME 62% vs. untrained 57% p=0.14 (No difference) Internship 65% vs. untrained 57% p=0.12 (No difference) LSS+PR/CME 62% vs. Internship 65% p=0.51 (No difference) **Knowledge:** LSS+PR/CME 65% vs. untrained 59% p=0.006 (significant difference) Internship 62% vs. untrained 59% p=0.12 (No difference) LSS+PR/CME 65% vs. Internship 62% p=0.24 (No difference) **Skills:** LSS+PR/CME 71% vs. No training 51%, p<0.001 (significant difference) Interns 62%, and no training 51%, p<0.006 (significant difference) LSS+PR/CME 71% vs. Interns 62%,	3b

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							p<0.009 (significant difference) Village midwives from the intensive program scored significantly higher in the practical demonstration of manual removal of placenta, bimanual compression, and neonatal resuscitation than the interns, but the scores on infection prevention and use of the partograph were not different between the two groups.	
21. (Msemo et al. 2013) **Tanzania**	Pediatrics, 2013, 131, 2, e353-e360	To evaluate the impact of the HBB programme on early neonatal mortality and fresh stillbirth rate	2 day training of 40 master trainings using HBB curriculum. The Master trainers trained HCW from 8 hospitals using 1 day HBB curriculum Master trainers subsequently provided on the job supervision and refresher training.	8 hospitals (3 main referral, 4 regional and 1 district)	Before/after study design Before n=8124, After n=78, 500 Primary outcomes: reduction in early neonatal deaths within 24 hours and fresh stillbirth rate. **Kirkpatrick Level 4**	5, 6, 7	Implementation of HBB training was associated with a significant reduction in neonatal deaths (relative risk [RR] 0.53; 95% confidence interval [CI] 0.43–0.65; P ≤ .0001) and rates of FSB (RR with training 0.76; 95% CI 0.64–0.90; P = .001). Stimulation use increased from 47% to 88% (RR 1.87; 95% CI 1.82–1.90; P ≤ .0001) while suctioning increased from 15% to 22% (RR 1.40; 95% CI 1.33–1.46; P ≤ .0001) whereas face mask ventilation decreased from 8.2% to 5.2% (RR 0.65; 95% CI 0.60–0.72; P ≤ .0001)	2c
22. (Nelissen et al. 2014) **Tanzania**	Acta Obstet Gynecol Scand 2014; 93:287–295.	To evaluate "Helping Mothers Survive Bleeding After Birth" (HMS BAB) simulation-based training in low resource setting- a half-day simulation-	Basic delivery care, active management of third stage of labor, and treatment of postpartum hemorrhage, including bimanual uterine	**4** master trainers trained **8** local facilitators **89** health care providers: Clinicians-10,	Before and after study design, using questionnaires information on course perception. Knowledge, skills and confidence of facilitators and learners were tested.	1, 2	After training, all facilitators passed the knowledge test, but pass rates for the skills test were low (29% pass rate for basic delivery and 0% pass rate for management of postpartum hemorrhage)	2c

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		based training, using a train-the-trainer model	compression	nurse-midwives- 60, Medical attendants 13, Ambulance drivers- 6, involved in maternity care	70% or more was considered a pass mark. Skills test was performed 1 week before the training and repeated 1 week after **Kirkpatrick's level 1 and 2**		**Level 1:** HMS BAB training was considered acceptable and feasible, although more time should be allocated for training, and teaching materials should be translated into the local language. **Level 2**: Knowledge (74% to 80%), skills, and confidence of learners increased significantly immediately after training. However, overall pass rates for skills tests of learners after training were low (3% pass rate for basic delivery and management of postpartum hemorrhage).	
23. (Nyamtema et al. 2011) **Tanzania**	Human Resources for Health 9:28	Evaluation training of non-physician clinicians in Emergency obstetric care	3 months hands-on, didactic and clinical training sessions for comprehensive emergency care and anaesthesia for caesarean section. Also Health care centres were upgraded.	43 health care providers (Assistant medical officers, nurses/midwives and clinical officers) from 12 health care centres at district level in Tanzania and Somalia	Before and after study, outcome measures: Number of institutional deliveries, change in stillbirth rates and obstetric referrals **Kirkpatrick Level 4**	1, 2, 4, 6 and 7	During training, participants performed 278 major obstetric surgeries, 141 manual removal of placenta and evacuation of incomplete and septic abortions, and 1161 anaesthetic procedures under supervision. The first 8 months after introduction of CEmOC services in 3 health centers resulted in 179 caesarean sections, a remarkable increase of institutional deliveries by up to 300%, decreased fresh stillbirth rate (OR: 0.4; 95% CI: 0.1-1.7) and reduced obstetric referrals (OR: 0.2; 95% CI: 0.1-0.4)). There were two maternal deaths, both arriving in a moribund condition.	2c
24.	Report	To compare the	Infection prevention	35 midwives in	Before and after	1, 2, 5, 6	Statistically significant improvement	

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(Osei et al. 2005) **Ghana**	Improving the Ghanaian Safe Motherhood Programme: Evaluating the effectiveness of alternative training models and other performance improvement factors on the quality of maternal care and client outcomes. Washington, DC: Frontiers in Reproductive Health, Population Council.	effectiveness of two methods of EmOC training: a traditional 3-week residential approach (TRA) versus self-paced learning (SPL) SPL also had component of supportive supervision.	practices, management of pregnancy induced hypertension, anaemia and post-partum haemorrhage, use of the partograph, infant resuscitation, post abortion care, family planning counselling and methods	the TRA and 40 in SPL group, from 4 districts (38 health care facilities)	comparison of impact on knowledge and skills, quality of care and change in provider performance in managing obstetric complications, normal labour and delivery, antenatal and post-natal care. Cost comparison done. **Kirkpatrick Level 2**		in knowledge scores for the SPL group only. **Provider performance indicator**: both approaches showed improvements for all 3 indices (SPL: 10-26%, TRA: 8-22%) but only statistically significant in managing obstetric emergencies by the SPL group (49% baseline, 55% end line) vs. TRA (54% baseline and 58% end line). There was a statistically significant improvement in both groups for labour and delivery skills but no statistically significant difference in PAC skills (n=13) **Cost effectiveness:** The SPL approach costs more per trainer than the TRA but the TRA was more cost effective than the SPL approach across all 3-performance indicators.	2c
25. (Opiyo et al. 2008) **Kenya**	Plos One 2008 Feb 13; Vol. 3 (2), pp. e1599	To determine if a simple one day newborn resuscitation training (NRT) alters health worker resuscitation practices in a public hospital setting in Kenya To evaluate the impact of early and late training in newborn resuscitation	Newborn resuscitation based on UK Resuscitation council guidelines	Early training with NRT (n=28) or late training (the control group, n=55)	Randomised controlled trial The primary outcome was the proportion of appropriate initial resuscitation steps with the frequency of inappropriate practices as a secondary outcome. Data were collected through direct observation	1, 2, 4	Trained providers demonstrated a higher proportion of adequate initial resuscitation steps compared to the control group (trained 66% vs. control 27%; risk ratio 2.45, [95% CI 1.75–3.42], p, 0.001, adjusted for clustering). There was a statistically significant reduction in the frequency of inappropriate and potentially harmful practices per resuscitation in the trained group (trained 0.53 vs. control 0.92; mean difference 0.40, [95% CI 0.13–0.66],	1b

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					of 97 and 115 resuscitation episodes over 7 weeks after early training in the intervention and control groups respectively. Baseline routine data was collected 6 months pre-intervention, 3months after the first training and 3months after all staff were trained. **Kirkpatrick level 3**		p = 0.004).	
26. (Ronsmans et al. 2001) **Indonesia**	Tropical Medicine and International Health, vol. 6, no. 10, pp. 799-810	To evaluate the impact of Life Saving Skills (LSS) training in Indonesia	American College of Midwives LSS training: normal obstetric care, newborn care and postnatal care. The intervention comprised of LSS training, interpersonal communication training (IPC), peer review supervision system, continuing education, a maternal and perinatal audit system and IEC strategy aimed at the community	128 facility based midwives and 284 village midwives in 3 districts.	Multiple intervention study. Quasi-experimental study design: before and after comparison. 5 skills were assessed. For assessment of interpersonal communication (IPC), direct observation of practice and client exit interviews were conducted at 3 and 12 months post training. Midwives who had only IPC training were compared to those who had both IPC and LSS training. **Kirkpatrick Level 2 and 3**	1, 2, 3	Improvement in the ability of both facility- and village-based midwives to perform the 5 key lifesaving skills. For facility-based midwives, the mean scores increased from 40 to 67% and the percentage 'competent' rose from 0 to 46% (P < 0.01). For village midwives, mean scores increased from 51 to 71%, and the percentage 'competent' from 6 to 67% (P < 0.01). Training enhanced the IPC skills of village midwives. Mean scores for IPCC trained village midwives decreased from 78% at 3 months to 64% at 16 months after training.	2c
27. (Sorensen et	International Journal of Gynaecology and Obstetrics 111 (2010) 8-12	To evaluate the management of prolonged labor and neonatal care before and after Advanced	Major obstetric and perinatal complications. Newborn resuscitation Estimation of blood	Number of mid and high level staff providing childbirth trained was not specified	Prospective Before and after study 558 deliveries before and 550 deliveries after		No difference in caesarean section rate, vacuum delivery was not practised after the training; decision to action time in cases of prolonged labour was more than 3 hours. Also	2c

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al. 2010) **Tanzania**		Life Support in Obstetrics (ALSO) training	loss, Active management of third stage of labour, Team work		Outcomes measures: Caesarean section rate, vacuum delivery rate, stillbirth rate, APGAR score and newborn resuscitation **Kirkpatrick level 4**		no difference in stillbirth rate, Apgar scores or frequency of newborn resuscitation. However There was a significant increase in the number of babies handed to their mothers within 10 minutes 5.6% to 71.5% (RR 12.71; 95% CI, 9.04-17.88). Immediate neonatal mortality decreased as well: 6 deaths before, 0 deaths after p=0.003)	
28. (Sorensen et al. 2011) **Tanzania**	Acta Obstetricia et Gynecologica Scandinavica, vol. 90, no. 6, pp. 609-614	To evaluate the impact of the Advanced Life Support in Obstetrics (ALSO) training on staff performance and incidence of post-partum haemorrhage (PPH) at a regional hospital in Tanzania	Lectures, workshops and case discussions on the major obstetric and perinatal complications. Estimation of blood loss, active management of third stage of labour, team work in the step wise management of PPH	2 medical doctors, 4 medical assistants and 16 midwives	Before and after comparison; assessment pre- and 7 weeks post-training on PPH prevention and management, estimated blood loss was compared with measured actual blood loss. **Kirkpatrick Level 4**	4, 6	Reduction of incidence of PPH from 32.9 to 18.2% [RR 0.55 (95%CI: 0.44–0.69)] and severe PPH from 9.2 to 4.3% [RR 0.47 (95%CI: 0.29–0.77)]. Staff identified 1 in 25 PPH cases before and 1 in 5 after training. A significantly higher proportion of women with PPH were managed with continuous uterine massage, oxytocin infusion and bimanual compression of the uterus after the training.	2c
29. (Singhal et al. 2012) **Kenya** **Pakistan**	Resuscitation 83 (2012) 90–96	To evaluate the an educational programme in neonatal resuscitation for resource limited settings at facilitator and learner levels	HBB emphasizes assessment at birth, stimulation to breathe, and assisted ventilation Use of contemporary educational theory and research and includes evidence-informed content, active learning, skill practice with feedback, case scenarios, self-	31 facilitators 102 learners.	Before/after study design Focus groups provided data on facilitator and learner perceptions used to supplement level 1 K level 2: Knowledge and skill assessments included pre/post scores from multiple choice questions (MCQ) and post-training		Participants expressed high satisfaction with the program and high self-efficacy with respect to neonatal resuscitation. Assessment of participant knowledge and skills pre/post-program demonstrated significant gains; however, the majority of participants could not demonstrate mastery of bag and mask ventilation on the post-training assessment without additional practice.	2c

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			reflection, group discussion, and structured assessment of knowledge, skills and performance		assessment of bag and mask skills, as well as 2 objective structured clinical evaluations (OSCE). **Kirkpatrick level 1 and 2**			
30. (Taylor 2010) **Ghana**	**Report** Issues in Essential Obstetric Care: Report of a Technical meeting of the IAG for Safe Motherhood May 31-June 2, 1995. New York: The Population Council; Family Care International. pp. 45-47	To describe the training and evaluation of rural based midwives in emergency obstetric care	2-week long training including; introduction to maternal mortality, haemorrhage, sepsis, pregnancy induced hypertension, obstructed labour, abortion, antenatal risk assessment, use of the vacuum extraction, adult and new-born resuscitation, repair of episiotomies	123 nurses-midwives	Observational study: Participant self-assessment at the end of every module and, follow-up field visits with assessment of new skills performed, observation of clinical practice (episiotomy repair, review of partograph) **Kirkpatrick Level 1 and 3**	4, 5	24 out of 123 rural based midwives trained were visited and 4 midwifery programmes were visited. Midwifery programmes had integrated materials from the training into their pre-service curricula. Procedures such as newborn resuscitation had improved, there were two successful adult resuscitations, episiotomies inspected were of high quality, and partographs inspected were properly completed and showed sound clinical management decisions had been taken.	2c
31. (Walker et al. 2012) **Mexico**	International Journal of Gynaecology and Obstetrics 116 (2012) 128-133	Evaluation of the PRONTO training course	Two modules 3 months apart covering team work, communication, strategic planning, Obstetric haemorrhage, neonatal resuscitation, pre-eclampsia and eclampsia	68 and 44 health care providers (General practitioners, midwives, Obstetricians, Paediatricians, General surgeons and medical interns) participated in modules 1 and 2 respectively	Before and after study Mixed methodology with 3 main outcome measures 1) Acceptability 2) Institutional goal achievement, 3) Team improvement Tools: Pre and post-test, participants knowledge and self-efficacy and programme evaluation	2, 3, 4	The trainees were highly positive in terms of both acceptability and feasibility of the training. There was an improvement in obstetric hemorrhage (50%–59% overall correct responses) and neonatal resuscitation (33%–40% overall correct responses) knowledge between pre- and post- 3 months. Self-efficacy scores measured pre- and post-3 months improved for obstetric hemorrhage, basic delivery	2c

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					questionnaire Data was collected at pre, immediately post training and at 3 months post training. **Kirkpatrick Level 1 and 2**		care, and obstetric emergency care. Overall, 31 goals were listed, of which 20 (64.5%) were achieved, 9 (29.0%) were in process, and 2 (6.5%) were associated with no action.	
32. (Zaeem-ul-Haq et al. 2009) **Pakistan**	Journal of the Pakistan Medical Association, vol. 59, no. 1, pp. 22-26	To assess motivational level post-training and the extent to which the health providers were using the skills learned	2 to 5 day Essential Surgical Skills - Emergency Maternal and Child Health (ESS-EMCH) training package; 12 modules - complications of pregnancy, newborn and adult resuscitation, transportation of ill patients, care of the newborn and paediatric emergencies	234 health providers	Retrospective cohort study, postal survey. **Kirkpatrick Level 1 and 3**	2	90% of respondents reported using acquired skills and the structured Airway, Breathing Circulation (ABC) approach in handling emergencies. Lack of equipment and lack of support from higher levels were common barriers to improving practice. 81% of respondents reported that training had resulted in better availability or use of supplies at their facilities. Health care providers caring for neonates expressed having confidence in obstetric procedures, while Obstetrician- gynaecologists described themselves as being more confident in neonatal resuscitation.	2c
33. (Zafar et al. 2009) **Pakistan**	Resuscitation, vol. 80, no. 4, pp. 449-452	To evaluate the use of a structured training programme in emergency care in Pakistan through the completion of logbooks documenting actual resuscitation attempts.	Essential Surgical Skills–Emergency Maternal and Child Healthcare (ESS–EMCH) training package	120 health care providers	Observational study, logbooks to document the use of newly acquired resuscitation skills **Kirkpatrick Level 4**	4, 5	1,123 resuscitation attempts were documented by 63 of 120 trained health care providers (response rate 53%; number of attempts 4–22 per participant). 76% (858/1123) of documented cases were received from doctors and 24% (265) from nurses. The patients receiving resuscitation were neonates 31% (n = 349), infants and children 38% (n = 426), pregnant mothers 21% (n =	2c

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							233) and other adults 10% (n = 111). Survival rate in cases reported was 89%.	
High income countries								
Authors, Year and Country of study	**Publication reference**	**Study objective**	**Training content**	**Number of trainees included in evaluation**	**Evaluation approach**	**PICO questions answered**	**Summary of results**	**Evidence Grade**
1. (Birch et al. 2007) **United Kingdom**	Nurse Education Today, vol. 27, no. 8, pp. 915-922	To compare the effectiveness of lecture based (LBT), Simulation based (SBT) or a combination of both types of teaching (LAS).	Management of Postpartum Haemorrhage -1 day training	6 teams of in total 36 midwives and medical doctors	Quasi experimental- cohort study; assessment **pre- and post**-training at 3 weeks, 3 months **Kirkpatrick Level 2**	2	Knowledge scores increased by 98, 74 and 75 points for SBL, LAS and LBT respectively. At 3 months post training the SBT group continued to improve by a further 25 points, LBT declined by 3 points LAS group declined by 4 points (p=0.086).	2c
2. (Crofts et al. 2007b) **United Kingdom**	BJOG An International Journal of Obstetrics and Gynecology, vol. 114, no. 12, pp. 1534-1541	To explore the effect of obstetric emergency training on knowledge and to assess if acquisition of knowledge is influenced by the training setting or teamwork training.	1- or 2- day course; basic life support, advanced life support, hypertensive disorders of Pregnancy, shoulder dystocia, breech, twins, cord prolapse, postpartum haemorrhage and electronic fetal monitoring.	140 participants	**Randomized controlled trial**; Four arms: (a) 1-day course at local hospital, (b) 1-day course at simulation centre, (c) 2-day course with teamwork training at local hospital (d) 2-day course with teamwork training at simulation centre **Kirkpatrick level 2**.	2	Mean knowledge score increased by 20.6 points (95% CI 18.1–23.1, p < 0.001). Overall, 123/133 (92.5%) participants increased their score. No effect on knowledge score on location of training or inclusion of teamwork training.	1b
3. (Crofts et al. 2008) **United Kingdom**	Quality and Safety in Health Care, vol. 17, no. 1, pp. 20-24	To explore the effect of training on patient actor perception of care during simulated obstetric emergencies.	(As above) Eclampsia and PPH management assessed only.	Midwives and doctors from 6 hospitals.	**Randomized controlled trial;** Four arms: (a) 1-day course at local hospital, (b) 1-day course at simulation centre, (c) 2-day course with teamwork training at local hospital (d) 2-day course	6	For simulated PPH management, safety and communication scores were higher when patient-actor was cared for by teams trained locally with a patient-actor compared with teams trained at the simulation centre using a computerised patient mannequin (safety p=0.048, communication p=0.035), with a	1b

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					with teamwork training at simulation centre. **Kirkpatrick level 2**		trend towards higher scores for respect (p=0.077). For eclampsia this was similar with a trend towards better communication scores for teams trained with patient-actors compared to using mannequins (p=0.071). Additional teamwork training did not influence scores significantly.	
4. **Crofts, 2006** United Kingdom	Obstetrics and Gynaecology, vol. 108, no. 6, pp. 1477-1485	To compare effectiveness of training with low- and high-fidelity mannequins for the management Of shoulder dystocia	Management of shoulder dystocia, 40-minute training	144 midwives and doctors	**Randomized controlled trial**; 2 arms of 72 each **Kirkpatrick level 3**.	1, 2	For both arms training associated with improved performance scores for use of basic manoeuvres (p<0.002) and successful delivery (p<0.001), good communication with the patient (p<0.001) after training. Training with a high-fidelity mannequin was associated with a higher successful delivery rate than training with traditional devices: 94% compared with 72% (OR 6.53, 95% CI 2.05–20.81).	1b
5. **Crofts, 2007b** United Kingdom	Obstetrics & Gynaecology, vol. 110, no. 5, pp. 1069- 1074	To assess skills retention 6 and 12 months after shoulder dystocia training.	Management of shoulder dystocia, 40-minute training	122 midwives and doctors from 6 hospitals	Participants managed a standardized simulation in shoulder dystocia **pre-, and 3 weeks, 6, 12 months, post- training.** **Kirkpatrick Level 2**	2	Before training, 49% achieved delivery. This was 82% after 3 weeks, 84% after 6 months 85% after 12 months. Of 21 providers who could not deliver 3 weeks after training, additional training resulted in 79% achieving delivery at 12 months.	2c
6. **Crofts et al (2013)** United Kingdom	International Journal of Gynecology and Obstetrics 123 (2013) 81–85	To determine knowledge retention 1 year after training for intrapartum emergencies. (Including shoulder dystocia, eclampsia, and postpartum	1-day clinical training course on obstetric emergencies at a local hospital; or a 2-day clinical and teamwork training course on obstetric emergencies at a simulation center	Participants (22 junior and 23 senior doctors-obstetricians and anaesthetists, 47 junior and 48 senior midwives)	Randomized-controlled trial The primary outcome was change in factual knowledge over time, as assessed by a 185-question	2	Mean scores at 6 (97.6 ± 23.0; n = 107) and 12 (98.2 ± 21.6; n = 98) months remained higher than those before training (79.6 ± 21.9, n = 140; both P < 0.001), but were slightly lower than those immediately after training (101.0 ± 21.3, n = 133; P < 0.001 and P = 0.007, respectively).	1b

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		hemorrhage) Methods: Training was undertaken in 6 hospitals and the Bristol Medical Simulation Centre, UK,	with or without additional teamwork training		multiple-choice questionnaire and simulated obstetric emergency (shoulder dystocia, eclampsia, and postpartum hemorrhage) Participants underwent a baseline assessment before attending their training course. The assessment was repeated at 3 weeks, 6 months, and 12 months after training **Kirkpatrick Level 2**		The type of training had no effect on retention of knowledge.	
7. **Daniels, 2010** USA	Simulation in Healthcare, vol. 5, no. 1, pp. 40-45	To determine whether simulation was more effective than traditional didactic instruction to train crisis management skills to labour and delivery teams.	3 - hours training in shoulder dystocia and eclampsia	32 doctors and midwives, in teams of 4	**Randomised controlled trial** 2 arms: didactic training (DT) or simulation based training (SBT), before and after evaluation of knowledge and performance, 1 month post training. **Kirkpatrick Level 2**	2	No statistical difference in knowledge between groups. For both shoulder dystocia and eclampsia drills, SBT scored higher than DT (p = 0.002 and p=0.32 respectively)	1b
8. **Dijkman, 2010** Netherlands	BJOG: An International Journal Of Obstetrics And Gynaecology, vol.	To determine the incidence of a peri-mortem Caesarean Section (PMCS) after introduction of the	3 -day training in managing obstetric emergencies and trauma (MOET)	55 women had cardiac arrest and 12 of them underwent PMCS	**Secondary data analysis** Retrospective cohort study, 15-year period	4, 7	Before the introduction of the MOET course, 4 PMCS were performed (0.36/year), compared to 8 PMCS after (1.6/year, P = 0.01). No PMCS was performed within the	2c

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	117, no. 3, pp. 282-287	MEOT course.			**Kirkpatrick Level 3 and 4**		recommended 5 minutes after starting resuscitation. 8 of the 12 women regained cardiac output after PMCS, with two maternal and five neonatal survivors.	
9. **Draycott, 2006** United Kingdom	Fetal and Maternal Medicine Review, vol. 17, no. 3, pp. 229-237	To determine whether the introduction of obstetrics Emergency training was associated with a reduction in perinatal asphyxia and neonatal hypoxic–ischemic encephalopathy (HIE).	1-day training; CTG Interpretation,6 obstetric emergency drill stations; shoulder dystocia, postpartum haemorrhage, eclampsia, twins, breech, adult resuscitation and neonatal resuscitation.	Not specified	**Secondary data analysis** Retrospective cohort study of babies born between 1998 and 2003, training introduced in 2000. 19, 460 infants included **Kirkpatrick Level 4**	7	Following the introduction of training, the number of babies born with 5-minute Apgar scores of < 6 decreased from 86.6 to 44.6 per 10,000 births (P < 0.001). HIE decreased from 27.3 to 13.6 per 10,000 births (P = 0.032) Stillbirth rates remained unchanged.	2c
10. **Ellis, 2008** United Kingdom	Obstetrics and Gynaecology, vol. 111, no. 3, pp. 723-731	To compare the effectiveness of training for eclampsia in local hospitals and a regional simulation centre, with and without teamwork training.	Management of eclampsia	24 teams of midwives and doctors.	**Randomised controlled trial** 4 arms - training in local hospital or in a simulation centre and teamwork training or not **Kirkpatrick Level 4**	2, 3, 5, 6	Training was associated with an increase in completion of basic tasks; 87% before and 100% after training. Basic tasks were completed more quickly (p=0.012), magnesium Sulphate loading dose was administered by 61% of teams before and 92% after training (p=0.04), median time to administration decreased (p=0.011). Training at the simulation centre was not associated with additional improvement compared to training in the hospital setting. Teamwork improved overall after training (p< 0.001) with no additional benefit of teamwork training per se.	1b
11. **Fisher, 2010** USA	American Journal of Obstetrics & Gynecology, vol. 203, no. 4, pp. 379, e1-5	To compare eclampsia and magnesium toxicity management among residents randomly assigned to	Eclampsia and magnesium toxicity management	38 residents in obstetrics and gynaecology	**Randomised controlled trial** 3 arms: Simulation- and Lecture (SL), Simulation (S),	2, 7	Post training maternal scores were significantly better in S compared with L groups (p<0.05). Post intervention magnesium toxicity and fetal scores were not different	1b

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		lecture or simulation based education			and Lecture (L) **Kirkpatrick Level 2**		between groups. Adding lectures to simulation training (SL) did not lead to incremental benefit.	
12. **Fransen et al 2012** Netherlands	BJOG 2012; 119:1387–1393.	To determine whether obstetric team training in a medical simulation Centre improves the team performance and utilizations of appropriate medical technical skills of healthcare professionals.	Staff from 24 obstetric departments was randomly assigned to a 1-day session of multiprofessional team training in a medical simulation Centre (80% crew resource training and 20% medical technical skills) or to no such training. The Team training was given with high-fidelity mannequins by an obstetrician and a communication expert.	The obstetric departments of 24 Dutch hospitals 12 hospitals with 74 obstetric teams in the intervention group	**Cluster randomized control trial** Team performance evaluated after 6 months with the validated Clinical Teamwork Scale (CTS) and the employment of two specific obstetric procedures for the two clinical scenarios in the simulation (delivery of the baby with shoulder dystocia in the maternal all-fours position and conducting a perimortem caesarean section within 5 minutes for the scenario of amniotic fluid embolism). These were carried out during unannounced sessions that were videotaped. Two independent experts evaluated the team performance and utilization of appropriate medical skills. **Kirkpatrick Level 3**	3	Teamwork performance in the training group (74 obstetric teams from 12 hospitals) was significantly better in comparison to the non-training group (median CTS score: 7.5 versus 6.0, respectively; P = 0.014). The use of the predefined obstetric procedures for the two clinical scenarios was also significantly more frequent in the training group compared with the non-training group (83 versus 46%, respectively; P = 0.009). Conclusions Team performance and medical technical skills may be significantly improved after multiprofessional obstetric team training in a medical simulation Centre.	1b
13. **Freeth, 2009** United Kingdom	Journal of Continuing Education in the Health Professions,	To describe and evaluate the multidisciplinary obstetric simulated	1- day, multidisciplinary training in simulated obstetric emergency	Thirteen MOSES courses were conducted with 93 course	**Prospective cohort study** Modified Kirkpatrick	1, 3	The team training was well received. Participants were able to check out assumptions and expectations of others and develop	

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	vol. 29, no. 2, pp. 98-104	emergency scenarios course (MOSES), which was designed to enhance non-technical skills among obstetric teams and, evaluate participants' perceptions, learning, and the transfer of learning to clinical practice.	scenarios.	participants comprised 57 midwives, 21 obstetricians, and 15 anesthetists. 55 (59%) participants contributed to this evaluation.	evaluation method. **E-mail** and **telephone interviews**. Facilitator feedback was received from 9 courses, spanning the 4 DS teams. Video recordings of sufficient quality for analysis were received from 11 courses, spanning 3 delivery suite (DS) teams. **Kirkpatrick Level 1 and 3**		respect for different roles within the delivery suite team. Skilful facilitation of debriefing after each scenario was central to learning. Participants reported acquiring new knowledge or insights, particularly concerning the role of communication and leadership in crisis situations.	3c
14. **Gardner, 2008** USA	Obstetrics and Gynecology clinics of North America, vol. 35, no. 1, pp. 97-127	To describe the development, implementation, and evaluation of an obstetric simulation-based team training course grounded in crisis resource management (CRM) principles	Obstetric emergencies, simulation based team training.	Pilot course- 36 health care providers, obstetric simulation-based team training -176 participants	**Cohort study:** trainee course evaluation immediately after pilot course and 1-year or more post training follow-up with self-assessment questionnaires. **Kirkpatrick Level 2**	1, 3	The course was highly regarded immediately and 1 year or more after completing the course. Most survey responders reported improved teamwork and communication when managing a critical obstetric event since training.	3c
15. **Guise, 2008** USA	Best Practice and Research: Clinical Obstetrics and Gynaecology, vol. 22, no. 5, pp. 937-951	To determine the added value of in-situ obstetric simulation training over training at a simulation centre	In situ obstetric simulation training: shoulder dystocia, postpartum haemorrhage, eclampsia	150 health care workers (nurses and medical doctors) from labour wards across 6 hospitals	Before and after comparison with short debrief after each scenario and didactic session **Kirkpatrick Level 1**	2, 3, 6	Participants reported that in situ simulation was more appropriate and cost effective. Conducting simulation in the location where care is delivered is convenient for staff and maximizes learning because the participants are in a familiar environment. This approach is also considered useful to explore and analyse system issues that affect quality of care delivered during emergencies.	3c
16. **Howie, 2011** Scotland	**Report** Published by the School of Health	To measure the impact on maternity services following the	Obstetric and newborn emergencies: normal pregnancy, Maternal	Phase 1: NA Phase 2: 540 participants	Retrospective study Observational mixed	1, 2, 5, 7	**Phase 1:** There was a 90% positive rating on teaching methods, teaching and learning materials,	2c

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	Nursing and Midwifery University of the West of Scotland An evaluation of the Scottish Multi-professional Maternity Development Programme (SMMDP)	introduction of the Scottish Multi--professional Maternity Development Programme (SMMDP)	and newborn resuscitation, stabilisation and transfer, uterine rupture and inversion, sepsis, shoulder dystocia, malpresentations, pre-eclampsia/eclampsia, haemorrhage and cord prolapse	Phase 3: 15	methods study based on Kirkpatrick framework for training evaluation. **Phase 1**: analysis of pre-existing SMMDP internal course evaluation. **Phase 2**: evaluation individual course participant's perception of impact on practice and benefit of the training. **Phase 3**: evaluation of the perception of impact on practice and cost benefit **Kirkpatrick Level 1 and 2**		instructor's helpfulness and knowledge, appropriateness of assessments. **Phase 2**: Participants identified if training had increased confidence levels (42%), preparedness for role (37%), knowledge (35%) or level of clinical competence (35%). Overall participants found the course to be enjoyable, beneficial and an effective mode of training. **Phase 3**: The SMMDP was perceived to be cost effective, value for money and an efficient use of time.	
17. **Harris, 1995** USA	Journal of Obstetric, Gynaecologic, and Neonatal Nursing: JOGNN / NAACOG, vol. 24, no. 9, pp. 829-835	To determine whether there was an increase in knowledge when a multidisciplinary group of health care providers participated in the same comprehensive perinatal continuing education program and to determine whether care practices followed before the program differed from those followed 1 year after its completion.	Perinatal Continuing Education Program: emergency obstetric and newborn complications including endotracheal intubation and umbilical catheter insertion	Physicians, nurses, and other providers of perinatal health care. Hospitals in Oklahoma providing perinatal care. Test data derived from health care providers in 24 hospitals; data on care practices obtained from 12 hospitals	Cohort study; pre-and post-test knowledge assessment and 1 year post training, audit of medical records of sick or at risk newborns **Kirkpatrick Level 2 and 3**	2, 4, 6	Pre- and post-training knowledge scores show increase for each group of providers studied ($p<0.001$). Statistically significant increases in use of 2 care practices and a trend toward an increase in the use of 3 others. Health care practices performed significantly more often after training include gestational assessment using the Dubowitz scale taught in PCEP ($p = 0.001$) or any other method ($p = 0.001$) and blood pressure measurement ($p = 0.003$).	2c
18. (Monod et al.	Archives of Gynecology and Obstetrics. April 2014 vol. 289 Issue	To investigate the influence of simulation	Obstetric emergency training: shoulder dystocia, postpartum haemorrhage, pre-	168 medical doctors and midwives	**Before and after study** Anonymous self-administered questionnaire	1	92.9% (156) response rate immediately after the training but only 36.3% at 3 months.	2c

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2014) **Switzerland**	4, p733-738.	training on four specific skills: self-confidence, handling of emergency situations, knowledge of algorithms and team communication after training in obstetric emergencies.	eclampsia, maternal basic life support neonatal resuscitation and operative vaginal birth using low and high fidelity mannequins.		with a 5-point Likert's scale immediately after the training and at 3 months post training. **Kirkpatrick level 1 and 3**		High scores for all 4 skills tested except for communication at 3 months post study p<0.05.	
19. (Markova et al. 2012) **Denmark**	Acta Obstet Gynecol Scan 2012; 91:346-352	To evaluate the effect of multi-professional obstetric skills training on the incidence of post-partum haemorrhage	Multidisciplinary emergency obstetric care training shoulder dystocia, postpartum haemorrhage, severe pre-eclampsia and newborn resuscitation	168 Midwives, nurses, auxiliary nurses and doctors on call	**Secondary analysis of data** Database audit Information on 10, 461 women were audited, 201 transfusion episodes occurred, of which 179 were included. **Kirkpatrick level 1, 3 and 4**		Significant increase in self-assessed confidence in the management of PPH, improved use of uterotonics and PPH protocols and self-directed infrastructural changes in delivery room such as emergency box for PPH management. There was no significant difference in the rates or requirements for blood transfusion before, during or after the training. They're also no delay in implementing interventions to minimize haemorrhage across all three periods (MVA, MRP or Caesarean section).	3b
20. **Nielsen, 2007** USA	Obstetrics and Gynecology, vol. 109, no. 6, pp. 1458	To evaluate the effect of teamwork training on the occurrence of adverse outcomes and process of care in labour and delivery	Standardized teamwork training curriculum based on crew resource management that emphasized communication and team structure and a curriculum used in hospital emergency and obstetric departments	1,307 labour and delivery room personnel	**Cluster- Randomised controlled trial** 7 intervention and 8 control hospitals. The primary outcome was the proportion of deliveries at 20 weeks or more of gestation in which one or more adverse maternal or neonatal outcomes or both	3, 4, 7	The mean adverse outcome Index (range) was 9.4 (6.5–16.6) in the control arm and 9.0 (5.9–14.7) in the intervention arm. One process measure, the time from the decision to perform an immediate Caesarean Section to the incision, differed significantly after team training (33.3 minutes versus 21.2 minutes, p=0.03).	1b

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					occurred (Adverse Outcome Index). Additional outcomes included 11 clinical process measures. **Kirkpatrick Level 3 and 4**			
21. **Robertson et al, 2009** USA	Simulation in Healthcare, vol. 4, no. 2, pp. 77-83	To evaluate a simulation-based team-training program called Obstetric Crisis Team Training Program (OBCTT) (based on the original training program of Crisis Team Training) framed within a multilevel team theoretical model.	Training consisted of participation in four standardized, simulated crisis scenarios with a female birthing simulator mannequin: foetal bradycardia, anaphylactic shock, shoulder Dystocia and PPH.	22 perinatal health care professionals (attending medical doctors, nurses, residents, and nurse-midwives)	Quasi-experimental, before and after comparison **Kirkpatrick Level 1 and 3**	2, 3, 4	Significant improvement in 3 outcome variables ($p<0.004$); attitude toward competence in handling obstetric emergencies ($t = 1.6$), individual ($t = 4.2$) and team performance ($t = 4.1$). The remaining 6 variables; attitude toward simulation technology, attitude toward rapid response team, confidence in handling obstetric emergencies, utility of team skills in the workplace, comfort in assuming various team roles, and knowledge, were not statistically significantly different. Overall task completion from the first to the last simulation substantially improved ($p < 0.05$).	2c
22. **Reynolds et al 2011** Portugal	European Journal of Obstetrics & Gynecology and Reproductive Biology 159 (2011) 72–76	To evaluate the self-perceived impact of attending a simulation-based training course on the management of real-life obstetrical emergencies.	Simulation-based training course for the management of four obstetric emergencies.	Obstetric nurses and obstetricians (n = 54) from a tertiary care university hospital	A prospective follow-up study One year after the last session of the course, participants were asked to complete a questionnaire evaluating the self-perceived impact it had on their knowledge, technical skills, and teamwork skills during experienced real-life	4	There was a response rate of 85% (46) and 87% perceived an improvement in their knowledge and skills during real emergencies. Obstetric nurses expressed a significantly higher improvement than obstetricians in their ability to diagnose or be aware of obstetrical emergencies ($p = 0.002$), in their technical skills ($p = 0.024$), and in their ability to deal with teamwork related issues ($p = 0.005$).	2c

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					situations. A five-point Likert grading scale was used. **Kirkpatrick level 3**		Participants who had experienced in real-life situations all four simulated scenarios rated the impact of training significantly higher than others (p = 0.049), and also reported a better improvement in their knowledge of management guidelines (p = 0.006).	
23. **Siassakos et al, 2009** United Kingdom	Journal of Obstetrics and Gynaecology, vol. 29, no. 6, pp. 499-503	To assess the validity of mixed techniques for the analysis of team communication and whether clinical and non-clinical team training improve communication.	All teams received emergency obstetric clinical training (TW-) but only two out of four teams received additional aviation-based crew resource management (CRM) teamwork training (TW+): roles and responsibilities, clear directed communication, situational awareness.	24: 4 teams of 6 medical doctors and midwives.	**Randomised controlled trial** 2 teams in the intervention and control group each. **Kirkpatrick Level 3**	3	Proportion of directed commands higher after training for teams that received additional teamwork training (TW+): 22/31 (71%) compared with 9/35 (26%) before training. The teams that did not receive specific teamwork training (TW-) used less directed commands after training: 13/20 (65%) compared with 31/32 (97%) before training.	1b
24. **Siassakos, 2010** United Kingdom	BJOG: An International Journal of Obstetrics and Gynaecology, vol. 117, no. 10, pp. 1262-9	To determine the active ingredients of effective teams, regardless of their training status	All teams received emergency obstetric clinical care training	114 maternity care professionals randomly allocated to one of four teams from each unit, to make a total of 24 simulation teams	**Secondary analysis** of data from a RCT of training for obstetric emergencies (Simulation and Fire-drill Evaluation [SaFE]) **Kirkpatrick Level 3**	3	There was a strong, highly significant correlation between clinical efficiency score (magnesium administration) and the Generic Teamwork Scores for all three dimensions; team skills score (taub = 0.54, p < 0.001), team Behaviour score (taub = 0.41, p = 0.001), and the overall teamwork score (taub = 0.51, p < 0.001). There was a significant negative correlation between the time taken to perform all of the three key clinical actions and teamwork skills scores (recovery position: taub	1b

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
							=−0.29, p = 0.012; oxygen administration: taub =−0.39, p < 0.001; blood sampling: taub =−0.35, p = 0.002). There were similar correlations with the overall teamwork score (recovery position: taub =−0.25, p = 0.026; O2 administration: taub =−0.41, p < 0.001; blood sampling: taub =−0.35, p = 0.002). For the teamwork behaviour scores the correlation was statistically significant for oxygen administration (taub =−0.28, p = 0.014) and blood sampling (taub =−0.35, p = 0.002) but not for recovery position.	
25. **Siassakos, 2011** United Kingdom	BJOG: An International Journal of Obstetrics and Gynaecology, vol. 118, no. 5, pp. 596-607	To determine whether team performance in a simulated emergency is related to generic teamwork skills and behaviour.	Eclampsia, shoulder dystocia and PPH management was assessed only	Six secondary and tertiary Maternity Units in Southwest England. Participants – 140 healthcare professionals, in 24 teams	**Secondary analysis** - of data from a RCT of training for obstetric emergencies (Simulation and Fire-drill Evaluation [SaFE]). **Kirkpatrick Level 3**	3	The clinical conduct of a simulated emergency was strongly linked to generic measures of teamwork. There was significant positive correlation between clinical efficiency and teamwork scores across all three dimensions; skills (taub = 0.54, p < 0.001), behaviour (taub = 0.41, p = 0.001), and overall score (taub = 0.51, p < 0.001). Better teams administered the essential drug 2.5 minutes more quickly (p < 0.001).	1b
26. **(Xu et al. 2014)** **China**	Resuscitation 85 (2014) 253-259	To evaluate the effectiveness of a neonatal resuscitation intervention package at county level hospitals Components of	Neonatal resuscitation training	Eleven intervention and 11 control site hospitals were involved with 97 and 87 obstetricians, pediatricians and	Cluster randomized control trial 4 intervention and 4 control counties Data on knowledge, self-confidence and incidence of	1, 2, 4, 7	**K L1: Self-reported confidence: Intervention=**57.3%+/-2.5%, control=54.1%+/-8.2. p=<0.001) **K L2: Knowledge assessments:** 92%+/-12%, control=84%+/-1.5. p=<0.001)	1b

Authors, Year and Country of study	Publication reference	Study objective	Training content	Number of trainees included in evaluation	Study design/Evaluation approach	PICO/PEO questions answered	Summary of results	Evidence Grade
		intervention -Training workshops -Training of national and provincial instructors -Establishment of hospital resuscitation teams		midwives respectively.	deaths from birth asphyxia was collected for 2 years post intervention **Kirkpatrick level 1, 2, 3 and 4**		**K L3: Implementation of neonatal resuscitation related protocols:** Intervention=90%, control=55% **K L4**:Incidence of birth asphyxia decreased from 8.8% to 6.0% (p<0.001) in the intervention counties Asphyxia related deaths in the delivery room decreased from 27.6 to 5.0 per 100, 000 (p=0.076) The asphyxia rates did not decrease over time in the control counties.	

Chapter 3: Methodology

This chapter presents the key research questions answered in this mixed methods research, and describes and discusses the evaluation frame work used, the setting where the research was conducted, the methods used, the analysis and the limitations of the approach.

3.1 Introduction

This study was conducted in Kenya between 2009 and 2011 as an operational research under the Making it Happen programme. Its objective was to determine the effectiveness of an EmONC training package for maternity care providers. Also to identify any challenges with its implementation, determine its acceptability by health care providers, and explore the effect of relevant policy on the impact of the intervention, the impact on the quality and availability of EmOC and on health outcomes.

There are several determinants of maternal and newborn health, and complex interventions are required to minimize the risk of morbidity and mortality (Thaddeus, Maine 1994, Nyamtema, Urassa & van Roosmalen 2011). Skilled attendance at birth and emergency obstetric care are two such interventions on the 'supply side'; other interventions that will contribute to improving the health of women and newborns include demand creation and effective referral systems. In order for such interventions to be effective, implementation must be embedded within the health system.

There is some evidence that EmOC and skilled birth attendance reduces maternal morbidity and mortality; there is also evidence that maternity care providers may not have the knowledge or skills to provide EmOC. Usually, managing obstetric and newborn emergencies requires teamwork at health care facility level. A capacity building intervention at maternity care provider level (individual level) can be expected to impact positively on the availability and quality of EmOC at the health care facility level. A critical mass of maternity care workers can therefore be expected to have this impact provided that there is sufficient

demand for services and that they practise in an enabling environment (drugs supplies, policy, referral systems etc.)

Due to the high burden of maternal mortality, the available evidence of effectiveness of EmOC and skilled birth attendance, and the focus on improving maternal health in order to meet MDG targets, research designs that are likely to restrict implementation of these interventions to any parts of the health system are considered inappropriate by governments in countries affected. This makes randomized controlled trials, which are considered the most robust research design investigating cause-effect relationship between an intervention and outcome difficult to use in such settings (Mdege et al. 2011).

The interventions evaluated in this study are at health care provider level (capacity building to improve knowledge and skills) and at health care facility level (training sufficient numbers to make an impact on maternal/newborn health, and provision of essential EmONC equipment). The expected outcomes are measured at both levels.

This Chapter presents the research questions, study setting, study design, evaluation framework, a description of indicators used, data collection methods and tools, a description of the analysis plan, ethical considerations for the study and limitation of the methods used in this study.

3.2 Research questions (RQ)

In order to meet the overall research objective the following research questions were developed:

1. What is the reaction of trained maternity care providers to the EmONC training programme? This was to evaluate their acceptability of the training programme. (**Kirkpatrick Level 1)**
2. Does the EmONC training intervention improve the knowledge and skills of maternity care workers trained? (**Kirkpatrick level 2)**
3. Does the EmONC training intervention result in 'up-skilling' of non-physician clinician of maternity care providers? This was to evaluate the uptake and performance of critical EmOC signal functions or skills by non- medical doctors after the training. **(Kirkpatrick Level 3)**

4. Does the EmONC training intervention improve availability of skilled birth attendance and emergency obstetric care? This was to evaluate any change in availability of skilled attendance at birth and practice after implementation of the intervention. (**Kirkpatrick Level 3 and 4)**
5. Does the EmONC training intervention improve maternal and newborn health outcomes? This is to evaluate the effect of the intervention on DOCFR, SBR, FSBR and the proportion of babies admitted to newborn care unit for birth asphyxia. (**Kirkpatrick level 4)**
6. What are the challenges and enablers to performing emergency obstetric care after implementation of EmONC training intervention? This was to identify barriers and facilitators of change in practice following implementation of the intervention. **(Kirkpatrick Level 3)**

3.3. Intervention

The intervention package had the following components

3.3.1. Lifesaving skills emergency obstetric and newborn care training

The Life Saving Skills-Emergency Obstetric and Newborn Care training (LSS-EONC)[8] training package is a competency based training developed specifically for low resource settings. It was developed in 2006 through a collaboration of the Liverpool School of Tropical Medicine (LSTM) with the World Health Organisation (WHO) and Royal College of Obstetricians and Gynaecologists (RCOG). It was piloted in Somaliland and Swaziland in 2007, and is now delivered in several countries in Africa and South Asia (Grady et al. 2009, Ameh et al. 2012a, Ameh et al. 2011, Raven et al. 2011, Van Lonkhuijzen et al. 2008, Van Den Broek 2007).

The training was first piloted in Kenya in 2008 under the Essential Health Services (EHS) Programme, covering 6 districts in Nyanza province. Provincial obstetricians, senior midwives, World Health Organisation technical officers and Kenya Ministry of Health (MoH) programme officers/managers participated in the initial training after which slight adaptations were made for Kenya. These adaptations included restricting the content of the assisted vaginal delivery (AVD) module to vacuum extraction only (teaching on obstetric forceps was to be excluded) and the WHO modified partograph (no latent phase, partograph

[8] The EmONC training is used subsequently instead of LSS-EOC&NC training

is opened from 4 cm cervical dilation) was to be taught rather than the WHO composite partograph (latent phase and partograph opened from 3 cm cervical dilation).

The course is designed to cover the essential knowledge and skills required by skilled birth attendants to prevent or manage the major causes of maternal death in LMIC- haemorrhage, sepsis, eclampsia, complications of obstructed labour and abortion (Khan et al. 2006) and the signal functions of Emergency Obstetric Care (WHO et al. 2009, Van Den Broek 2007).

Training content

The course is delivered over 3 days and a list of topics covered in the training is presented in **Box 3**. The training package includes a section on surgical skills and on normal delivery (Skilled Birth Attendance). A cross cutting theme throughout the training is **effective communication and teamwork.**

A **multidisciplinary** training approach is used, where midwives, medical doctors and clinical officers are trained together by multidisciplinary teams of experienced specialist obstetricians, midwives and anaesthetists (UK based volunteers and in-country volunteers). The training is delivered as close as possible to the health care providers' place of service delivery.

1. **Resuscitation** of mother and newborn
2. **Early newborn care** (prematurity, sepsis, hypoglycaemia and hypothermia)
3. **Communication, triage and referral**
4. Management of **shock and the unconscious patient**
5. Management of **severe pre-eclampsia and eclampsia**
6. Prevention and treatment of **obstetric haemorrhage**
7. Prevention of **obstructed labour**
8. Diagnosis and treatment of pregnancy related Sepsis
9. Assisted vaginal delivery-**vacuum delivery**
10. Other common **obstetric emergencies** (breech delivery, cord prolapse, twin delivery and retained placenta)

Box 3: LSTM EmONC training content

Training delivery approach

The training is based on the key principles of adult learning and uses interactive learning sessions comprising of short lectures (15%), simulation and hands-on sessions using low fidelity obstetric, newborn and resuscitation manikins including interactive workshops (70%), mentoring (5%) and in-course monitoring and evaluation (10%). To ensure effective learning there is a low trainer to trainee ratio (1:4). This allows for adequate hands-on training within the allocated time (**Annex 1: Training programme)**.

3.3.2. Supportive supervisors/master trainers

National master trainers (certified Kenya master trainers) are usually obstetricians, senior midwives, clinical officers or medical officers, and selected by the international faculty during an EmONC training based on their knowledge and potential to teach/mentor others on the job. These master trainers go through a 1-day training (similar to that for UK based trainers-see **section 3.82**) then they are also mentored during another EmOC training course. The UK based faculty used set criteria to evaluate their performance during the mentoring phase of the train the trainer course; this will lead to certification to become a trainer.

The master trainers also received 1-day additional training in supportive supervision. The interactive workshop covers the principles of supportive supervision, introduces tools for supportive supervision, developing and implementing action plans from the process of supportive supervision. Each site had 4-6 certified master trainers/supervisors who were expected to provide on the job support to other colleagues, facilitating behaviour change after the training. Each supportive supervisor was allocated a number of trainees to supervisor and mentor. Supportive supervisors provided logbooks for trainees to document EmONC procedures performed every month **(Annex 2: Supportive supervision tools).** A supervisor and trainee were expected to review the logbook during a formal supervision meeting every month. Supervisors make a collective action plan on what EmONC topics to discuss during a continuous medical education (CME) meeting every month after meeting all of their allocated trainees.

Each site was also provided with some training equipment to be used during CME sessions organised by the master trainers.

The research team during 3-monthly visits to the study sites encouraged master trainers/supervisors to organize CME sessions. The master trainers based their decision of EmONC topics for these sessions, on discussions held with trainees, other maternity care providers, observed practice, review of delivery registers and records. The topics selected had to be covered within 1-2 hour sessions using the same training materials used for the initial EmONC training. The research team observed at least 1 CME session during the time of the first follow-up visit (3 months post training) at all study sites.

3.3.3. Provision of essential emergency obstetric care equipment

All hospitals were provided with essential equipment to support practice of new skills and knowledge acquired during the training **(Box 4).** The equipment lacking in each unit was identified during the baseline survey and the MiH programme and the various hospital management filled the gaps. The equipment was handed over to hospitals in a particular cluster at the end of EmONC training.

1. Adult resuscitation bag and mask
2. Patella hammer x 4
3. Kiwi reusable omnicup x 4
4. Paediatric ambu bag & mask x 2
5. Adult ambu bag & mask x 1
6. Aneriod Sphygmometer x 6
7. Standard dual-head stethoscope x 6
8. Pinard stethoscope x 4
9. Hand held electronic fetal heart monitor x 1

Box 4: List of equipment supplied to all health care facilities immediately after training

3.4. Research setting

The selection of health care facilities (study sites) for inclusion was opportunistic. A stakeholders group (representatives from academia, government and hospital management for the entire country) reviewed the proposal to implement and evaluate the EmONC intervention in 2009. They determined that for optimal impact, all level 5 (l5) hospitals (administered by the central Ministry of Health) responsible for management of obstetric and newborn emergencies should be included, excluding those already receiving EmONC

training intervention (Based on current information from experts on the committee or based on baseline survey findings).

There were a total of 13 level 5 hospitals across 8 provinces in 2009, one in each province except Eastern, Nyanza and Nairobi **(Table 10).**

On the committee's recommendation Thika level 5 General Hospital was excluded; this was to ensure a good geographical spread of the major obstetric referral hospitals in the country **(**

Figure 6**)** and this was to keep the number of units included in the study at 10, consistent with the research design (maternity care providers from two hospitals were to be trained together). Also the available funding could only support training and evaluation in 10 sites.

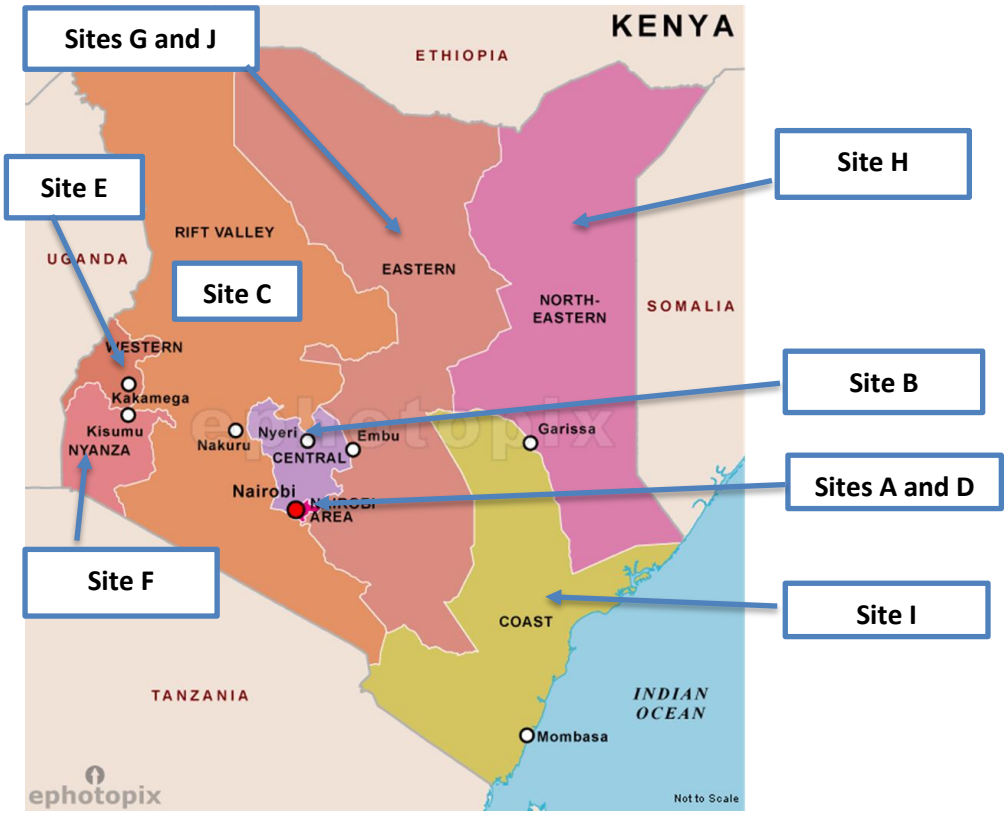
Table 10: List of all level five health care facilities in Kenya[9]

S/No.	Province	Name of hospital	Included or Excluded	Remarks
1.	Central	Provincial General Hospital Nyeri	**Included**	
2.	Central	Thika Level 5 District General Hospital	**Excluded**	Stakeholders determined that PGH Nyeri served a larger population compared to Thika PGH.
3.	Coast	Provincial General Hospital Mombasa	**Included**	
4.	Eastern	Provincial General Hospital Embu	**Included**	
5.	Eastern	Machakos Level 5 Hospital	**Included**	
6.	Nairobi	Mbagathi Level 5 Hospital Nairobi	**Included**	
7.	Nairobi	Pumwani Maternity hospital Nairobi	**Included**	
8.	North eastern	Provincial General Hospital Garissa	**Included**	
9.	Nyanza	Provincial General Hospital Nyanza	Excluded	LSTM EmONC training package was implemented here from 2006-2009
10.	Nyanza	Kisii Level 5 General	**Included**	

[9] Kenya health care facilities Master list E health Kenya 2010. Available at http://www.ehealth.or.ke/facilities/

S/No.	Province	Name of hospital	Included or Excluded	Remarks
		hospital		
11.	Rift Valley	Provincial General Hospital Nakuru	**Included**	
12.	Western	Provincial General Hospital Kakamega	**Included**	
13.	Western	Moi University Teaching hospital	**Excluded**	The ALARM international training course was being implemented and evaluated at the time of baseline survey visit

Figure 6: Location of study sites



3.4.1. Inclusion Criteria

1. All level 5 public health care facilities where EmONC care training intervention has not been implemented within 2 years of the start of this study.
2. All maternity care providers at these hospitals

3. Intervention site approved and recommended by central advisory stakeholders group

3.4.2. Exclusion criteria

1. Any level 5 public health care facility receiving EmONC training intervention at the time of the baseline survey visit
2. Health care workers who do not routinely provide maternity or newborn care
3. Intervention site not approved or recommended by central advisory stakeholder group

The intervention could not be delivered to all the included health care facilities at the same time, so they were paired to receive the intervention forming 5 clusters based on geographical proximity **(Table 11),** such that training was implemented systematically across participating health care facilities. Maternity care workers from both hospitals in a cluster were trained within the same period.

Table 11: List of study sites and clusters

Site	Name of hospital included	Cluster number
A.	Pumwani Maternity Hospital Nairobi	1
B.	Nyeri Province General Hospital	
C.	Nakuru Province General Hospital	2
D.	Mbagathi Province General Hospital	
E.	Kakamega Province General Hospital	3
F.	Kisii Level 5 General Hospital	
G.	Embu Province General Hospital	4
H.	Garissa Province General Hospital	
I.	Mombasa Province General Hospital	5
J.	Machackos Level 5 General Hospital	

3.4.3. Target population for training in each study site

The maternity units at each of the study sites were made up of the labour ward, newborn care unit, antenatal ward, post natal ward and maternity operation theatre.

Medical officers are posted to maternity units for a minimum of 2 years, while medical interns come for 3-month rotations and junior midwives are rotated annually (usually in July). None of the hospitals included medical interns in the training, they were keen to prioritise 'more permanent' staff for training. Each hospital has at least 2 obstetricians and the senior midwifery staff in the labour ward are usually not posted out to other wards more frequently than once every 5 years but some can be posted to strengthen maternity units in new hospitals (this happened at Kakamega PGH and Mbagathi GH). These senior midwifery and medical staff formed the bulk of master trainers/supervisors in this study.

During the baseline survey, agreements were reached with hospital management (Medical superintendent and chief nursing officer) to retain trained staff in the maternity units for as long as possible and also to consider redeploying only small numbers of staff at a time. It was agreed also that the training was likely to be effective if there was at least one trained staff (especially midwife) per shift. The number of staff trained in each hospital who were retained in the maternity ward was tracked and when 5 or less staff had been replaced, the new staff were retained with the next cluster.

Selection of maternity care providers to attend each 3-day training workshop from each of the 2 units per cluster was organized in such a way that there was minimal disruption to clinical services during the workshop. All maternity care providers from labour, antenatal, postnatal and newborn care units/wards were targeted for training and it was assumed that if up to 20% of targeted staff were not retained in the maternity wards after training, there will still be enough trained health care workers on each shift to make a positive impact on health outcomes. All participants received a formal invitation to attend the training including information about the research **(Annex 3: Participant information sheet**).

3.5. Study design

It is known that implementation and evaluation of programmes within functional health systems is problematic and difficult; this may be a key reason why many health intervention programmes are not effectively evaluated. Experimental research designs that randomize at individual level may not have generalizable results at population level, while before/after intervention evaluation, usually involving weaker non-randomized designs tends, to overestimate the effect of the intervention (Torgerson, Togerson 2008).

A **cross-sectional stepped wedge (SWD) design** variant of a cluster randomized control trial design was used in this research (Brown, Lilford 2006, Mdege et al. 2011). This research design is suitable because there is evidence that EmONC training may be effective (the intervention is considered to do more good than harm and so it is considered **unethical** to with-hold the intervention from one group-such as the control group, as in a parallel study design). A SWD is suitable for evaluating interventions during routine implementation. Due to **logistical and financial** resource restrictions it was not possible to introduce the intervention to all units at once. However each unit can act as its own control and it is possible to study the effect of time on the intervention (Brown, Lilford 2006, Mdege et al. 2011).

The external validity of the SWD is improved by matching eligible population groups into clusters according to demographic characteristics and by randomly allocating clusters in to the order at which they will receive the intervention. These measures reduce possible systematic variability between population groups in each cluster. A minimum of 3 data collection points and the use of frequent and repeated measures at intervals reasonable for the intervention to have had an effect can enhance internal validity (Atienza, King 2002).

Clusters of health care facilities defined by geographical proximity were randomly allocated to receive the intervention at 3-monthly intervals. Randomization was by computer-generated random numbers and all clusters eventually received the intervention (Haahr 1998-2014). Health care facility data was collected 3 months before the intervention, then 3, 6, 9 and 12 months after the intervention from all clusters whether they had received the intervention or not (control group)-**(Table 12).** The clusters crossed over regularly from control to intervention group (one-way cross over).

Table 12: Stepped wedge design

Time periods		-3M	+3M	+6M	+9M	+12M	+15M
Cluster	1: A+B	O	X	X	X	X	X
	2: C+D	O	O	X	X	X	X
	3: E+F	O	O	O	X	X	X
	4: G+H	O	O	O	O	X	X
	5: I+J	O	O	O	O	O	X

Direction of cross over

Key: - Baseline (before intervention), + after intervention, O control group, X intervention group,

The Stepped Wedge Design for this research has a sample size of 10 health care facilities and 5 clusters; each cluster has 2 health care facilities and there are 5 steps. Switching is at 3 monthly intervals in one direction only; this is the time that a new cluster receives the intervention (only one cluster switches at a time). It is also expected that the intervention will have immediate effects/impact on the quality of care delivered by trained maternity care providers at each site (Hussey, Hughes 2007).

3.5.1. Sample size calculation

The initial sample size estimation for a SWD data collection and analysis, was calculated based on outcome indicator stillbirth rate, mean baseline value of 5% and estimated minimum of 30% reduction (SBR 3.5%) at a 0.05% significance level. Also the mean number of deliveries at the end of the study in each unit was estimated at 6500 and intra cluster correlation (ICC) 0.05, between cluster variations 0.0017.At calculated power of the study of 0.8000 (80%) (Hemming, Marsh 2013), the study will require a sample of 10 health care facilities with two facilities per unit.

Table 13: Stepped wedge study design power calculation

Parameter	
Proportion 1	0.050
Proportion 2	0.035
Significance level	0.05
Intra cluster correlation (ICC)	0.05
Between cluster variation (tau squared)	0.0017
Average cluster (cell) size	1500
Design effect/precision (matrix)	2.18490e+05
Total number of observations	6500
Power	0.8000

Due to the variability of hospitals within each cluster and the extent of missing data for some data collection points (data for more than 2 steps missing for some hospitals prior to

receiving the intervention) of the SWD, analysis for this study was based on before/after comparisons using t-tests for each study site/hospital.

The intervention was implemented as per the SWD but data was collected at each site 3 months before the intervention and for 3 monthly intervals up to 12 months. The sample size calculation was based on paired (before and after) t-tests, using the outcome measure SBR, baseline value of 5% and expected minimum reduction of 30% (based on pilot study [10]). A minimum sample size of 9-hospitals/study sites will give 92% power for the study (Faul et al. 2007).

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
	Effect size dz	=	0.9559164
	α err prob	=	0.1
	Power (1-β err prob)	=	0.9
Output:	Non centrality parameter δ	=	2.8677492
	Critical t	=	1.3968153
	Df	=	8
	Total sample size	=	9
	Actual power	=	0.9236601

Box 5: Sample size calculation using G power 3.1

3.6. Evaluation framework

A four level framework for evaluating the training package was adapted from the techniques for evaluating training programmes described by Donald Kirkpatrick (Kirkpatrick 1996a). He reported that there are 3 main reasons for evaluating training programmes; these are to determine whether to continue offering the training programme, to improve future programmes, and to validate the organizers' existence and job as training professionals.

The four levels of Kirkpatrick's framework and the relevance to this study are described as follows:

3.6.1. Level 1: Reaction

[10] Unpublished study from previous evaluation of LSTM EmONC training in Nyanza PGH from 2006-2009

This is a composite reaction of the health care provider being trained to the entire training (content, mode of delivery, venue and schedule). It is a measure of the acceptability of the training that measures trainees' feelings but not learning. This is essentially a type of customer satisfaction survey that is important in making improvements to training programmes and to check that participants are motivated and interested in learning. It does not guarantee that learning has taken place or that behaviour will change after the training. However is more likely that learning will take place if the participants react positively to the training. It is also subject to courtesy convention, so any factor that facilitates enthusiasm from the participant will result in a favourable score (for example an eloquent speaker, a luxurious training venue or very tasty refreshments). Selection of the wrong type of trainees may result in dissatisfaction and a poor reaction.

Kirkpatrick recommended the use of a simple quantifiable scale through self-administered questionnaires but with provision for written comments. Trainees may not recall accurately how they felt about a particular session, the longer the internal between completing the relevant question and the time the session was delivered. Recall bias can be minimized through frequent reminders and requests to complete the questionnaire by the faculty during the training. Also, ensuring that the feedback is anonymous is likely to improve its objectivity (Kirkpatrick 1996a, Penny, Murray 2000).

3.6.2. Level 2: Learning

At this level, knowledge, skills, and improvement in attitude after training are assessed. Guidelines for objective evaluation of learning that has taken place at this level include;

a. Use of a before-after approach,
b. Use of objective measurement scale/system,
c. Use of a control group where possible,
d. Statistical analysis of results,
e. High response rate,
f. Use of results to take appropriate action (Kirkpatrick 1996a).

Depending on the type of training programme, attitude may be difficult to measure at this level. For the EmONC training, the objective is to improve knowledge and skills, so the level of knowledge and skills are assessed objectively before and immediately after the training.

A statistically significant improvement at 95% confidence interval (a p value of less than 0.05) was considered indicative of an effective training. Setting up evaluation at this level is complicated and requires high quality assurance.

While a control group is ideal, this was not possible in this study because of limited funding and lack of permission from the Ministry of Health.

An immediate improvement in knowledge or/and skills is no guarantee that behaviour will change or that this improvement will be translated into improved clinical practice and better maternal and newborn health outcomes, but may be indicative of a step in the right direction.

3.6.3. Level 3: Behaviour

It is crucial to evaluate the change in behaviour as it is assumed that change in practice as a result of training is likely to result in improved health outcomes. Change in behaviour however has several determinants, not just training or improved knowledge and skills. Kirkpatrick noted the following key requirements for a change in work behaviour to occur;

a. The desire by the trainee to improve,
b. Trainees must recognize their own weaknesses,
c. Trainees must work in a permissive climate (for example 'the enabling environment'),
d. Trainees must have help from someone who is interested and skilled and
e. Trainees must have an opportunity to try out new ideas (Kirkpatrick 1996a).

The EmONC training package used in this study had some of these key elements; adult learning principles where used to ensure that ideas where 'unfrozen' and reflection on evidence based knowledge and skills in the context where trainees practiced was encouraged through the various teaching methods and mentoring sessions (Daines, Daines & Graham 2006).

Training of medical doctors and midwives together helped ensure that midwives had an enabling and supportive climate to practice new skills (Midwives may depend on medical doctors to initiate some interventions). Nurses/Midwives may be restricted by policy

(national or hospital level) to perform some EmOC procedures and medical doctors usually have an influence on hospital level restrictive policies.

Finally some trainees (determined by faculty to be more knowledgeable and motivated) were selected in each hospital to receive additional training to enhance their trainer and supervision skills. There were expected to provide 'on the job' support in the work place, thereby facilitating behaviour change after training.

The ideal assessment of behaviour change would have been by **direct observation**; this is because it provides data on behaviour as well as accounts of behaviour change (Green, Thorogood 2004). This is seen as the gold standard for evaluating behaviour change due the direct access to new/improved 'behaviour' by the researcher. There are 2 types of observational methods, participant and non-participant observation methods but these methods are time consuming, expensive and may present significant ethical challenges in a health care setting (Richie, Lewis 2003, Green, Thorogood 2004). The observing researcher may have to intervene during observation if a trainee is providing inappropriate or substandard care and consent will have to be obtained from both trainee and women being cared for.

Alternative qualitative methods include key informant interviews and/or FGDs. These may only provide a partial account of behaviour change, however triangulation with quantitative data, accounts of behaviour change from key informants (managers and supervisors), and interviews and FGDs with trainees provide a reasonable account of behaviour change.

Kirkpatrick recommended the following guidelines for evaluating behaviour change;

a. Use of a control group where feasible,
b. Allow enough time for behaviour change to take place,
c. The survey or assessment should include trainees, their bosses or supervisors,
d. Choose 100 trainees or an appropriate sampling,
e. Repeat the evaluation at appropriate times and consider the cost of evaluation versus the potential benefits. (Kirkpatrick 1996a)

In this study qualitative research methods (key informant interview, paired interviews and focus group discussions) were used at 3, 6 and 12 months to evaluate behaviour change. The intervals were considered long enough to allow for behaviour change, the initial 2 intervals

were only 3 months each, while the last interval was 6 months. Evaluation of behaviour change was done for up to 12 months post training to assess if any behaviour change reported was sustained for this period of time.

3.6.4. Level 4: Results

Kirkpatrick reported that evaluation becomes increasingly expensive and difficult as we move from level 1 to level 4. Level 4 is the final measure of effectiveness of training and is considered as the most measure by many stakeholders (Kirkpatrick 1996a). Recommended guidelines for level 4 evaluations are;

a. Use of control group where feasible,
b. Allow enough time for results to be achieved,
c. Measure before and after the training if feasible,
d. Repeat measurements at appropriate times,
e. Consider the cost of evaluation versus the potential benefits and
f. Being satisfied with evidence if absolute proof isn't possible to attain.

Indicators that reflect a change in the availability, performance and quality of EmOC as defined by the United Nations (UN) were used. EmOC signal functions used to identify available and performed signal functions are presented in **Table 14** below.

Table 14: Emergency Obstetric Care signal functions

S/No.	BEmOC health care level	CEmOC health care level
1.	Administer parenteral antibiotics	Perform signal functions 1-7, plus
2.	Administer uterotonic drugs (1st line drug: Oxytocin, Second line drug: Ergometrine and 3rd line drug Misoprostol)	**8.** Perform surgery (e.g. caesarean section)
3.	Administer parenteral anticonvulsants for pre-eclampsia and eclampsia (for example magnesium sulphate)	**9.** Perform blood transfusion
4.	Manually remove placenta	
5.	Remove retained products (e.g. manual vacuum extraction, dilation and curettage)	

S/No.	BEmOC health care level	CEmOC health care level
6.	Perform assisted vaginal delivery (e.g. vacuum extraction, forceps delivery)	
7.	Perform basic neonatal resuscitation (e.g. with bag and mask)	

The performances of some of these signal functions are dependent on other variables not directly provided through the intervention. For example with regards to administration of antibiotics or magnesium sulphate; the training covers indications for and drug treatment including monitoring of treatment. Also monitoring tools including patella hammers and monitoring charts are provided but there is no provision of parenteral antibiotics or magnesium sulphate per se.

The number of women coming for treatment also affects the performance of the signal function. All health care facilities involved were province referral hospitals, so it was expected that there would be sufficient caseload.

Routinely collected health care facility data was used for level 4 data, this is consistent with operational research approach used in this study.

At the time of baseline data collection it was noted that, there was very poor routine documentation of performance of EmOC signal function number 7 (perform basic neonatal resuscitation-with bag and mask). A proxy indicator proportion of newborns admitted to the newborn care unit was derived. Newborn resuscitation with bag and mask, and monitoring of pregnancy and delivery are taught in the training course, it is expected that if the intervention is effective (training in newborn resuscitation equipment-bag and mask), the proportion of newborns admitted with a diagnosis of birth asphyxia will decrease.

These indicators monitor the impact of the intervention at health care facility level but the training occurred at individual maternity care provider level. A positive impact therefore will depend on training a critical mass of maternity care workers and the retention of these workers within those maternity units. Nurses and midwives may not provide some of the EmOC signal functions because they are not trained or supported (via legislation/scope of practice or by medical doctors) to do so. Examples include performing caesarean section, manual vacuum aspiration, assisted vaginal delivery and manual removal of placenta. So

indicators to monitor change in practice or 'up-skilling' were derived; Proportion of vaginal breech deliveries out of all deliveries, Proportion of vaginal deliveries by vacuum extractions and of vacuum extractions performed by non-physician clinicians.

Table 15 presents research questions, research questions, and timing of data collection, indicators measured, Kirkpatrick level of evaluation and a brief description of the data collection/extraction tool.

All level 4 indicators were collected at 3 monthly intervals, from before the training to 12 months post training. The data used were routine MNH data collected in maternity units, so could be collected retrospectively for the 3 months preceding the data collection visit. This approach ensured that the cost was kept low but is potentially affected by the quality of data available.

The 3-month reference period is recommended by the World Health Organisation (WHO), it provide a snapshot of the functioning of a facility at the time of assessment; there is a reduced risk of recall bias. Monitoring of emergency drug stocks (parenteral antibiotics, anticonvulsants and oxytocics) and EmOC skills required to perform assisted vaginal delivery, manual vacuum aspiration, caesarean section and manual removal of placenta can be closely monitored at 3 monthly intervals because these skills are easily lost if not practiced (WHO et al. 2009).

Generally data at baseline was considered to be of the lowest quality therefore trained trainers/supervisors were encouraged to improve the quality of record keeping during the train the trainers/supervisors training workshop.

Table 15: Research questions, methods, outcome measures and evaluation framework

RQ No.	Research question	Research method	Timing of data collection	Outcome measures/indicators	Kirkpatrick level and description of tool
RQ 1	What is the reaction of maternity care providers trained in EmONC to the training programme?	**Quantitative** Likert scale: Maternity care workers evaluated the usefulness of each teaching/learning session during the EmOC training	During the training	Acceptability of the training package based on score for each session and overall reaction to the training (venue, usefulness of knowledge/skills after training, ease of participation). The results were also disaggregated into cadre groups.	**Kirkpatrick level 1: Reaction** Anonymous self-administered semi quantitative questionnaire with provision for free comments. The questionnaire had four; sections, Section 3 and 4 have a Likert scale from 1-10. **(**Annex 5: Participants' Feedback/Course Evaluation form**)** **Section 1:** Collects information on the training date, location and cadre of trainee **Section 2:** Requires assessment of every training session in chronological order in which they occur. **Section 3**: Overall feedback on the training course (venue, easy of following sessions, usefulness of training back on normal job) **Section 4:** Free comments
RQ 2		**Quantitative**	Before the	Statistically significant	**Kirkpatrick level 2: Learning**

RQ No.	Research question	Research method	Timing of data collection	Outcome measures/indicators	Kirkpatrick level and description of tool
	Does the EmONC training intervention improve the knowledge and skills of maternity care workers trained?	40 multiple choice questions to assess knowledge on 8 EmONC modules taught Skills testing	training and immediately after the training	improvement in knowledge and skills after the training Mean difference in knowledge and skill score at statistical significance 95% confidence interval ($p<0.05$)	All questions were randomly generated from question bank. The testing was timed and trainees (or knowledge test scripts) were excluded in they presented after testing for the whole group had started or were found to be discussing or disruptive during testing. All trainees to participate in knowledge test while 75% of them were randomly selected to participate in the skills test. Only health care workers who consented to participating in the testing took the knowledge and skills test. Skills tests were conducted separately for each participating trainee. Skills test were administered by trainers and coordinated by the research assistants and Course Director.
RQ 3	Does the EmONC training intervention result in 'up-	**Qualitative and quantitative**	3, 6, 9, 12 months	1. Proportion of all deliveries by breech vaginal delivery	**Kirkpatrick level 3: Behaviour**

RQ No.	Research question	Research method	Timing of data collection	Outcome measures/indicators	Kirkpatrick level and description of tool
	skilling' of non-physician clinician of maternity care providers?			2. Proportion of all deliveries by assisted vaginal delivery (vacuum extraction) 3. Proportion of all AVDs by non-physician clinicians	Data is collected at 3 monthly intervals from various sources within a health care facility using a data extraction tool and key informant/FGD qualitative question guides. (Annex 6: Level 4 baseline survey/follow-up data extraction tool) and Annex 7: Topic guide for key informants, paired/triad interviews and focus group discussions
RQ 4	Does the EmONC training intervention improve availability of skilled birth attendance and emergency obstetric care?	**Quantitative and qualitative**	3, 6, 9 and 12	4. Number of deliveries 5. Institutional caesarean section rate (CSR) 6. Number of obstetric complications recorded and managed. 7. Proportion of expected EmOC signal functions available 8. Proportion of newborn unit admissions for birth asphyxia	**Kirkpatrick level 3 and 4** All EmOC signal functions were used **(Table 14)** however a proxy indicator for newborn resuscitation with bag and mask- proportion of babies admitted with birth asphyxia was used. Data is collected at 3 monthly intervals by two data collectors, from various sources within a health care facility using a data extraction tool and key informant/FGD qualitative question guides. (Annex 6: Level 4 baseline survey/follow-up data extraction

RQ No.	Research question	Research method	Timing of data collection	Outcome measures/indicators	Kirkpatrick level and description of tool
					tool) and Annex 7: Topic guide for key informants, paired/triad interviews and focus group discussions
RQ 5	Does the EmONC training intervention improve maternal and newborn health outcomes?	**Quantitative**	3, 6, 9 and 12 months	9. Direct obstetric case fatality rate (proxy indicator for quality of care) 10. Stillbirth rate (SBR) 11. Fresh stillbirth rate (FSBR)	**Kirkpatrick level 4: Results**
RQ 6	What are the challenges and enablers to performing emergency obstetric care after implementation of EmONC training intervention?	**Qualitative** Focus group discussion, paired/triad interviews, key informant interviews To explore further the	3, 6 and 12 months after training	Challenges and enablers to practicing evidence based EmOC identified.	**Kirkpatrick level 3: Behaviour** Naturally occurring groups (Midwives/nurses, medical doctors or clinical officers) were involved. Maternity ward managers, hospital administrators/managers and senior obstetricians

RQ No.	Research question	Research method	Timing of data collection	Outcome measures/indicators	Kirkpatrick level and description of tool
		reaction to the training methodology, challenges and enablers to practicing evidenced based EmOC after EmONC training			participated were key informants. All sessions were conducted in English language using a topic guide (Annex 7: Topic guide for key informants, paired/triad interviews and focus group discussions)

3.7. Selection and description of outcome measures and data collection procedures

Data collection was carried out from August 2010 to November 2011. The researcher and a research assistant visited each cluster at 3-monthly intervals to collect data.

During baseline data collection, 3 months prior to implementation of training for Cluster 1, all 10 hospitals were visited to sensitize the administration on the intervention and the need for appropriate selection of maternity care providers for training and the importance of retention of health care providers within maternity services after training.

During follow-up visits the researcher provided support to trained master trainers in EmOC, these involved a review of EmOC CME activities carried out since the training up to the time of visit, discussions around challenges with mentorship and supervision. The researcher and research assistant observed the CME sessions conducted during the first follow-up visit, provided support were necessary and debriefed the team afterwards.

3.7.1. Quantitative data

Quantitative research methods were used to collect Kirkpatrick Level 1, 2 and 4 data.

Level 1 data

The assumption is that a positive reaction to the training will facilitate learning and eventually change in behaviour and practice. Anonymous self-administered semi quantitative questionnaire with provision for free comments. The questionnaire had four; sections, Section 3 and 4 have a Likert scale from 1-10. **(Annex 5: Participants' Feedback/Course Evaluation form).** The form had four sections;

a. **Section 1:** Collects information on the training date, location and cadre of trainee
b. **Section 2:** Requires assessment of every training session in chronological order in which they occur.
c. **Section 3**: Overall feedback on the training course (venue, easy of following sessions, usefulness of training back on normal job)
d. **Section 4:** Free comments

Participants were encouraged to complete the relevant question in section 2 of the form as soon as that activity was completed, this was to minimise recall bias. They were also reminded constantly that the evaluation was anonymous.

Level 2 data

Knowledge assessments

Trainees who registered for the course after the pre-test had started were excluded from that-test it but were allowed to participate in the post-test. All participants who missed at least 1 module usually due to late arrival to the course were excluded from both tests, but extra sessions were arranged to cover what they had missed or they were invited to the next training course to complete the sessions they missed.

Participants were administered tests with 5 multiple-choice questions for each of the 8 modules covered during the course (40 questions). The assessments were self-administered before and after the course. The maximum possible score per module assessed was 5 marks and the total score obtainable by each participant was 40 marks.

Skills assessments

Clinical skills were also assessed before and after the course. After registration and administration of the knowledge tests, 24 (75% of the trainees on a course) randomly selected course participants who consented to participate in the assessments were tested. In other not to keep the total duration of the training to three days, only 75% of the trainees were invited to participate in the skills tests. Three trainees were assessed for each module and each participant completed two skills tests. All trainees who participated in the skills tests were debriefed after the post training assessment.

The assessments were conducted in separate breakout rooms by facilitators using pre-determined guidelines and checklists. Each assessment had a maximum score of 10 marks. One participant was assessed at a time and each assessment was completed within 10 minutes.

Level 4 data

A data collection tool designed to collect information relevant to the research is presented in **Annex 6: Level 4 baseline survey/follow-up data extraction** tool. Data was collected on 11 indicators mentioned in **Table 15** and **Table 16** (3 'up-skilling indicators, 5 indicators to evaluate any change in availability of skilled birth attendance and EmOC and 3 health outcome indicators). Indicators that were easy to collect from hospital data sources and reflect the objective of the training package were selected.

The definitions of each indicator, assumptions made and sources of data are described below. Data from various sources were combined to reduce the amount of missing data.

During each health care facility visit after training, information regarding additional support to that facility to improve the availability of EmOC was also requested (for example additional EmONC training or equipment received). Indicators calculated collected from each of the health care facility (study sites) and the specific data sources are described in (**Table 16**).

1) **Proportion of all vaginal deliveries that are breech vaginal deliveries**

   One of the topics covered under the obstetric emergencies module of the EmONC training is vaginal breech delivery. The proportion of all vaginal deliveries that were breech deliveries conducted at the health care facility was used as an indicator of change in practice and 'up-skilling'

   Assumption: If the training has been successful in improving knowledge, skills and changing practice, this indicator will be expected to go up from the pre-training value

2) **Proportion of all deliveries by assisted vaginal delivery (vacuum extraction)**

   There are critical obstetric skills that make a difference during an obstetric emergency, some of these are generally not performed due on or a combination of the following factors; lack of knowledge/skills, equipment or lack of appropriate cases or lack of policies supporting performance by some cadre of maternity care providers at national or health care facility level and lack of support for non-physician clinicians from medical doctors. Availability and performance of assisted vaginal delivery (AVD), Manual Removal of Placenta (MRP) and Manual Vacuum Aspiration (MVA) are expected at both BEmOC and CEmOC health care facilities.

   The literature suggests that AVD is one of the least performed EmOC signal functions performed by both medical and non-physician clinicians.
   The proportion of all deliveries by vacuum extraction is expected to increase after the intervention.
   Assumption: Maternity care providers have the 'enabling environment' (Vacuum delivery equipment, supportive policies and colleagues) to practice

Table 16: Type of indicator, numerator and denominator for specific indicators and data source

Type of indicator	Indicator	Numerator	Denominator	Data source
Up-skilling' indicators	Proportion of all deliveries by breech vaginal delivery	Number of breech vaginal deliveries recorded	Number of all vaginal deliveries recorded	Maternity ward/labour room, antenatal ward, operation theatre registers and nursing/midwifery handover reports
	Proportion of all deliveries by assisted vaginal delivery (vacuum extraction)	Number of all vaginal deliveries by vacuum extraction	Number of all vaginal deliveries recorded	Maternity ward/labour room register, nursing/midwifery handover reports and hospital health information records.
	Proportion of all AVDs by non-physician clinicians	Number of all vaginal deliveries by vacuum extraction conducted by non-physician clinicians	Number of all vaginal deliveries recorded	
Availability of skilled birth attendance and EmOC indicators	Number of deliveries	Total number of deliveries (vaginal and caesarean section)		Maternity ward, antenatal/postnatal/gynaecology ward register, operation theatre register, hospital health information records.
	Institutional caesarean section rate (CSR)	Total number of deliveries by caesarean section	Total number of deliveries (vaginal and caesarean section)	
	Number of obstetric complications recorded and managed	Number of obstetric complications recorded and managed		
	Proportion of expected EmOC signal functions available	Number of EmOC signal functions available	Total number of EmOC signal functions that the HCF is expected to provide.	Maternity, postnatal, antenatal, operation theatre registers and nursing/midwifery hand-over reports.
	Proportion of newborn unit admissions for birth asphyxia	Total admissions into newborn unit with a diagnosis of birth asphyxia	Total admissions in to newborn care unit	Newborn unit (NBU) register, labour/maternity ward register and nursing/midwifery handover reports

Type of indicator	Indicator	Numerator	Denominator	Data source
Health outcome indicators	Direct obstetric case fatality rate	Number of direct obstetric maternal deaths	Number of obstetric complications recorded and managed	Maternity ward, antenatal/postnatal/gynaecology ward register, operation theatre register, maternal/perinatal death review committee minutes/register, hospital health information records.
	Stillbirth rate (SBR)	Number of stillbirths recorded	Total number of babies born	
	Fresh stillbirth rate (FSBR)	Number of fresh stillbirths recorded	Total number of babies born	

3) Proportion of all assisted vaginal deliveries by non-physician clinicians

This signal function is expected to be available at both comprehensive and basic EmOC facilities. Both trained medical and non-physician clinicians (nurse, midwives, clinical officers) should perform assisted vaginal delivery

Assumption: Non-physician clinicians have the 'enabling environment' (vacuum delivery equipment, supportive policies and support from medical doctors) to perform AVD

4) Number of deliveries

The total number of women who deliver (vaginal and C/S deliveries) at EmOC health care facilities in the 3 months prior to data collection. This gives an indication of the number of women receiving skilled attendance at birth.

Assumption: Improved quality of care in the included facilities will result in more women utilising their services for deliveries.

5) Institutional caesarean section rate (CSR)

The proportion of all deliveries in the health care facility that were by caesarean section.

Assumption: The training results in increased number of critical lifesaving caesarean sections. More women received skilled care at birth, more obstetric complications managed and therefore more caesarean sections with appropriate indications will be expected post intervention. However if there were many caesarean sections for the wrong indications prior to training, the expected change in proportion of deliveries by caesarean section may not change. Also if the proportion of deliveries by vacuum extraction increases, this may affect the caesarean section rate.

6) Number of obstetric complications recorded and managed.

All obstetric complications managed in the included health care facilities.

Assumptions: With the training maternity care providers will have improved capacity to recognise and manage obstetric and newborn complications.

7) Proportion of expected EmOC signal functions available

Quantitative data to indicate performance of each EmOC signal function during the preceding 3-month period was used to calculate the proportion of expected EmOC performed in that health care facility.

Assumption: Trainees have improved knowledge and skills to successfully manage major obstetric complications. The WHO have linked obstetric complications to signal functions presented in **Table 14.**

8) Proportion of newborn unit admissions for birth asphyxia

All babies admitted from the labour ward of that hospital (excluding any born elsewhere and those referred in) with a diagnosis of birth asphyxia.

Assumptions: If the training was effective, pregnancies will be monitored better, interventions resulting from evidence based decisions will be implemented, harmful or non-evidence based practices will reduce significantly, there will be fewer cases of intrapartum

asphyxia, fewer babies will require resuscitation, resuscitation will be carried out with improved techniques in labour ward for those babies who require it and fewer babies will require admission into NBU due to birth asphyxia after the training.

9) Direct obstetric case fatality rate

DOCFR is the proportion of women admitted to an EmOC facility with any of the 7 major direct obstetric complications **(Table 17)** or who develop one of these after admission and who die prior to discharge out of all women recognised to need and recorded to have received EmOC (WHO et al. 2009). Only data for direct obstetric deaths[11] are included, therefore the numerator is the number of women dying of direct obstetric complications during a specific period (recent 3 months) at an EmOC health care facility, while the denominator is the number of women who were treated for all direct obstetric complications at the same facility during the same period.

Assumptions: CEmOC facilities involved manage most obstetric complications; women with complications attend these health care facilities for care; there are (sufficient) trained skilled health workers at the facility who recognise women with complications and manage them.

Table 17: EmOC signal functions and related complications (WHO et al. 2009)

S/No.	Major obstetric complication	Signal function
1.	Haemorrhage (antepartum and post-partum)	***Antepartum:***
		Perform blood transfusion
		Perform surgery (e.g. caesarean section for placenta praevia)
		Post-partum:
		Administer uterotonic drugs
		Perform blood transfusion
		Perform manual removal of placenta
		Perform removal of retained products
		Perform surgery (hysterectomy) for uterine rupture
2.	Complications of obstructed labour	Perform assisted vaginal delivery
		Perform Surgery* (caesarean section)
		Administer uterotonic drugs

[11] Direct maternal deaths are those resulting from obstetric complications of the pregnant state (pregnancy, delivery and post-partum), interventions, omissions, incorrect treatment, or a chain of events resulting from any of the above. Deaths due to, for example, obstetric haemorrhage or hypertensive disorders in pregnancy, or those due to complications of anaesthesia or caesarean section are classified as direct maternal deaths (World Health Organisation 2012a)

S/No.	Major obstetric complication	Signal function
		Perform neonatal resuscitation
3.	Postpartum sepsis	Administer parenteral antibiotics
		Remove retained products
		Perform surgery* for pelvic abscess
4.	Complications of abortion	***For haemorrhage:***
		Perform blood transfusion
		Perform removal of retained products
		For sepsis:
		Administer parenteral antibiotics
		Perform removal of retained products
		For intra-abdominal injury:
		Administer parenteral antibiotics
		Perform blood transfusion
		Perform surgery*
5.	Pre-eclampsia or eclampsia	Administer parenteral anticonvulsants
		Perform neonatal resuscitation
		Perform Surgery* (Caesarean section)
6.	Ectopic pregnancy	Perform surgery*
		Perform blood transfusion
7.	Ruptured uterus	Perform surgery*
		Perform blood transfusion
		Administer parenteral antibiotics
8.	Newborn distress (intrapartum)	Perform neonatal resuscitation
		Perform Surgery* (caesarean section)

*The CEmOC signal function, perform surgery includes surgery for any complication associated with direct causes of maternal deaths such as laparotomies for ectopic pregnancy, pelvic abscess, perforated uterus, ruptured uterus and caesarean section (WHO et al. 2009)

10) Stillbirth rate (SBR) and fresh stillbirth rate

Stillbirths[12] are recorded as fresh[13] or macerated stillbirths. Depending on the quality of the data, the stillbirth and fresh stillbirth rate can be calculated. Most of stillbirths are a result of intrapartum or immediate postpartum birth asphyxia and related to obstetric complications

[12] Stillbirth is defined as a baby born with no signs of life at or after 28 weeks' gestation. (WHO 2006)

[13] A "fresh stillbirth" is a baby born dead without signs of skin disintegration or maceration and the death is assumed to have occurred < 12 hours prior to delivery (Lawn, Shibuya & Stein 2005)

listed in **(Table 17)** (Lawn et al. 2011). Congenital abnormalities and prematurity also accounts for fewer cases of asphyxia that are not likely to improve with good quality intrapartum and immediate postpartum care especially in low resource settings. The ideal indicator should exclude babies with congenital abnormalities and those that are premature but capture intrapartum stillbirths. The fresh stillbirth rate will capture intrapartum stillbirths but is likely to include premature babies and babies with congenital abnormalities.

Assumption: CEmOC facilities will record sufficient data on stillbirth, fresh or macerated, and gestational age of pregnancy. Fresh stillbirth rate can be calculated as it best reflects the quality of intrapartum care. This type of good quality EmOC is expected after the training intervention, resulting in significantly reduced FSB rates after the training.

3.7.2. Qualitative data collection

Qualitative research methods were used to collect Kirkpatrick **level 3 data**. A qualitative research approach was considered to be the most appropriate method for answering the RQ 6 but also contributed to quantitative data collected for RQs 3 and 4. Qualitative approach allowed for detailed exploration of trained maternity care worker experiences in the settings in which they occur and in order to understand and derive meanings from them (Richie, Lewis 2003).

Qualitative sampling

A purposeful or criterion based sampling strategy was used, focusing on the richness and diversity of information that was explored in detail with each participant/group of participants. This was guided by existing knowledge, the study aims and the principle of maximum variation (Richie, Lewis 2003). Common themes were identified during the data collection process, and were used to refine the selection of additional participants for the study to the point of 'data saturation'. This is when the addition of more participants will not add any new information (Patton 2002). Due to the long duration of data collection, it was likely that the point of data saturation would be achieved.

Participants were **purposively** selected based on attendance on the EmONC training, managerial role within the health care facilities and the Ministry of Health. It was important to select participants based on the time they received the training, the hospital from where they were trained and their cadre (medical doctor, nurse/midwife or clinical officer, clinical or administrative manager).

Snowballing technique was used to identify additional participants; participants were encouraged to identify colleagues who could have relevant experiences to share. These colleagues may be on 'off

duty' or a duty shift outside the period of data collection. This sampling method ensured that the views of all categories of maternity care workers trained and all identified key stakeholders in the provision of EmOC were explored (Richie, Lewis 2003, Patton 2002).

There were 1 -2 key informant interviews, 2 -3 FGD and 1 -2 paired/triad interviews at 3, 6 and 12 months post training at each study site for the various groups of interest. Data collection continued until saturation was reached and no new information was emerging.

A topic guide was developed and used to guide open ended questions and discussions during in-depth key informant interviews, focus group discussions and paired interviews **(Annex 7: Topic guide for key informants, paired/triad interviews and focus group discussions)**. All qualitative data collection was digitally recorded.

The initial interviews and first focus group discussion were used to test the topic guide as part of a pilot study but the information collected was still analysed and included in the final analysis. The topic guide was then refined to facilitate in-depth exploration of the issues (Richie, Lewis 2003). Specific additional issues explored were; comparison of the training methods used in the short EmONC training programme implemented in the study with the longer MoH EmONC training, the approximate additional time for the training to improve the training experience of participants and ways of improving staff retention in the maternity/labour ward after training.

Qualitative data collection methods

a. In-depth interview

In-depth interviews/key informant interviews were carried out at each intervention site with key informants including the obstetrician in-charge, midwife/nurse in-charge and hospital administrator/manager, or at the Ministry of Health with programme officer or MNH programme manager, these key informants were rich sources of data on the influence of policy on practice of EmOC after training. These interviews were to provide 'undiluted focus' on key informants, exploring their perspective of the enablers and challenges to providing EmOC after the training (Richie, Lewis 2003). This method also provided an opportunity for clarification and detailed understanding of issues arising from other qualitative methods used in this research.

b. Paired/triad interviews

Paired or triad interviews were conducted if there were insufficient numbers (fewer than 4) of a homogenous group (medical doctors or midwives or clinical officers) to conduct a focus group discussion. The method has the advantage of allowing for individual focus, depth and, discussion and drawing comparison with what the other members of the interview were contributing. This method was considered the ideal approach for senior maternity care providers; this group is usually few in number and have the potential to intimidate more junior care providers during larger focus group discussions. Paired or triad interviews with these cadre also provided an opportunity to explore complex issues emerging from the FGDs further. The procedures for conducting paired/triad interviews were similar to those for FGD and in-depth interviews. All or part of the guide questions was used to facilitate 45 -60 minutes long interviews **(Annex 7: Topic guide for key informants, paired/triad interviews and focus group discussions).**

c. Focus group discussions

Groups of 6-10 trainees of the same cadre for example medical doctors or nurses/midwives were brought together to explore their experiences of providing maternity and newborn care after the training in addition to exploring their perspectives of the enablers and challenges to providing EmOC after the training (Richie, Lewis 2003, Green, Thorogood 2004). Smaller groups were favoured during data collection as this was likely to ensure that the participants were highly engaged since the discussion cantered on their practice (Richie, Lewis 2003).

The group discussions were an opportunity for observation of the interaction between participants, for ideas generated during the discussions to be moderated by the participants through reflection and, refinement potentially deepening their insights into their own circumstances, attitudes or behaviour (Richie, Lewis 2003). The FGDs also provided direct and explicit discussion on differences of experience that emerged in the group. Midwives/nurses constituted the largest numbers in each training site and more FGD sessions with midwives than medical doctors or clinical officers were conducted per training site. The group discussions provided an opportunity to explore the impact of the training on the working relationship between medical doctors and nurses/midwives. This was important to explore as it was expected that the mixed training methodology used would improve communication and teamwork.

Each FGD was 1 -1.5 hours long; the exact time, location, reimbursement of travel costs and availability of refreshments for a particular group discussion, were specified in an invitation letter

(including a copy of the study information sheet) passed on to the trainee through the head of the maternity ward. Thus the number of participants and duration of each qualitative interview (KII, paired or triad interview or FGD) was determined in advance. When groups were less than four, paired or triad interviews were conducted rather than FGDs.

Hospital conference facilities or maternity ward seminar rooms were used; they were organized in such a way that all participants could sit around a table and the recording device could be well positioned to record the discussion. These venues were away from distractions. The audio recording equipment was tested and the serial number, date and location of the discussion were recorded at the start of each session. The recording was also checked immediately after the discussion to rule out any equipment malfunction.

The research team welcomed all participants; a research assistant and the researcher took notes (to compliment the audio recording and as a backup, in-case of equipment malfunction) and research assistant co-moderated the sessions with the researcher. The research team introduced themselves, followed by the participants. Thereafter the topic guide was used to facilitate the discussion, reframing emergent issues to encourage deeper discussion and exploration (Richie, Lewis 2003).

3.8. Quality assurance

3.8.1. EmONC training materials

There are pre-designed materials for delivery of the training package, which include a simple manual: Life Saving Skills - Essential Obstetric and Newborn Care (Van Den Broek 2007) and a Facilitators Manual (Grady et al. 2009). Every training programme was delivered under the leadership of a Course Director and 8 certified trainers who make up the teaching faculty. An administrative assistant who helps with time management and other administrative needs of the faculty and participants.

All teaching materials were designed with an awareness of the barriers to accessing care that women in resource poor countries have, as well as with the realization that many health care providers trying to provide Skilled Attendance at Birth and EmOC for women with complications, work in difficult circumstances with limited resources. All case scenarios are based on actual every-day scenarios that would be encountered in EmOC facilities in sub-Saharan Africa.

One Course Director and 8 trainers are required to facilitate each training course, the ratio of experienced trainers to newly certified trainers is maintained at 1:1 while the maximum number of maternity care providers trained during a course is 32, with a facilitator to trainee ratio of 1:4. Each

of the health care facilities included had 4-6 certified master trainers, who were also expected to support behaviour change within each hospital, introduce and sustain continuous medical education (CME) in EmOC. A full set or part of a full set of obstetric, newborn or resuscitation mannequins were donated to each of the hospitals, to support this process.

3.8.2. Training of trainers and quality assurance of trainers

Trainers usually have experience teaching in low resource settings or work in teams with other facilitators who have such experience. They are trained through a two-stage process resulting in certification to train others.

UK based trainers are required to be obstetricians, midwives or anaesthetists, who have to attend a 1.5 day orientation workshop covering the training content, teaching and facilitation techniques, administrative/logistic support and training evaluation. Thereafter they are mentored during an EmONC training delivered to international students in the UK. The UK based trainers work as part of a team to train maternity care workers in low and middle-income countries (LMIC).

The UK based trainers select and train master trainers who work with international trainers to train health care workers in the next cluster (Selection and training of master trainers discussed in **section 3.3.2**.)

3.8.3. Development and validation of knowledge and skills questions

At the time of development of the training package, over a two-year period a question bank with knowledge (10 multiple choice questions per module) and skills (10 skills based questions) per module questions was developed and piloted.

Experienced trainers (Those who had facilitated four or more training courses) were invited to submit questions using standard guidelines; these were standardized and refined by senior obstetricians and midwives with extensive experience (minimum of 5 years) working in resource poor countries. The process of refinement was to ensure that the questions reflected the full content of the training package and that expected answers to each questions were unambiguous. The questions were then piloted, after which questions were refined accordingly to ensure that they were clear, could be answered within the allocated test time and were at the right level of difficulty. All skills/knowledge questions were listed serially per module, random numbers generated for each module and the question for the number generated was included in a particular test paper.

3.8.4. Research team

Two research assistants were recruited for the study; one was a trained midwife and the other a Clinical officer. Both had a Master's degree in Public health. They were expected to participate in data collection at baseline, during the EmONC trainings and 3-monthly intervals post training up to 12 months post training.

They were trained on the protocol for data collection during the EmONC trainings (Kirkpatrick level 1 and 2 data collection), use of research data extraction form during facility visits at baseline, 3, 6 and 12 months (Kirkpatrick level 3 and 4 data collection) post training and how to time, facilitate and record qualitative data collection sessions.

All members of the EmONC training faculty were updated on the use of the skills check lists a day prior to the training. This was complementary to mandatory training of trainers training mentioned in **3.8.2** above.

3.8.5. Ethical considerations

At every stage of data collection participants were provided with detailed information on the objectives of the study, the role of the research team, information regarding the data collection methods, use and storage of data. Participants we reassured that their participation was voluntary and that withdrawal at any stage or non- participation would not have any consequences.

a. Consent and communication

All participants were aged 16 years and above. Communication in Kenya is usually in the English language, therefore all assessment materials, data collection tools, consent forms, and information leaflets and teaching materials were in English language.

Participants attending training were provided with a copy of the participant information sheet **(Annex 3: Information sheet)** consent form **(Annex 4: Consent form)** at the time of registration for the training and this was summarized verbally to the whole group (with opportunity for questions) prior to data collection (Richie, Lewis 2003). Verbal consent was obtained prior to all qualitative data collection, this included consent for audio recording of the sessions.

Participants were informed of their right to withdraw from the study at any point. Consent and permission for the evaluation of the training was also obtained from the Ministry of Health and administrative heads of each hospital. This included permission for the use of their premises for the

training and data collection. The MoH officials and Heads of all study sites were reassured that data collection will not disrupt the provision of care by participants and that findings would be disseminated to all stakeholders at the end of the study. The following measures were put in place to minimise disruption of clinical services during training and data collection:

a. The **EmONC training** was planned in collaboration with the chief nursing officer and head or maternity: This was to ensure that maternity care providers could be trained in batches with minimal or no disruption to clinical services.
b. **Qualitative data collection** was done during lunch break or at the end of each shift. Otherwise participants had to assure the researcher that arrangements had been made to cover their duties while they participated in paired/triad interviews, in-depth interviews or focus group discussions. No financial incentive was provided for participation in the study.

Transportation cost was reimbursed if participants attended the sessions outside of their regular working hours. Light refreshments were provided for those attending the sessions.
It was agreed that the hospital premises were the best location to ensure optimal participation by trainees and also the best approach to ensure minimal disruption to clinical services.

Any non-evidenced practice disclosed during qualitative data collection, while describing EmONC practice after training was noted. At the end of the session, the correct procedure was discussed with the group or individual. This was done because if left uncorrected, this could lead to continued non-evidence based care.

Similarly participants were debriefed after the post training skills assessment, during which a member of the training team conducting the assessment provided constructive feedback and repeated/demonstrated the correct skill for that scenario. Participants were also given the opportunity to ask questions or seek clarifications.

b. Data storage

The researcher ensured that all information obtained during the study process was kept confidential and could not be linked to any specific individual. The research team only, knew the identity of anyone who participated in qualitative interviews. All quantitative and qualitative data collected during the training were anonymous and could not be traced back to the trainee/participant who had provided the information

All qualitative data collected was anonymised from the point of collection, names of participating hospital units were coded and stored separately in 'pass word protected' lap top computer. All paper copies of data collection forms were stored in locked cupboards in a secured office.

All qualitative interviews were digitally recorded and the audio files were downloaded onto a password protected flash drive and copied onto a password-protected computer handled by the primary researcher only. All digital qualitative audio recordings were then erased from the recording device after importing into QSR International's NVivo 9 qualitative data analysis software for storage and processing on a personal computer.

3.8.6. Qualitative data

To improve on the rigour of the data collection and the **credibility** of the data collection process, a clear account of all procedures used was kept to facilitate an audit trail. Member validation including analysis of deviant cases and disconfirming data was carried out to maximize validity. Analysis of data from each site was carried out immediately after data collection from that site, until the entire data set was analysed. This was to maximise **reliability** and it also allowed for **comparability**. Data from study sites were compared, as well as data between and within the various cadre of health care providers and managers who participated. The majority of trainees were midwives; medical doctors or non-clinician physicians were the minority. It could therefore be expected that more midwives would participate in the qualitative data collection, this may affect the **transferability** of the findings (Green, Thorogood 2004).

Reflexivity is important for objectivity, neutrality and validly of a qualitative study; it is the recognition that the researcher is part of the process of producing, interpreting data and consciously reflecting on that process (Green, Thorogood 2004, Green, Thorogood 2004, Richie, Lewis 2003).

The researcher was part of the team that designed the EmONC training package, piloted tools for this study and developed the monitoring and evaluation framework. It is possible that the researcher's presence at interviews may have influenced the reported experiences of the participants. Whilst this is more likely to happen during key informant interviews, the likelihood decreases with increased number of participants in the group for example paired, triad and FGDs. In the absence of covert observation of practice, KII and FGDs were used to triangulate information. In-depth interviews/paired/triad interviews were used to explore and validate information emerging from FGDs and level 4 quantitative data, and FGDs were very useful in confirming level 4 data. Triangulation was a means of investigating 'convergence' of both the data and the inferences/conclusions derived from them (Richie, Lewis 2003).

Quality was maintained when analysing and presenting data through the use of quotations to report the data in its original form and thereby ensuring that both positive and negative views were presented (Richie, Lewis 2003, Patton 2002).

3.9. Data analysis

3.9.1. Quantitative data Analysis

All quantitative data were collected with tools specifically designed for this research. Data was extracted into IBM SPSS databases (version 21) specifically created for this research and for each level assessed.

The null hypothesis specific for level 2 evaluations for this research was that the EmONC training intervention is ineffective in improving maternity care providers EmONC a) knowledge, b) skills, while the alternate hypothesis is that the training intervention is effective.

The null hypothesis specific for level 4 evaluations was that EmONC training intervention is ineffective in improving maternal and newborn health outcomes and 'up-skilling outcomes'. In other words there will be no difference in pre and post training observations of the relevant data. The alternative hypothesis was that EmONC training intervention was effective.

The probability of observing a true significant effect due to the intervention was set at less than 0.5% (for the alternate hypothesis to be accepted).

Level 1-Reaction: Descriptive analysis of trainees' reaction to training. Results will be presented as simple proportions. The reaction to training was also disaggregated by professional cadre. Characteristics of outliers were noted for example with respect to trainee cadre and ward of practice. The training was intended specifically for maternity care providers, participants attending from other wards may react negatively to the training.

Level 2-Learning: Differences in mean knowledge and skills scores before and after the training were compared.

Independent T-test were used for level 2 (knowledge tests) while paired T-test were used for level 2 (skills tests). The knowledge tests were anonymous and every participant was expected to participate with an option to opt out, therefore analysis by the whole group (group pre-training mean was compared to the group post-training mean) and sub-analysis of the mean difference by cadre was also carried out, noting average pre and post-training scores by cadre.

While only 50% of the participants in each training course, who were randomly selected participated in the skills tests. The same assessor examined the participants on the skills tests before and after the training, so the scores could easily be paired. For skills test analysis it was possible to do paired t-test analysis and cadre disaggregated this as well.

The significant value for the Levene's test was used to determine the value of the t-test used, this is important to ensure that basic assumption of homogeneity of variance is met. When the Levene's test was larger than 0.05, equal variances were assumed and when the value was equal to or less than 0.05, equal variances were not assumed (Pallant 2013). Eta squared was used to report on the size of the effect, when there was a statistically significant difference. The Eta squared statistic, provides an indication of the effect size, giving an indication of the magnitude of the differences between groups. Reference values: 0.01= small effect, 0.06=moderate effect and 0.14=large effect (Pallant 2013)

Level 4-Results: A paired t-test was performed to ascertain whether the EmONC training intervention was effective (Level 4: before and after outcome and 'up-skilling measures) (Pallant 2013)

Paired t-test was used because the number of hospitals involved was small (less than 100), the outcome variables were continuous and a comparison of the effect of the intervention, before and after its implementation was required.

It was also assumed that the difference in pre and post observations were, independent, equal variance, normally distribution and that they represent a random sample from the population. At analysis stage normality and equality of variance were assessed using box plots and histograms, and the Levene's test for equality of variances respectively (Pallant 2013).

Comparison of baseline and 12 months post-intervention continuous variables described in (**Table 15)** was carried out. The trend in all outcome measures was also analysed (3 months pre training and 3, 6, 9 and 12 months post training) for each hospital.

3.9.2. Qualitative data analysis

Nvivo 9 was used to analyse the qualitative data. Nvivo software was found to be a suitable platform to organize, keep track of all data files (audio files and filed notes from interviews and FGDs), information on data sources, memos and ideas emerging including conceptual maps. It also allowed for **visualization** of data, showing the content, structure of ideas, concepts, cases and timelines. It

was used to keep a record of the interpretative process, creation of models showing relationships between various data and attributes (**mapping and interpretation**) (Bazeley, Jakson 2013, Richie, Lewis 2003).

Analysis of qualitative data was by **framework analysis**, aimed at preserving the integrity of individual respondents' accounts throughout analysis. Once the audio recordings were imported into NVivo, all field notes entered and transcription completed, the researcher **familiarized** himself with the data leading to the development of codes based on the emerging themes (thematic analysis), comparing within and between data sources. Finally the codes were applied to the data (Green, Thorogood 2004, Richie, Lewis 2003).

Annotations such as reflections, comments or reminders about the text were also created during data processing and familiarization (Bazeley, Jakson 2013). Memos were used to guard against 'definitional drift' which occurs when codes are categorized differently at different stages of the research process. Memos are thoughts, ideas and discussions that guide analysis and one can always refer to the process behind which codes were created, make constant comparisons and ensure that there is consistency (Richie, Lewis 2003).

Nodes were created to store all information relating to a particular concept or category or code. This was very important for organizing the data, attributes such as evaluation site, cadre of participant (health facility manager, obstetrician or midwife in-charge, trainee midwife or medical doctor) were made.

Queries were used to store questions to be explored from the data such as patterns of coding, recurrence of key words and/or patterns of coding. Results from queries were stored alongside the queries (Bazeley, Jakson 2013).

3.10. Strengths and limitations of study

3.10.1. Strengths

The study design was operational and allowed for ethical and cost effective approach with appropriate stakeholder involvement. The intervention was considered to have a potential for positive impact on maternal health and could not be implemented at the same time to all health care facilities involved.

Seasonal variations in obstetric complications can affect the outcome measures, but since each health care facility acted as its own control and proportions rather than absolute values were used (except for number of women receiving SBA) this effect will be minimal.

It was also likely that the impact of the intervention on health outcomes will be stronger soon after the intervention has been implemented that this will reduce with time. This is because there is a possibility that staff trained in each unit will not be retained within the maternity unit, once a critical mass of trained staff is lost from the service, it is likely that the quality of care will reduce. This study was able to monitor the attrition of trained staff at each data collection point (baseline, training, 3, 6, 9 and 12 months post training).

The assessors of level 2 skills test were also trainers on the course, therefore creating the potential for bias, however two trainers assessed each trainee (before and after the training) and arrived at an agreed score based on the structured checklist.

The assessment at level 4 used objective routinely collected health facility data, thus minimizing the risk of information bias. The quality of records was a concern, so only uniformly defined variables were used such as eclampsia, ruptured uterus, antepartum haemorrhage, retained placenta, ectopic pregnancy, sepsis and abortion/miscarriage were used for the calculation of CFR. Other variables such as obstructed labour were not defined uniformly across or even within the same health care facility. Also records were triangulated from multiple sources such as maternity, Operation Theatre, maternal death registers, blood transfusion registers, records department monthly summary sheets. Only direct obstetric deaths[14] were included in the calculation of DOCFR.

3.10.2. Limitations

Level 2 assessments: Knowledge test were not paired, it can be assumed that the pre training scores of medical doctors will be higher that of non-physician clinicians, this may skew the distribution of scores before and after the training potentially affecting the validity of the T-tests. However due to the smaller sample size for skills assessments the before and after samples were paired, this was to improve the ability of the test to detect differences.

[14]**Direct obstetric deaths**: direct obstetric deaths are those resulting from obstetric complications of the pregnancy state (pregnancy, labour and the puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above {{960 World Health Organization 2012 ;}}.

An assumption that the intervention can have outcomes in one direction only was made (one sided test) but in reporting the results in that direction, the default two-tailed p-value was divided by 2 (p=0.05/2=0.025).

Although equal variances are preferred with the T-Test, SPSS produces T-test values for equal and unequal variances assumed; it also produces the Levene's test for equality of variance. If this score is less than 0.05, it was concluded that the variances were unequal and the test based on unequal variance were reported.

Level 4 assessments: Although it was assumed that the impact of the intervention will be positive (unidirectional: one tailed), any poor implementation of this multifaceted intervention has the potential for a negative outcome/impact. Several scenarios can result in a 'negative' impact of this intervention based on the evaluation framework used:

a. Health care providers who do not provide routinely maternity services are trained
b. Trained health care workers are prevented from practicing new EmOC skills either by local hospital level or national policy
c. EmOC equipment provided soon after training are not utilized (this affects performance of EmOC signal functions such as manual vacuum aspiration and assisted vaginal delivery)
d. Maternity workers who are trained are not retained in the maternity ward
e. Maternity care workers have a very low pre-training knowledge/skills of EmONC that cannot be improved through a short in-service training in EmONC

Although there were advantages having homogenous groups for qualitative interviews (Paired/triad or group discussions) (participants feeling safer and more comfortable with colleagues in the same job cadre), this has a potential to limit the extent of the discussion. A mixed group can limit disclosure.

Chapter 4: Results
Level 1 (Reaction), Level 2 (*knowledge and skills)*

The results of this research are presented in 3 chapters: ***Chapter 4****: level 1 and 2 results (quantitative),* ***Chapter*** *5: level 3 (Change in behaviour) qualitative findings, and* ***Chapter 6****: level 4 (Change in health outcomes) quantitative results.*

This chapter describes the proportion of trainees by hospital and cadre, the extent of staff retention after the intervention, and presents their reaction to the training (level 1) and assessments of participants' knowledge and skills (level 2) before and after the training, highlighting differences by module of the training package and across the professional cadres.

4.1. Introduction

Improving the knowledge and skills of health care providers who specifically treat women during labour and the immediate post-natal period is likely to improve the identification and treatment of obstetric and early newborn emergencies. It will then be expected to improve availability of quality skilled attendance at birth and EmOC, ultimately reducing the risk of morbidity and mortality.

On registration for the training sessions, information about their hospital, ward and cadre was collected on a registration sheet, the analysis of this data provided a general description of the trainees (proportion of each major cadre trained and proportion of trainees from each hospital). An analysis of this data is presented in this Chapter. The proportion of maternity care providers trained from each study site was calculated using information collected during baseline data collection in each hospital and also the proportion of maternity staff trained who were retained in the maternity services of each hospital at 3 and 12 months post training is presented in this is presented**.**

The acceptability of the training by maternity care workers trained was assessed at Kirkpatrick level 1 (reaction) of training evaluation. The response rate for level 1 evaluation, the reaction of various cadre to the training programme, reaction disaggregated by lectures, breakout sessions and cadre are also presented. The overall reaction to the training (venue, usefulness, ease of joining interactive sessions) and additional written comments on the training was analyzed. The semi quantitative data from overall feedback was analyzed by cadre and major themes and presented in tables and graphs.

A narrative analysis of the additional comments was carried out and comments were grouped into major themes and presented as text quotes.

The change in learning was assessed at Kirkpatrick level 2 of the adapted evaluation framework. Knowledge and skills evaluation results are presented in tables by training module and cadre. Modules where the most and least change was observed are also highlighted. Statistically significant improvements in knowledge and skills are also highlighted.

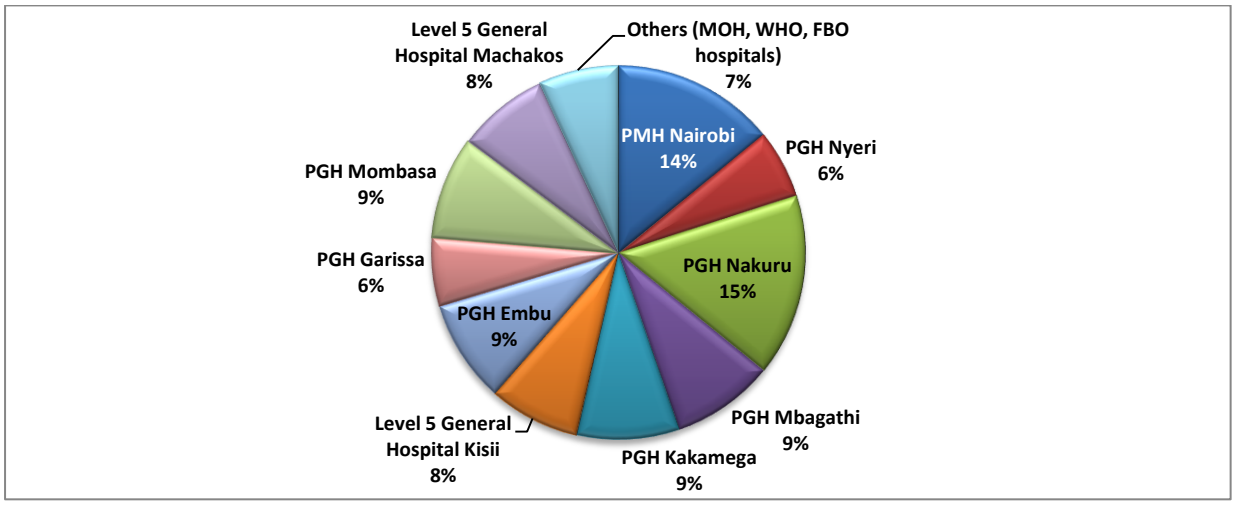
4.2. Description of trainees

4.2.1. Numbers trained and distribution by professional cadre

Overall 400 maternity care workers were trained. The highest number were trained from Pumwani Maternity Hospital 75 (14%) and the lowest from PGH Garissa 23 (6%) **(Figure 7).** Twenty 26 (7%) of health care workers trained were from MoH, RH/MNH development partners[15], private tertiary health institutions or Faith Based Organization (FBO) medical units.

The high proportion of maternity care providers trained from Nakuru PGH was due to additional training of newly posted staff to the maternity unit. A larger proportion of the staff trained from that hospital were redeployed within 3 months of the intervention, so an additional training was conducted 12 months after the intervention.

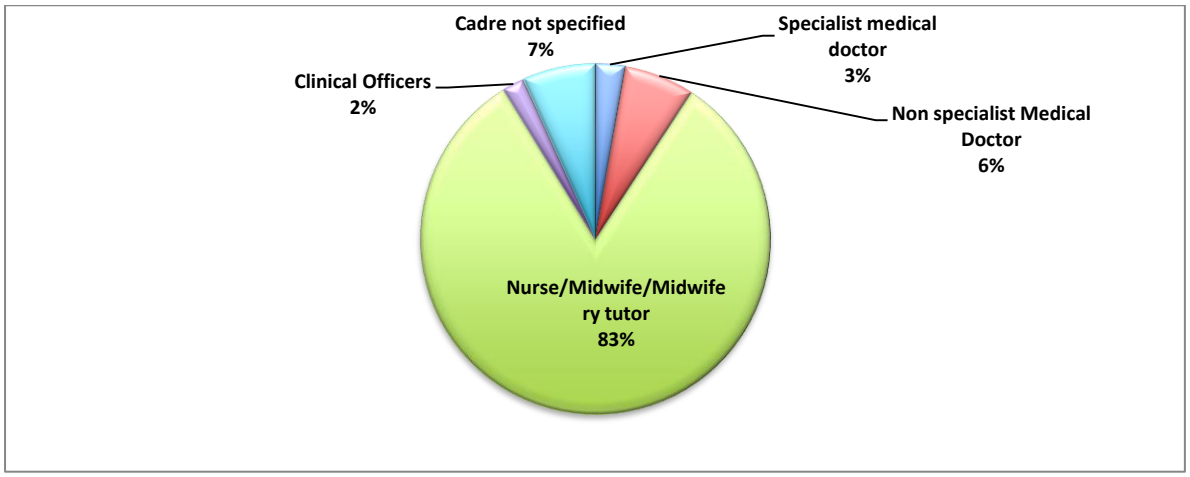
Figure 7: Pie chart showing proportion of all staff trained by study sites



[15] Reproductive/Maternal and Newborn Health development partners: these are non-governmental organisations supporting the Kenya Ministry of health in Reproductive, maternal and newborn health

Most (83%) of the trainees were nurses/midwives and only 3% (11) were specialist obstetricians. Midwives are the largest cadre providing maternity care in Kenya, non-specialist medical doctors are graduate medical doctors (usually less than 5 years post-graduation) who have not commenced specialist medical training (usually second on call), and this group comprised only 6% (26) of the total trained **(Figure 8).**

Figure 8: Distribution of trainees by professional cadre



4.2.2. Numbers trained and staff retention post intervention

Most maternity care workers identified at baseline were trained. Due to staff posting from the maternity ward, new members of staff identified during post training data collection visits were trained with the next cluster. Where large numbers needed to be trained in at a particular site this was deferred until the last cluster was trained.

141 staff from all the study sites were trained after the initial training (77 maternity care providers were trained 3-9 months after the initial training and 64 were trained after the initial training for the last cluster). Most of the additional training was for staff from Nakuru PGH and Mbagathi DGH, others were staff that were on leave at the time of initial training.

Most hospitals had 76% or more of trained staff retained at the maternity wards at 3 months post training except Nakuru PGH (38.5%). PGH Nakuru posted out over 60% of trained staff within the first 3 months, and the new team could only be retrained 12 months after the initial training. At 12 months post training the proportion of maternity ward staff trained in each hospital was at least 83% except for Nakuru PGH (23%) and Mbagathi GH (50%)-(**Table 18)**.

Table 18: Proportion of staff trained at baseline and 12 months post intervention

S/No.	Name of hospital	Proportion staff trained	Proportion of staff trained at 3M	Proportion of staff at 12M
1.	PMH Nairobi	76% (57)	76%(57)	83% (62)
2.	Nyeri PGH	72% (24)	72% (24)	85.7% (28)
3.	Nakuru PGH	100% (26)	38.5% (10)	23% (6)
4.	Mbagathi DGH	92.3% (26)	80% (21)	50% (13)
5.	Kakamega PGH	100% (34)	81% (28)	81% (28)
6.	Kisii L5GH	100% (32)	80% (26)	80%(26)
7.	Embu PGH	100% (37)	81.1% (30)	81.1% (30)
8.	Garissa PGH	96% (23)	96% (23)	79% (19)
9.	Mombasa PGH	100% (34)	94% (32)	94% (32)
10.	Machakos L5GH	94% (32)	94% (32)	94% (32)

4.3. Level 1 and 2 results

380 (95%) out of the 400 maternity care workers trained, participated in the level 1 evaluation. 20 trainees did not return their assessment questionnaire. 73.2% (278) of the level 1 respondents were nurses/midwives.

All trainees were expected to participate in the level 2 knowledge assessments. 382 (95.5%) out of 400 maternity care workers trained, participated in the level 2-knowledge assessment while 18 opted out of participation.

75% (300) of all trainees were randomly selected to participate in the skills assessment. Only participants who completed both pre and post skills test were included in the analysis. So any participant who arrived late to the training and misses the pre-training skills assessment was excluded from the post skills testing. 284 or 95% of trainees expected to participate in the skill test completed both pre and post assessments **(Table 19).**

Table 19: Response rate for level 1 and 2 evaluation

Cadre	Trained	L 1: n (%)	L 2: n (%)	
		Reaction	Knowledge	Skills
Specialist medical doctor	11	11 (2.9%)	10	1
Non specialist medical Officer	26	22 (5.8%)	21	18
Nurse/Midwife/ Midwifery tutor	328	276 (73%)	317	250
Clinical officers	8	8 (2.1%)	7	4
Others	27	61 (16.1%)	27	11
Total	400	378 (94.5%)	382 (95.5%)	284 (71%)

4.3.1. Level 1 results

Results of 3 components of level 1 evaluation are presented below; reaction to lectures, reaction to breakout sessions and analysis of additional written comments/feedback.

A.1. Reaction to lectures

Trained maternity care workers assessed each of the 9 lectures in the training programme on a likert scale of 1 to 10 (1: not very useful, 10: extremely useful).

The overall average score was 9.38 out of 10, the highest score was in preventing obstructed labour module (N= 376, mean score: 9.48, SD: 0.71) and the lowest mean score was for the Shock and unconscious patients module (N= 369, mean score: 9.28, SD: 0.92). This high overall average score indicates a strong positive reaction to the lectures delivered during the training **(Table 20).**

Table 20: Reaction of trainees to lectures

S/No.	Lecture title	N (%)	Mean score (min.=0, max.=10	Std. Deviation
1.	Airway, Breathing, Circulation	376 (94%)	9.40	0.91
2.	Care of the Newborn	374 (93.5%)	9.35	0.90
3.	Shock and unconscious patients	**376 (94%)**	**9.28**	**0.92**
4.	Management of Eclampsia and severe pre-eclampsia	373 (93.3%)	9.36	0.89
5.	Haemorrhage	370 (92.5%)	9.45	0.81
6.	Sepsis	370 (92.5%)	9.30	0.93
7.	Obstetric emergencies	**366 (91.5%)**	9.44	0.80
8.	Preventing obstructed labour	**369** (91.5%)	**9.48**	**0.72**
9.	Assisted vaginal delivery	371 (92.8%)	9.33	0.89
	Overall mean score		**9.38**	

A.2. Reaction to breakout sessions

Trainees evaluated the 24 breakout sessions of the EmONC training programme. Specialist medical doctors assigned the lowest overall score (8.8 out of 10) while nurse/midwives had the highest overall score (9.36 out of 10)-**(Table 21).**

Table 21: Participant's reaction to breakout sessions by group cadre

Grouped cadre	Breakout sessions	N	Mean	Std. Deviation
Specialist medical doctor	ABC demonstration	11	9.00	1.10
	Airway management and Resuscitation skills	11	8.82	1.08
	Newborn resuscitation skills	11	8.91	0.94
	Venous access skill	**10**	**9.60**	**0.70**
	Shock patient management	11	9.27	0.79
	Communication, Triage and Referral	10	8.90	0.99

Grouped cadre	Breakout sessions	N	Mean	Std. Deviation
	Recognition eclampsia	11	9.09	0.94
	Management of eclampsia	11	8.82	1.25
	BP, fluid balance management in (pre) eclampsia	11	8.91	1.30
	Obs. haemorrhage: Volume replacement	11	8.55	1.29
	Obs. haemorrhage: Atonic_uterus	11	8.55	1.70
	Obs. haemorrhage: Placenta abruption	11	8.27	1.55
	Obs. haemorrhage: Placenta previa	11	8.55	1.13
	Pregnancy related sepsis management	**11**	**7.64**	**1.80**
	Other Obs. Emergencies: Breech delivery skills	11	8.55	1.70
	Other Obs. Emergencies: Shoulder dystocia	11	8.82	1.08
	Other Obs. Emergencies: Cord prolapse	11	8.64	1.36
	Other Obs. Emergencies: Multiple pregnancy	11	8.82	1.08
	Preventing obstructed labour: Use of partograph	10	9.30	0.82
	Assisted delivery skills	11	9.36	0.81
	MVA ERPOC	10	8.50	1.58
	Managing retained placenta	11	8.82	1.40
	Managing difficult caesarean sections	11	8.64	1.36
	Perineal repair skills	11	8.91	1.38
	Mean score for specialist medical doctors		**8.8**	
Medical Doctor	ABC demonstration	21	9.14	1.39
	Airway management and Resuscitation skills	21	9.10	1.48
	Newborn resuscitation skills	**21**	**8.81**	**1.50**
	Venous access skill	21	9.00	1.34
	Shock patient management	21	9.05	1.07
	Communication, Triage and Referral	20	8.60	1.43
	Recognition eclampsia	21	9.38	0.87
	Management of eclampsia	21	9.29	1.19

Grouped cadre	Breakout sessions	N	Mean	Std. Deviation
	BP, fluid balance management in (pre) eclampsia	20	9.40	0.94
	Obs. haemorrhage: Volume replacement	21	9.48	0.93
	Obs. haemorrhage: Atonic_uterus	21	9.43	0.87
	Obs. haemorrhage: Placenta abruption	21	9.24	1.09
	Obs. haemorrhage: Placenta previa	21	9.43	0.98
	Pregnancy related sepsis management	21	9.33	0.91
	Other Obs. Emergencies: Breech delivery skills	21	9.57	0.60
	Other Obs. Emergencies: Shoulder dystocia	21	9.57	0.68
	Other Obs. Emergencies: Cord prolapse	21	9.52	0.75
	Other Obs. Emergencies: Multiple pregnancy	21	9.24	1.04
	Preventing obstructed labour: Use of partograph	**22**	**9.73**	**0.55**
	Assisted delivery skills	22	9.59	0.80
	MVA ERPOC	20	8.90	1.52
	Managing retained placenta	20	9.45	0.89
	Managing difficult caesarean sections	19	9.21	1.03
	Perineal repair skills	20	9.35	1.18
	Mean score for medical doctors		**9.04**	
Nurse-Midwife	ABC demonstration	276	9.49	0.77
	Airway management and Resuscitation skills	276	9.43	0.82
	Newborn resuscitation skills	276	9.43	0.81
	Venous access skill	272	9.23	1.16
	Shock patient management	274	9.35	0.84
	Communication, Triage and Referral	271	9.23	0.91
	Recognition eclampsia	274	9.41	0.80
	Management of eclampsia	269	9.38	0.80
	BP, fluid balance management in (pre) eclampsia	272	9.27	0.88
	Obs. haemorrhage: Volume replacement	275	9.39	0.80

Grouped cadre	Breakout sessions	N	Mean	Std. Deviation
	Obs. haemorrhage: Atonic_uterus	272	9.43	0.78
	Obs. haemorrhage: Placenta abruption	275	9.30	0.82
	Obs. haemorrhage: Placenta previa	275	9.37	0.80
	Pregnancy related sepsis management	272	9.37	0.82
	Other Obs. Emergencies: Breech delivery skills	272	9.44	0.80
	Other Obs. Emergencies: Shoulder dystocia	272	9.27	1.01
	Other Obs. Emergencies: Cord prolapse	273	9.60	0.64
	Other Obs. Emergencies: Multiple pregnancy	273	9.47	0.73
	Preventing obstructed labour: Use of partograph	**272**	**9.70**	**0.58**
	Assisted delivery skills	273	9.35	0.93
	MVA ERPOC	269	9.26	0.92
	Managing retained placenta	271	9.54	0.78
	Managing difficult caesarean sections	**241**	**8.99**	**1.21**
	Perineal repair skills	261	9.33	1.12
	Mean score for nurse/midwife		**9.15**	
Mid-level cadre	ABC demonstration	7	9.71	0.49
	Airway management and Resuscitation skills	7	9.57	0.79
	Newborn resuscitation skills	6	9.33	0.82
	Venous access skill	**6**	**9.83**	**0.41**
	Shock patient management	6	9.17	0.41
	Communication, Triage and Referral	**6**	**8.67**	**1.03**
	Recognition eclampsia	7	9.57	1.13
	Management of eclampsia	7	9.43	1.13
	BP, fluid balance management in (pre) eclampsia	6	8.33	1.51
	Obs. haemorrhage: Volume replacement	7	9.43	0.79
	Obs. haemorrhage: Atonic_uterus	7	9.43	0.79
	Obs. haemorrhage: Placenta abruption	7	9.14	0.90

Grouped cadre	Breakout sessions	N	Mean	Std. Deviation
	Obs. haemorrhage: Placenta praevia	7	9.57	0.79
	Pregnancy related sepsis management	7	9.43	0.79
	Other Obs. Emergencies: Breech delivery skills	7	9.43	0.79
	Other Obs. Emergencies: Shoulder dystocia	7	9.29	1.11
	Other Obs. Emergencies: Cord prolapse	7	9.29	1.11
	Other Obs. Emergencies: Multiple pregnancy	7	9.57	0.54
	Preventing obstructed labour: Use of partograph	8	9.63	0.74
	Assisted delivery skills	8	9.50	0.76
	MVA ERPOC	8	9.50	1.07
	Managing retained placenta	8	9.38	0.92
	Managing difficult caesarean sections	6	9.33	1.21
	Perineal repair skills	8	9.00	1.31
	Mean score for clinical officers cadre		**9.2**	
Cadre not stated	ABC demonstration	61	9.39	0.88
	Airway management and Resuscitation skills	60	9.18	1.01
	Newborn resuscitation skills	61	9.30	0.97
	Venous access skill	61	9.00	1.06
	Shock patient management	60	9.12	0.98
	Communication, Triage and Referral	**60**	**8.97**	**1.12**
	Recognition eclampsia	61	9.31	0.92
	Management of eclampsia	61	9.26	0.95
	BP, fluid balance management in (pre) eclampsia	61	9.13	1.15
	Obs. haemorrhage: Volume replacement	61	9.15	1.01
	Obs. haemorrhage: Atonic uterus	61	9.28	0.84
	Obs. haemorrhage: Placenta abruption	60	9.23	0.89
	Obs. haemorrhage: Placenta previa	60	9.27	0.90
	Pregnancy related sepsis management	60	9.23	0.81

Grouped cadre	Breakout sessions	N	Mean	Std. Deviation
	Other Obs. Emergencies: Breech delivery skills	61	9.31	0.90
	Other Obs. Emergencies: Shoulder dystocia	61	9.23	0.84
	Other Obs. Emergencies: Cord prolapse	61	9.48	0.79
	Other Obs. Emergencies: Multiple pregnancy	61	9.30	0.99
	Preventing obstructed labour: Use of partograph	**58**	**9.59**	**0.68**
	Assisted delivery skills	58	9.36	0.81
	MVA ERPOC	57	8.84	1.70
	Managing retained placenta	57	9.39	0.84
	Managing difficult caesarean sections	51	8.92	1.16
	Perineal repair skills	55	8.98	1.57
	Mean score (MS)		40.99	

Midwives found the partograph breakout session most useful (n=272, **MS=9.7**, SD=0.60) as did medical doctors (n=22, **MS=9.7**, SD=0.5) while specialist medical doctors (n=10) and clinical officers (n=6) found the venous access breakout session most useful; **MS=9.6**, SD=0.70 and **MS=9.8**, SD=0.41 respectively. This is an interesting observation because venous cut-down was a new skill being taught and those cadres with previous surgical training and experience found it more useful compared to those who had basic or no surgical training for example the non-specialist medical doctors (n=21, **MS=9**, SD=1.34) and nurses/midwives (n=272, **MS=9.2**3, SD=1.16) who had not.

It was also not surprising that midwives scored managing difficult caesarean section breakout session least useful n=241, **MS=8.99**, SD=1.214 compared to the other cadre, for similar reasons **(**

Table 22**).**

Table 22: Lowest and highest scored breakout session by professional cadre

Grouped cadre	Mean score (MS) min=0, max=10	
	Lowest	Highest
Specialist Medical Doctor	*Pregnancy related sepsis: n=11, **MS=7.6**, SD=1.8*	*Venous access skill: n=10, **MS=9.6**, SD=0.70*
Medical Doctor	*Newborn resuscitation skills: n=21, **MS=8.8**, SD=1.5*	*Use of partograph: n=22, **MS=9.7**, SD=0.5*
Nurse-Midwife	*Managing difficult caesarean sections: n=241, **MS=8.99**, SD=1.21*	*Use of partograph: n=272, **MS=9.7**, SD=0.58*
Mid-level cadre	*Communication, Triage and Referral: n=6, **MS=8.7**, SD=1.0*	*Venous access skill n=6, **MS=9.8**, SD=0.41*

A.3. Overall reaction to training

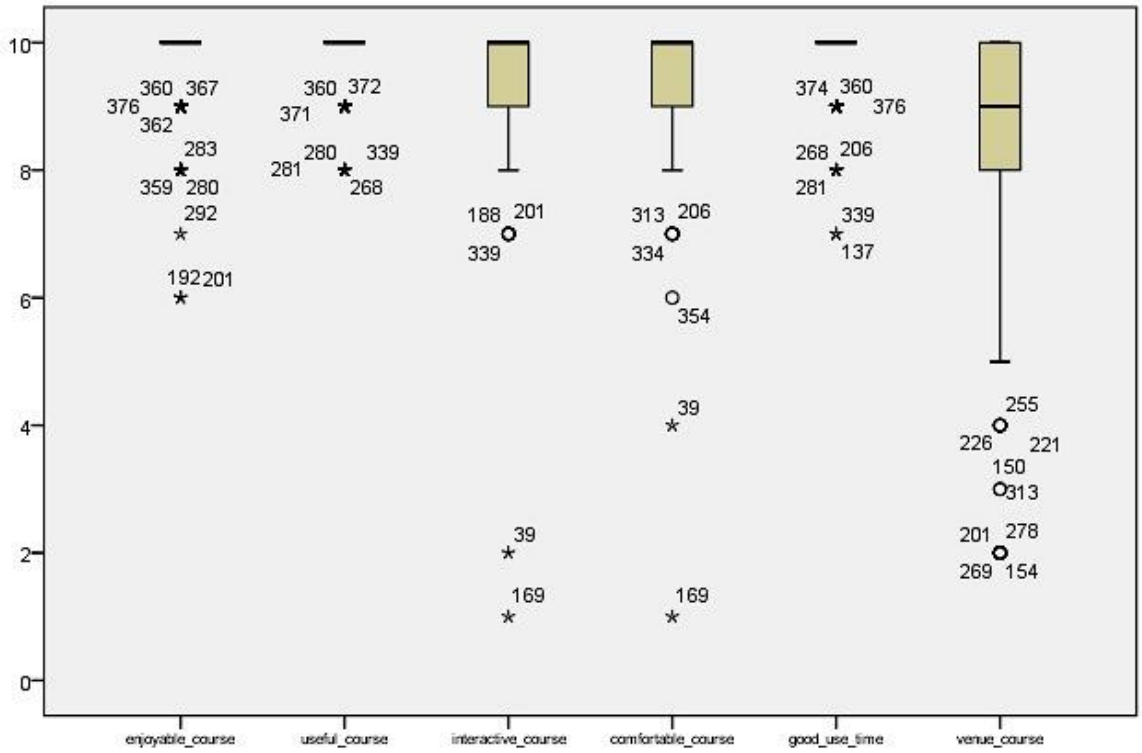
All trainees were asked to provide an overall evaluation of the course, looking at 5 key areas: Enjoyment, usefulness, interactive nature, comfort during, good use of time and the venue of the course. A maximum score of 10 was reported by all respondents in four of the five parameters except the venue parameter (median score of 9-lowest score of 5 and highest score of 10)

The median score for enjoyment, usefulness and good use of time was 10 with 25 (7.8%) extreme outliers **(Figure 9).** The least frequent score was for the training venue (median score of 9 and there were 9 outliers), this is not surprising because health care providers are used to attending in-service training in hotels compared to hospitals or midwifery training colleges, specialist medical doctors were least impressed by the venue **(**

Figure 10**).**

A box plot with the reaction of trainees broken down to four professional cadre allowed for visual inspection for the extent in variability in their reaction to the five parameters and for comparison across the various cadre. A similar pattern of variability in three parameters (enjoyment, comfort and venue) is seen across the various cadre trained who responded. Midwives and medical officers, both at the frontline of providing emergency obstetric and newborn care, mostly reported that the training was useful and a good use of their time. The midwives appeared to have enjoyed the course the most.

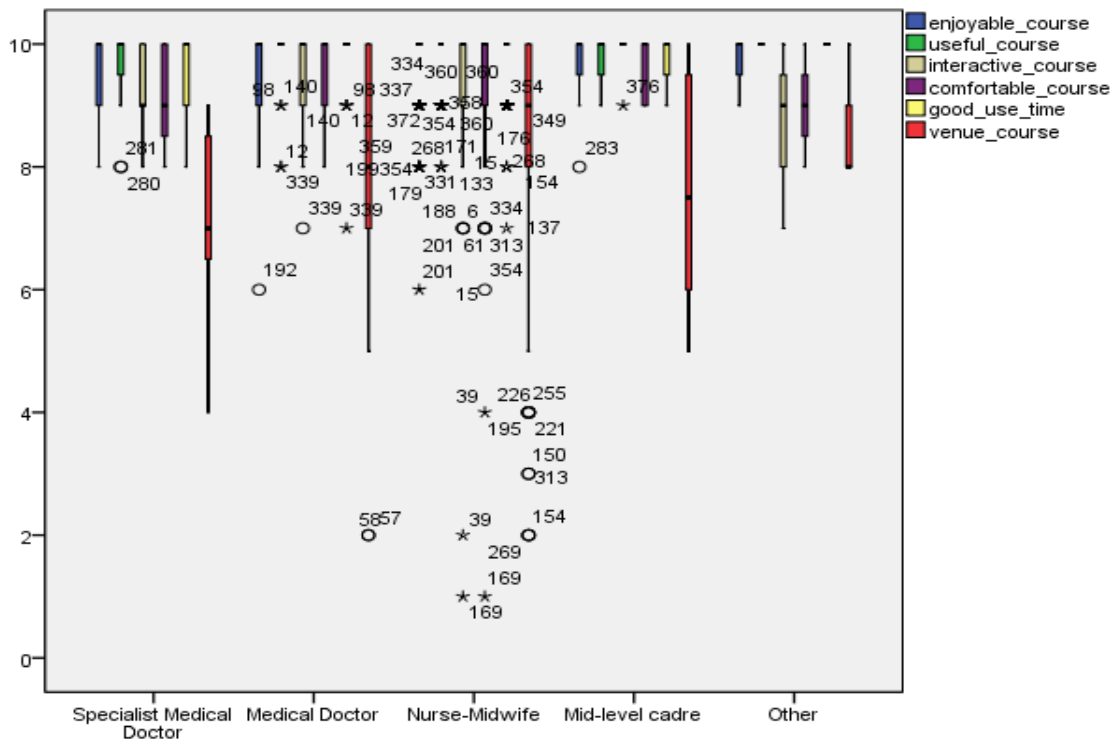
Figure 9: Overall reaction to training (Box and whisker plots max score 10, min. score 0)



*O and * (extreme) are outliers that lie more than 1.5 and 3 box lengths from the edge of the box respectively.*

Figure 10: Overall reaction to training by professional cadre

(Box and whisker plots max score 10, min. score 0)



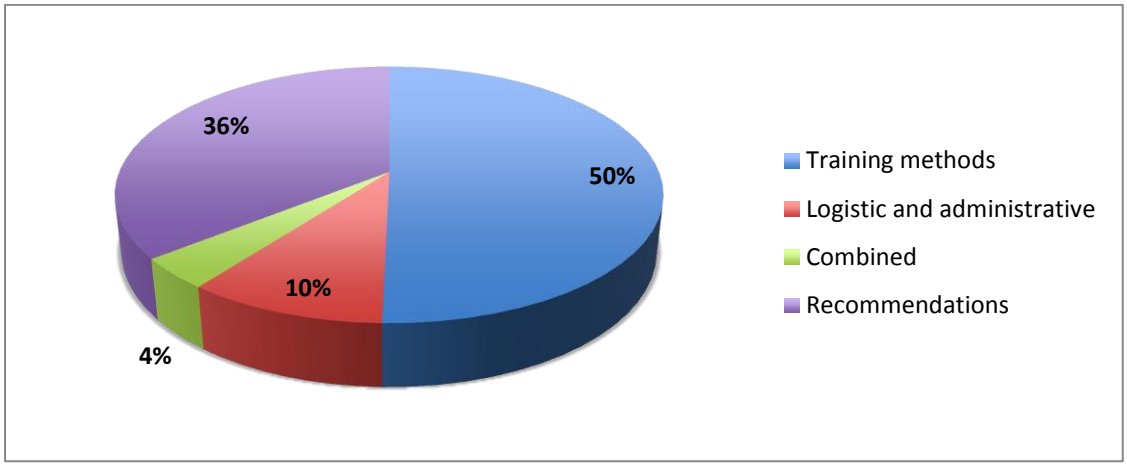
A.4. Additional written comments

Of the 378 participant feedback forms returned (level 1 evaluation), 280 (74.1%) provided additional written comments.

Narrative analysis was used to analyze these additional comments, grouping them into major themes. The comments were categorized as positive, negative comments, or recommendations in two main themes; a) training methods (training content, teaching methods, training materials, duration of training, faculty, training evaluation) and b) logistic and administrative issues (participant selection, training venue, transport allowance, catering)-**Figure 11**

Some comments were a combination of both themes and therefore are presented as combined feedback.

Figure 11: Types of comments received categorized by predominant theme



All identifying comments to specific health care institutions or individuals were anonymized. All comments that were similar to those presented were excluded in **Box 6 to Box 10.**

Of the 280 additional comments analyzed, 218 (77.9%) were from nurse/midwives and there were only 7 (2.5%) from clinical officers, 7 (2.5%) from specialist medical doctors and 19 (6.8%) from medical doctors **(Table 23).**

Table 23: Distribution of level 1 feedback, additional comments by professional cadre

Professional cadre	No comments provided n (%)	Comments provided n (%)	Total L1 response n (%)
Specialist medical doctors	4 (4.1%)	7 (2.5%)	11
Medical doctors	3 (3.1%)	19 (6.8%)	22
Nurse/midwives	58 (59.2%)	218 (77.9%)	276
Clinical officers	1 (1.%)	7 (2.5%)	8
Other non-specified	32 (52.5%)	29 (10.4%)	61
Total n (%)	98 (25.9%)	280 (74.1%)	378

50% (141) and 10% (28) of all written comments were mainly on the training method and logistic/administrative issues respectively. 100 or 36% of all written comments were recommendations on improvements in training methods, scale up, logistic and administrative issues.

a) Positive comments

128 (45.7%) of the 280 comments analyzed were positive.

I. Training methods

Most of the positive comments were on the training methods, quality of teaching, the faculty, training materials and usefulness of the training programme. Typical responses are presented in **(Box 6)** below

Box 6: Positive comments on training methods and faculty -Typical quotes

Appreciation for the training methods, quality of facilitation
*"The teaching methods were good that in **discussions, demonstrations, DVD of which I will not forget easily**. The content was up to standard to help our obstetric on post natal mothers"*
*"The trainers **were sample from different countries with experience which is broad and good experience**, the participants had good interaction since they came from different facilities sharing experience and knowledge"*
*"The training **was perfect as the lectures were short**; in case one didn't grasp **the lecture the workshop was extremely perfect to reminder**"*
"Clarity of concept was mainly brought out in demonstration**. **Demonstration and lecture was excellent approach"
***"Quite good and away from distraction**, however the room was a bit small. **Facilitators were knowledgeable and very nice they made learning enjoyable and kept time**"*
"We are grateful for the demonstrations and teachings since some of those practices are seen in books only"
*"It was a good training with everything available for practicals and very knowledgeable and friendly facilitators. They organize this training again and **leave some of the teaching dummies for teaching others at the hospital"***
Usefulness of the training

*"I should have **gone through this training earlier than this as a provincial RHC** to be able **to plan and coordinate training/supervise maternities and do on job training to the staff**. I feel very good and wish I had an earlier invitation to join in from day 1 of the training. Thank you very much for the efforts to reduce our maternal perinatal deaths/complications during delivery"*
*"The course was actually enjoyable and educative **as some of the skills were not being practiced**"*
*The training was **very informative, interesting and educative.** The technique used to **teach was very unique and interesting**. The **tutors were very active and interesting**. Thank you so much, we should do this more often*
*I thank you for all this session. I **did learn more on what I theoretically know for example vacuum & forceps delivery** and I am **glad the midwives have been included** in this session as now I hope they shall be **more confident in patient management and the doctor shall not always be called to start from scratch**.*
*This has been **the best and most useful course I have ever** had **because its concentrated on the practical part which is most important since most of us have the theory***
*Skills given very useful and I now will be able to **give quality competence skilled care**. **It has been very, very useful**. Thank you.*
*Very fantastic**. I am hundred percent different from the time I step into this lecture hall in terms of skill and competence**. Thanks to those all who contributed to my change*
*The **course was relevant and I feel competent and confident in attending to the mothers and babies** (new-born) in my unit. Thank you very much*
*It has **been very good learning time**. I have learnt **a lot and very beneficial for me and the community** I serve*
*Keep up the good work of **empowering health care providers** with knowledge and skills required to improve services*
*Thank you very much, please brings some other training. **You have empowered me a lot**. Keep it up, and God bless you.*
Resolve to use new skills and knowledge
*I have enjoyed the seminar and I have learnt many changes **which I should apply in the work place***
*I have gained knowledge and skills on emergency obstetric and newborn care, which is **very useful to the patients/clients and me.***
*I have obtained much and **will be able to serve my patient effectively**. Thanks to our facilitators we loved it all.*
*Fantastic workshop, educative and updating**, looking forward for improvement on our part**.*

It was hectic tiresome course though ***very interesting and looking forward for fruitful practice and results***
Updates
I wish I could have more updates as from now my difference will be felt. ***The lecturers were wonderful and practically were the best ever attended***
We should be trained ***more on the latest updates to enable us to avoid old practices*** *that can* ***cause harm and danger to our patients and practices that have no relevance to our patients****.*

II. Logistic and administrative issues

There were only 8 positive comments on logistic/administrative issues. These were on effective participant selection and invitation of for the training. Typical responses are presented in **(Box 7)** below.

Box 7: Positive comments on logistic and administrative issues

Invitation for training and participant selection
…this was the ***first time that I was nominated to go for a training****, the chief nursing officer insisted that only those from labour ward were required to attend. I* ***received an invitation letter*** *and other documents as well. All trainings should be organized this way.*
..I ***received a letter with all the information*** *I required, logistic arrangements, venue and what the training was about. Keep it!*

b) Negative comments

42 (15%) comments were categorized as negative, covering training method, administrative and logistic issues.

I. Training methods

Participants reported that the training was intense, not enough time allocated to breakout sessions particularly obstetric emergency breakout sessions, they argued that increasing the duration of the course will ensure that all participants fully understand and have sufficient practice during the breakout sessions. They also expressed concern about participants who dominated some of the

breakout sessions. Few participants recommended that the audiovisual content of the training programme should be increased because this facilitated understanding. Typical responses are presented in **(Box 8)** below

Box 8: Negative feedback on training methods-Typical comments

Duration of training
*"It was **marathon training with very little time for digesting the learnt issues"***
"Course is extremely important but too short- **better 5 days** to ensure wider coverage as well internationalization of the **skills and practical concepts"**
***"Breakout sessions not enough as per the time allocated**. Breech breakout session should be allocated more time"*
*"Moving up and down was a constraint on **demonstration room was far from the lecture hall"***
*"The course period should be lengthened. **More video procedure is needed. Ample time for skill progression"***
Level of participation
***"Some participants dominated the sessions** denying others a chance to contribute"* *"In the afternoon **allow warm ups** so that people can stop sleeping"*

II. Logistic and administrative issues

There were 22 negative comments on the logistic/administrative support for the training **(Box 9)** these were grouped into venue, catering and travel allowance themes.

Participants were reimbursed for travel only, provided lunch and tea breaks. Some participants came from longer distances and therefore received more compared to others who travelled shorter distances. Government of Kenya circular on allowances for training recommended payments by cadre and distance, this guided payment for both participants and locally trained trainers.

Comments on catering differed from one location to another, the quality of venue and meals were monitored with each training and improvements made in subsequent trainings. Participants were concerned about the distance from their residence to the venue of the training, in order to participate in all sessions, they had to pay more for transport and days when the training overran, they had to travel late to their homes. Such comments were unusual because the training venues were within hospitals (29%) or Kenya Medical Training Colleges (71%) both within working distance of their daily place of duty.

Also some hospital venues were described as '***congested, lacking adequate tables and chairs'***, also associated with ***'distraction'*** to participants.

Of note is the need for ready access to drinking water during the training which was described by some participants as '***very intense and long'*** with training taking place when the weather was very hot.

Box 9: Negative feedback of logistic and administrative comments: Venue, Catering, allowances- Typical quotes

Venue
*Change of **venue** - **transport problems**. To come again for more updates/new skills.*
*Thank you for the course was very timely and useful. **Theatre/classroom lacked tables to write on.***
*Sometimes there were **distractions** in between the lectures because the **venue** was in the middle of the ward. Prepare a **quiet environment** if possible next time. Thank you, god bless you all*
*The **venue should be larger and spacious**. The training should be possible be trained in each PGH to benefit those from HFCs who conduct deliveries. More experience and practical's shown.*
Catering
*The hotel that offered outside **catering was having meals not cooked well**. Need to work on that. Otherwise, all was well. Congratulations to all the team!*
***Catering department needs improvement**, quality food, enough water, Mombasa is hot.*
*The **food was not properly made or served**. The training should be outside Mombasa. Students should also be trained. The model should be left with the hospitals for further training.*
*The venue was not very good. The **meal also needed improvement** especially tea and snacks.*
Allowance
*Midwives had to hire taxis to travel home since the sessions were ending after 5pm (too late) yet **no allowance was given.***
*Pre-organisation of the course is paramount. We didn't **know any logistic arrangements***
*I feel that the **allowances should be equalised for all nurses and doctors.***
*I will put whatever I learnt during the 4 days into practice when I go back to my hospital. **The money I was paid was not within my job group as per government policy.***

c) Recommendations

34% (95) of written comments were recommendations on adaptations to the training content, methods and duration provided by 36% (4), 36% (11) and 26% (278) of specialist medical doctors, non-specialist medical doctors and clinical officers respectively **(Box 10).**

Most participants expressed appreciation for the training and recommended that colleagues from other EmOC facilities should be trained. There was a general perception of **empowerment, satisfaction, improved confidence and a desire to put new skills and knowledge into practice**.

The complementarity of the training methods (short lectures, videos, hands-on sessions, simulations) and the diverse experience of the faculty/trainers were appreciated and commended.

Respondents reported that the practical and hands-on approach enabled them to understand management approaches for which they only knew theoretically and were not properly taught during pre-service training (example given was assisted vaginal delivery). There was also a desire for continuous updates after the training.

On the duration of the training, participants recommended that the ideal length of the training should be between 4 days and 2 weeks, arguing that this will optimize the opportunity for learning by slow learners. On the training content there was a recommendation to expand the content to include sessions on breast-feeding. Trainees were keen to see this training extended to maternity care providers in both public and private sectors. The competency based training methods used were also considered very useful for pre-service medical training. The respondents suggested that provision of EmONC equipment, appropriate polices, and regular supportive supervision and continuous medical education EmONC for updates would facilitate the practice of newly acquired skills and knowledge.

Box 10: Categorized recommendations on training methods, content and timing-Typical quotes

Duration of training and scope of content
*Disseminate the **course for more people to learn**. 2. Very involving breakout sessions should have more time. 3. Excellent!*
*I suggest that in future participants stay near the training venue so that **they can have time to practice with models at their own time***
*If the days for the course can be increased **to allow more practice and learning skill especially for slow learners to benefit***
*Make the course **a 5 days** training* *The course **was wonderful, wonderful facilitators and even meals**. Time was a bit short I feel it needed more*

days
*The training needs to take **one week** possibly*
*Need **more time during breakout sessions**. Some needed **more time than others** e.g. MVA, episiotomy/perineal tear repair. Lucy mannequin was excellent, most real.*
*Please **include breast-feeding** sessions.*
Train more maternity care providers
***Extend the course** to other institutions **like private aid faith based organisation**.*
*All midwives should go through **this refresher course**. **Doctors** need to be exposed to the course to **help correct anomalies**. **Medical/nursing institutions to adopt the approach in teaching reproductive health or EOC** and newborn care. Course **highly recommended**.*
*Let **every Dr, nurse/midwives and RCOs to be trained on this wonderful and helpful course***
*It will be great if **all the midwives were trained**. **Vacuum extraction instruments are very rare**, hence practice was very possible. Some procedures get complicated due to insufficient staff.*
*The course should be done **more frequently than before as it has shown to be very educative empowering** and all the SBA should have a chance so as to reduce mortality (maternal and neonatal)*
Factors that will facilitate practice of new skills
*We do not have enough **supplies**, this will probably make it difficult to apply life-saving skills to my clients*
*We need **more time to practice** especially the **manoeuvres of the shoulder dystocia and vacuum extraction**.*
*More training **on MVA is needed & to be done practically**.*
***Equipment, policy support and supervision** will enable me practice when I go back to my health facility*
*Kindly increase course updates even in other areas e.g. Tropical Diseases. We need **equipment & policy & working areas after acquiring skills to enable us to practice***
Follow-up and supportive supervision
I wish we could be called again to assess us practically, whether we are performing on our own. Please call us for another course/seminar.
Regular updates. Supportive supervision
*Would wish to be having **continuous CME** in the hospital in order **to update those** who did not attend the seminar*
Pre-service training
*Need to **incorporate this training in basic trainings** so that students come out complete with the knowledge*
*The course should be **introduced in basic training** in order for all health workers to have skills and knowledge*

on LSS and BEmOC.
Training schools *to be assisted with the materials e.g. partograph and mannequins to use in training.*
The Course was very timely, well done to all the facilitators. ***The course should be included in the basic midwifery course.***

4.3.2. Level 2 results

382 (95.5%) trainees participated in the knowledge assessments. The number of maternity care providers who participated in the knowledge assessments by cadre, by assessed modules completed, mean pre/post training scores are provided in **Table 24, Table 25 and Table 26** below.

Table 24: Knowledge assessment participants by professional cadre

Cadre – grouped		Number of maternity care providers
Cadre not stated	Pre-course	27
	Post-course	20
Specialist Medical Doctor	Pre-course	9
	Post-course	10
Medical Doctor	Pre-course	14
	Post-course	21
Nurse-Midwife	Pre-course	295
	Post-course	317
Mid-level cadre	Pre-course	4
	Post-course	7

B.1. Knowledge results

Generally there were fewer respondents during the pre-test compared to post-test, this is likely due to the exclusion of those who registered for the training after the commencement of the pre-course assessment (**See section 3.9.1**). Modules are listed sequentially as they appear on the test sheet.

Table 25 below presents the number of maternity care providers trained who participated in the pre/post knowledge assessments, by module assessed.

Table 25: Mean knowledge pre/post-test scores by module (n=number of trainees)

Modules	Pre/Post	N	Mean	Std. Deviation	Std. Error Mean
Communication, Triage and Referral	Pre-course	**349**	3.64	0.94	0.05
	Post-course	**375**	3.91	0.95	0.05
Maternal and Newborn Resuscitation	Pre-course	**349**	2.62	1.15	0.06
	Post-course	**375**	3.24	0.97	0.05
Shock and the Unconscious Patient	Pre-course	**349**	3.06	1.03	0.06
	Post-course	373	3.59	1.11	0.06
(Pre) Eclampsia	Pre-course	**349**	3.29	1.17	0.06
	Post-course	372	3.80	0.97	0.05
Obstetric Haemorrhage	Pre-course	347	2.47	1.41	0.08
	Post-course	372	3.51	1.07	0.06
Preventing Obstructed Labour	Pre-course	346	3.20	1.04	0.06
	Post-course	373	3.09	1.10	0.06
Obstetric Emergencies	Pre-course	338	2.97	1.17	0.06
	Post-course	371	3.50	0.96	0.05
Pregnancy Related Sepsis and Unsafe Abortion	Pre-course	334	3.27	1.18	0.06
	Post-course	**366**	3.74	0.88	0.05

The lowest number of respondents was for the pregnancy related sepsis and unsafe abortion questions in both pre-and post-test (last question of the test), this maybe because some participants did not have enough time to complete the assessment **(Table 25).**

Table 26 presents independent t-test analysis of knowledge assessments. It also presents the effect size when there is a statistically significant difference. The basic assumption of homogeneity of variance based on the Levene's test was met.

There was statistically significant improvement in knowledge in all modules except preventing obstructed labour.

Table 26: Results of independent t-test analysis of pre and post training knowledge assessment by modules

Modules	P value Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	Eta squared[16]
Communication, Triage and Referral (CTR)	<0.001	0.27	0.07	0.13-0.41	0.02
Maternal and Newborn Resuscitation (MNR)	<0.001	0.63	0.08	0.47-0.78	0.08
Shock and the Unconscious Patient (SUP)	<0.001	0.52	0.08	0.37-0.68	0.06
(Pre) Eclampsia	<0.001	0.50	0.08	0.35-0.66	0.05
Obstetric haemorrhage	<0.001	1.04	0.09	0.86-1.23	0.15
Preventing obstructed labour	**0.201**	**0.10**	**0.08**	**0.06-0.26**	N/A*
Obstetric emergencies	<0.001	0.53	0.08	0.37-0.69	0.06
Pregnancy related sepsis and complications of abortion	<0.001	0.47	0.08	0.31-0.62	0.05

***N/A**= Not applicable

Effect size of statistically significant differences:

Eta squared provides an indication of the **effect size** of a statistically significant difference; it gives an indication of the magnitude of the differences between groups. There was a statistically significant difference between the pre and post training knowledge assessment in all modules except the preventing obstructed labour module (n=346, 373, mean difference 0.10, SE 0.08, CI **0.06-0.26).** The effect size was **small** in CTR and (pre) eclampsia module, **moderate** in MNR, SUP, obstetric emergencies and pregnancy related sepsis/unsafe abortion modules while it was large in obstetric haemorrhage module only. The effect size for preventing obstructed labour was not calculated since no statistically significant difference was observed between the pre and post training knowledge assessments **(Table 26).**

[16] Eta squared provides an indication of the **effect size**, giving an indication of the magnitude of the differences between groups. Reference values: 0.01= small effect, 0.06=moderate effect and 0.14=large effect (Pallant 2013).

Mean pre and post knowledge assessment results per cadre:

The mean knowledge scores and number of participants involved in the test are presented in **below**

Table 27 below

Table 27: Mean pre and post knowledge score by cadre

Professional cadre	Mean score (min.=0, max. =5)	
	Pre-training (n)	Post-training (n)
Specialist Medical Doctor	3.83 (9)	3.93 (10)
Non-specialist Medical Doctor	3.62 (14)	3.91 (21)
Nurse-Midwife	3.34 (285)	3.52 (317)
Clinical officer	3.34 (4)	3.91 (7)

Additional analysis of knowledge assessments by professional cadre is presented in **Table 57 and Table 58 (Annex 8: Additional Level 2 knowledge assessment analysis):**

Specialist medical doctors:

Nine and 10 **specialist medical doctors** participated in the pre and post knowledge assessments respectively, their mean pre knowledge assessment (PreKA) score was 3.83/5, the lowest PreKA was in MNR module (3.0/5, SD=1.58) while the highest PreKA were in the obstructed labour (4.11/5, SD=0.93), pre/eclampsia (4.11/5, SD=0.93) and shock/unconscious modules (4.11/5, SD=1.05).

The mean post-KA was 3.93/5 and the highest mean PostKA score was in the pre/eclampsia module (4.4/5 SD=0.7). The highest mean difference between pre and post knowledge assessment was in the obstetric emergencies module and the lowest mean difference was in the CTR module. Due to the small size of the group valid conclusions cannot be made about the results of the t-test statistical analysis **(Table 57 and Table 58**).

Non-specialist medical doctors:

Fourteen and 21 **non-specialist medical doctors** participated in the pre and post knowledge assessments respectively, their mean pre knowledge assessment (PreKA) score was 3.62/5, the lowest PreKA was in MNR module (3.21/5, SD=0.98) while the highest PreKA was in pre/eclampsia (4.14/5, SD=1.03).

The mean post-KA was 3.91/5 and the highest mean PostKA score was in the CTR module (4.33/5 SD=0.91). The highest mean difference between pre and post knowledge assessment was in the preventing obstructed labour module and the lowest mean difference was in the CTR module. Due to the small size of the group valid conclusions cannot be made about the results of the t-test statistical analysis **(Table 57 and Table 58**).

Nurses/midwives:

295 and 317 **nurses/midwives** participated in the pre and post knowledge assessments respectively, their mean PreKA score was 3.34/5, the lowest PreKA was in obstetric haemorrhage module (2.44/5, SD=1.41) while the highest PreKA was in the pregnancy related sepsis/complications from abortion module (3.27/5, SD=1.13).

The mean post-KA was 3.52/5 and the highest mean PostKA score was in the pre/eclampsia module (3.22/5 SD=1.2). The highest mean difference between pre and post knowledge assessment was in the preventing obstructed labour module and the lowest mean difference was in the obstetric emergencies module. There was statistically improvement in knowledge in all modules except preventing obstructed labour **(Table 57 and Table 58**).

Clinical officers:

Four and Seven **clinical officers** participated in the pre and post knowledge assessments respectively, their mean pre knowledge assessment (PreKA) score was 3.34/5, the lowest PreKA was in obstetric haemorrhage module (2.50/5, SD=1.91) while the highest PreKA was in shock/unconscious module (3.75/5, SD=0.5).

The mean post-KA was 3.91/5 and the highest mean PostKA score was in the shock/unconscious module (4.29/5 SD=0.91). The highest mean difference between pre and post knowledge assessment was in the CTR module and the lowest mean difference was in the obstetric haemorrhage module. Due to the small size of the group valid conclusions cannot be made about the results of the T statistical analysis **(Table 57 and Table 58**).

B.2. Skills assessment results

284 (71%) trainees participated in the skills assessments The number of maternity care providers who participated in the skills assessments by cadre and module assessed, mean pre/post training and t-test analysis are provided in **(Table 28, Table 29, Table 30 and Table 31).**

Sub-analysis for each cadre that participated in each module was not presented because the numbers were too small, this will violate the assumption of normality and minimum sample size potentially putting results and conclusion at risk of a type 1 error (rejecting that there is no difference when indeed there is). The alpha level used for the calculations was 0.5.

Table 28: Number of maternity care providers who participated in skills assessments by test modules.

Cadre – grouped	Skills	Number of maternity care providers
Cadre not specified	Partograph	3
	Atonic uterus	1
	Basic life support and maternal resuscitation	3
	Breech delivery	4
	Total	**11**
Specialist Medical Doctor	Breech delivery	1
Non specialist-Medical Doctor	Basic life support in the Newborn	1
	Eclampsia	6
	Partograph	3
	Shoulder dystocia	3
	Atonic uterus	3
	Basic life support and maternal resuscitation	2
	Breech delivery	2
	Total	**20**
Nurse-Midwife	Basic life support in the Newborn	37
	Eclampsia	32
	Partograph	30
	Shoulder dystocia	33
	Unsafe abortion	35
	Atonic uterus	28
	Basic life support and maternal resuscitation	31
	Breech delivery	31

Cadre – grouped	Skills	Number of maternity care providers
	Total	**257**
Mid-level cadre	Shoulder dystocia	2
	Unsafe abortion	1
	Atonic uterus	1
	Total	4

Table 29: Skills assessment paired t-test statistical analysis results

Overall skills assessments	Mean	N	Std. Deviation	Std. Error Mean
PreTestScore	4.12	284	2.18	.136
PostTestScore	7.67	284	1.70	.106
Mean difference	3.55	**p-value**		<0.001
95% Confidence interval	3.29-3.81	**Standard deviation**		2.1
Standard error mean	0.131			

There were 284 pairs, the mean pre-skills test score was 4.12, Standard deviation: 2.18 while the mean post-test score was 7.67 with a standard deviation of 1.70. The mean difference between pre and post-test scores was statistically significant 3.5 CI (3.3-3.8) P<0.001, SD=2.1 **(Table 29)**

Table 30: Skills assessment- paired Samples t-test analysis results by module

Module tested - based on test number	n	Paired Differences			p-value
		Mean difference (95% Confidence Interval)	Std. Devtn.	Std. Error Mean	
Newborn resuscitation	38	3.90 (3.4-4.42)	1.44	.25	<0.001
Pre/Eclampsia	38	3.18 (2.64-3.72	1.51	.27	<0.001
Preventing obstructed labour	34	3.61 (2.78-4.44)	2.23	.41	<0.001

Module tested - based on test number	n	Paired Differences			p-value
		Mean difference (95% Confidence Interval)	Std. Devtn.	Std. Error Mean	
Obstetric emergencies: Shoulder dystocia	38	4.56 (3.89-5.22)	1.95	.33	<0.001
Complications from abortion	36	2.77 (2.06-3.47)	1.99	.35	<0.001
Obstetric haemorrhage: Atonic uterus	32	2.69 (1.79-3.58)	2.26	.43	<0.001
Maternal resuscitation	34	4.42 (3.59-5.25)	2.33	.41	<0.001
Obstetric emergencies: Breech delivery	34	3.03 (2.22-3.84)	2.27	.40	<0.001
Total	284				

Table 30 presents mean differences of all paired samples where professional cadre was specified by modules assessed. Between 32 and 38 trainees were assessed per module, the lowest mean difference was in the complications of abortions module 2.77 CI (2.06-3.47), SD=1.99, p<0.001, while the highest mean difference was in the Obstetric emergencies (Shoulder dystocia) module 4.56 (3.89-5.22), SD=1.95, p<0.001.

Results for all medical doctors were combined because of the small numbers involved in the skills assessments **(Table 28 and Table 29).** Medical doctors and nurses/midwives showed statistically significant improvements in skills after the training. The numbers of Clinical officers involved were very small, so conclusions cannot be drawn from the results in **Table 31**.

Table 31: Skills assessment paired Samples Test analysis results by professional cadre

Cadre	N	Mean difference	Std deviation	Stand. error mean	95% confidence interval	P value
Medical doctor	19	3.02	1.90	.48	2.00-4.03	<0.001
Nurse/midwife	250	3.62	2.10	.14	3.35-3.89	<0.001
Clinical officers	4	2.50	2.86	1.43	2.05-7.05	.178
Total	**273**					

4.4. Summary of level 1 and 2 results

Proportion of maternity care providers trained and retained post-training

a. Multi-disciplinary teams of maternity care providers were trained together this was an important aspect of the intervention design.

b. The design of the intervention was based on the assumption that the training of a critical mass of maternity care providers, adequately supported by equipment and policy will result in improved evidence based care for women and their newborn. Over 70% of all identified maternity care providers from all 10 hospitals were trained.

c. Most hospitals had 76% or more of trained staff retained at the maternity wards at 3 months post training except Nakuru PGH (38.5%).

d. Additional staff (new staff or those who were on leave) were trained during the period of follow-up. By 12 months post intervention an average of 83% of all maternity care staff except for Nakuru PGH (23%) and Mbagathi GH (50%) were trained. After the last cluster was trained all new staff at PGH Nakuru were trained.

e. The distribution of trainees by professional cadre was skewed towards nurse/midwives (86%), but this represents the available workforce of skilled birth attendants in Kenya and most countries of the world.

f. Medical interns are first on call during obstetric emergency, working alongside more experienced midwives but were not prioritized for training by the hospitals because they were only on 12 week postings to the maternity ward.

Level 1: Reaction

a. About 94.5% (378) participants responded to level 1 assessment questionnaire, most of who were nurses, midwives or midwifery tutors (73.2%). 95.5% (382) and 71% (284) trainees undertook the knowledge and skills test respectively.

b. Trainees reacted positively to all lectures, overall average score was 9.38/10, the highest score was in preventing obstructed labour module (N= 376, mean score: 9.48, SD: 0.71) and the lowest mean score was in the Shock and unconscious patients module (N= 369, mean score: 9.28, SD: 0.92)

c. Reaction to breakout sessions: Specialist medical doctors had the lowest overall score (8.8) while nurse/midwives had the highest overall score (9.36).

d. Midwives found the partograph breakout session most useful (n=272, **MS=9.7**, SD=0.579) as did medical doctors (n=22, **MS=9.7**, SD=0.5) while specialist medical doctors (n=10) and clinical officers (n=6) found the venous access breakout session most useful; **MS=9.6**, SD=0.699 and **MS=9.8**, SD=0.408 respectively.

e. Overall reaction to training: A maximum score of 10 was reported by all respondents in four of the five parameters except the venue parameter (median score of 9-lowest score of 5 and highest score of 10). The most frequent score for enjoyment, usefulness and good use of time was 10 with 25 (7.8%) extreme outliers. Midwives enjoyed the training the most.

f. Of the 378 participant feedback forms returned (level 1 evaluation), 280 (74.1%) provided additional written comments at the end of the training.

g. 50% (141) and 10% (28) of all written comments were mainly on the training method and logistic/administrative issues respectively. 34% (95) of written comments were recommendations.

h. 128 (45.7%) of the 280 comments analyzed were positive and 42 (15%) comments were categorized as negative, covering training method, administrative and logistic issues.

i. Of the 280 additional comments analyzed, 218 (77.9%) were from nurse/midwives and there were only 7 (2.5%) clinical officers, 7 (2.5%) of specialist medical doctors and 19 (6.8%)

j. The interactive, multidisciplinary and hands-on nature of the training was highly appreciated by the trainees.

k. Trainees found the content of the training relevant to their practice and perceived that it will make a positive impact on patient care.

l. Logistic issues were of great concern to trainees-travel time to location of training, dissatisfaction with training venue and duration of the training.

m. Non-availability of EmONC equipment was perceived as a potential limitation to practising new skills after the training.

n. Trainees recommended that all maternity care staff should be trained regularly using the same methods and content. They also recommended the use of the teaching methods and materials in pre-service midwifery and medical training.

Level 2: Knowledge assessments

a. 375 (94%) trainees participated in the knowledge assessments. There was a statistically significant difference between the pre and post training knowledge scores in all modules except in the module; preventing obstructed labour (n=346, 373, mean difference 0.10, SE 0.08, CI 0.06-0.26)

b. 9 and 10 **specialist medical doctors** participated in the pre and post-knowledge assessments respectively, their mean pre-training score was 3.83/5 and mean post-training score was 3.93/5

c. 14 and 21 **non-specialist medical doctors** participated in the pre and post-knowledge assessments respectively, their mean pre-training score was 3.62/5 and mean post-training score was 3.91/5

d. 295 and 317 **nurses/midwives** participated in the pre and post-knowledge assessments respectively, their mean pre-training score was 3.34/5 and mean post-training score was 3.52/5

e. 4 and 7 **clinical offers** participated in the pre and post knowledge assessments respectively, their mean pre-training score was 3.34/5 and mean post-training score was 3.91/5.

f. **Non-specialist medical doctors and nurses/midwives** showed the highest mean difference between pre and post-knowledge test scores in the **obstructed labour module**. They found this module most useful as well.

g. **Specialist medical doctors and clinical officers** showed the highest mean difference between pre and post-test knowledge scores in the **obstetric emergencies and communication referral and triage modules respectively**.

Level 2: Skills assessments

a. Between 32 and 38 trainees were assessed for skills per module, the **lowest mean difference** was in the **complications of abortions module** 2.77 CI (2.06-3.47), SD=1.99,

p<0.001, while the **highest mean difference** was in the **Obstetric emergencies (Shoulder dystocia/breech) module** 4.56 (3.89-5.22), SD=1.95, p<0.001.

b. The mean difference between pre and post-test scores was statistically significant 3.5 CI (3.3-3.8) P<0.001, n=282, SD=2.1 except in the module; preventing obstructed labour (n=346, 373, mean difference 0.10, SE 0.08, CI 0.06-0.26) p<0.001

c. Both medical doctors and nurses/midwives showed statistically significant improvements in skills after the training.

Maternity care workers accepted the short competency based multidisciplinary EmONC training and showed statistically significant improvements in knowledge and skills immediately after the training compared to before.

The next chapter will present the qualitative findings at Kirkpatrick level 3, based on data collected through key informant interviews, paired interviews and focus group discussions at 3, 6 and 12 months after the intervention was implemented in each site.Chapter 5: Results

Chapter 5: Results

Level 3 (Behaviour)

This chapter presents the findings of interviews and FGDs at level 3 of the adapted Kirkpatrick evaluation framework used. Interviews and focus group discussions were conducted at all sites at 3, 6 and 12 months post training with trainees and other stakeholders. Key thematic categories based on grounded theory emerged after analysis was presented by training site and common themes across the sites.

5.1. Introduction

The intervention had multiple components: EmONC training, provision of EmONC training equipment, training of master trainers/supportive supervisors, and provision of EmONC equipment, follow-up, monitoring and evaluation. The target primary population has been described in the last 2 chapters. At the end of each follow-up visit health care facility managers were provided with information they could use to improve the quality of service delivery. This is consistent with the principles of operational research.

The level 3 data was collected as part of the evaluation framework used in order to complement and improve understanding of the results from quantitative data (presented in Chapters 4 and 6). The objectives of the level 3 evaluations using a qualitative approach were to collect data on any changes in behaviour/practice and to obtain a deep understanding of the challenges and enablers to performing evidence-based EmOC after intervention.

Qualitative data was collected from all study sites, some of the results will be site specific but common themes that emerged will be highlighted and discussed. Reference will be made to relevant sections of Chapters 4 and 6 with quantitative data that supports qualitative data presented in this Chapter.

5.1.1. Overview of data sources

153 data sources were collected over 12 months and analysed; 73.2% (112) were focus group discussions, paired interviews or in-depth interviews and 26.8% (41) were key informant interviews

(Figure 12) 49% (184) and 34.5% (129) of trained maternity health care workers participated in the FGDs/PIs/IDIs at 3 and 12 months post intervention respectively while 20 key informants (medical superintendents, hospital administrators, nursing Officer in-charge/director of nursing services, maternity/labour ward in-charge, obstetrician/gynaecologists) were interviewed at 12 months post intervention and 11 at 3 months post intervention **(Table 32)**

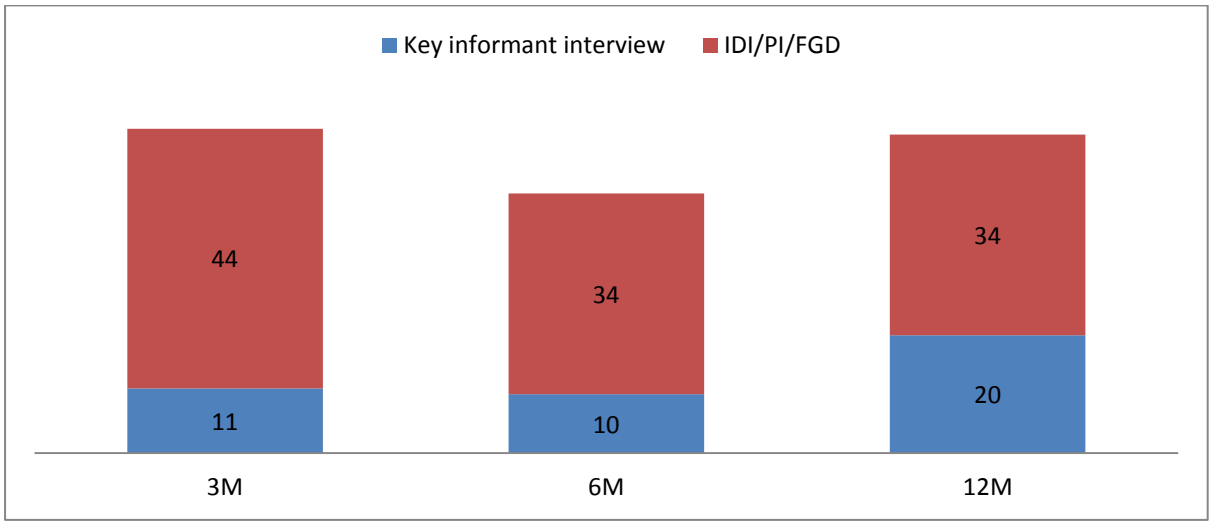


Figure 12: Number and type of qualitative data collection method used at 3, 6 and 12-month post intervention

Table 32: Number of participants by qualitative methods used.

Qualitative approach	Number of participants (% of total trained)		
	3M	6M	12M
KII	11	10	20
PI/IDI/FGD	184 (49.2%)	132 (35.3%)	129 (34.5%)

Findings

The 8 themes that emerged from the data under which all of the data were accounted for were; usefulness of the EmONC training, impact of supportive supervisors/ Master trainers, impact of provision of EmONC equipment on practice post training, impact of the training, improved organisation of care, maximizing the benefits of the intervention, barriers to provision of EmOC post intervention, enablers to performing EmOC post training, and barriers to providing EmONC post training.

Sub-themes that emerged from each main theme are also presented. Data has been preserved in its original form and presented as quotes where appropriate.

5.2. Usefulness of training

There were positive comments across all sites by various cadres of trained maternity health care workers and key informants during the period of data collection. The usefulness of the training materials and the training methodology were the 2 main sub-themes.

5.2.1. Usefulness of training materials

The use of teaching materials (mannequins, training manuals, CD-ROM, short lectures, hands-on and interactive practical sessions) was widely discussed. Each trainee was provided with a training manual, CD ROM and lecture handouts on registration. Handouts of all lectures delivered on a particular day of the training are handed out during registration on that day. Trained maternity care providers have found the materials they received during the training very useful, they have had to refer to them when confirming steps to be taken during procedures in the ward and in some instances as a quick reference before a procedure.

Trained maternity care providers reported improved confidence after training on mannequins; this is consistent with the level 1-evaluation results presented in **Chapter 4**.

> *I had no confidence in conducting breech vaginal delivery; my confidence grew after using the mannequins...* **PMH Midwife 3M**

> *When you are in a learning situation on a life patient, you may use your instincts rather than skills. The models used during the LSTM EOC training allows for increased knowledge, skills and confidence gained from practising on models...* **Nakuru PGH Medical Doctor 3M**

Trained maternity care providers described the CD ROM they received at the start of the training as 'detailed and comprehensive'. Few non-physician clinicians used the CD-ROMs frequently due to limited access to computers but the midwifery tutors and medical doctors found them most useful.

> *The CD ROM we received during the training was very detailed and we use it from time to time to refresh and update ourselves.* **PMH Medical Doctor 3M**

> *I have found the manual really useful in reminding myself of what was covered during the training, It has been difficult using the CD ROM, it did not work on my*

> *home DVD player and I do not have a personal computer.* **Mombasa PGH Midwife 12M**

In some hospitals the CD-ROMs had been copied onto the computers in the hospital library and labour ward computers, making valuable materials (lectures, guidelines and audio visual materials) readily available for use when staff are less busy, sometimes just to confirm the steps they have taken or seen taken while performing an EmONC procedure.

> *..I encountered a case of shoulder dystocia 2 weeks after the training, I successfully delivered the mother but had to refer back to my course manual to be reassured I did the right thing...* **Nyeri PGH Nurse-midwife 3M**

> *In addition to delivering of the breech I have also come across APH and the steps I took to handle it and then I went back to* ***the hand-out*** *you had given us, I was happy to see that I followed the exact steps and I was glad the patient was saved in time.* **Embu PGH Nurse-midwife 3M**

> *After I had a failed vacuum, I had to go back to my manual to find out what I did wrong, in that case I got the indication wrong. I could not watch the video because I had no computer to do so"* **Garissa PGH Midwife 6M**

Some trained maternity workers reported that it will be useful to have the EmONC training manual on the labour ward for quick reference and discussed ways of ensuring that the labour ward copy is not 'misplaced'. In some hospitals it was observed that this was already in place or that staff came with their copies to work.

> *If we had a (LSS-EOC & NC) manual in the labour ward, it will be very useful, it makes it easy to refer to a procedure that has been done. If we hand the manual over from one shift to another it should be safe"* **Neyri PGH Nurse-midwife 3M**

Two additional copies of training manuals and CD ROMs were subsequently provided to all hospitals specifically for the labour ward and hospital libraries. This will increase the availability of the training materials to medical interns, nurse/midwives and clinical officers who could not attend the training.

At 12 months post intervention trained maternity care providers still reported that they found the training materials and resources very useful.

> *"I refer back to the manual whenever I encounter a difficult case. That way I am sure I have done the right thing and it helps me prepare better for the next one".* **PMH Midwife 12 M**

5.2.2. Training methodology

Participants appreciated the content, the practical approach and the innovative teaching methods used and the duration of training received. They also thought this would contribute to CME programmes in their hospitals. Very few participants reported having attended other forms of EmONC training, notably Ministry of Health 2 -week version, which they described as being "mainly theoretical". Participants wanted future CME programmes in their hospital to include shoulder dystocia, vaginal breech delivery and vacuum extraction since these skills were not commonly used.

Maternity care workers who had attended other in-service EmONC training reported that they usually covered only a single aspect of EmONC (such as, partograph, new-born care or advanced life support) with each training course lasting 2 -5 days. Few maternity care staff (usually 1 or 2 senior staff per maternity unit) have attended the MoH 2 -week EmONC training. HCPs preferred the content and methodology used to deliver the LSS-EOC & NC training to that of the MoH EmONC training; they described it as interactive and effective. They particularly liked the '*practical sessions'*; they reported that the approach of learning made it *'easier'* for them to understand.

> *I have stayed for a long time - over 2 years without attending a seminar, I was happy to go out of town for this important training.* **Machakos L5GH Midwife 3M**

> *..(MoH) EmOC training was not as good as the LSS training (LSTM), it was too long and too theoretical. With the Liverpool course we really enjoyed the practicals, short lectures and interaction, it was enjoyable.* **Machakos L5GH Senior Labour Ward Midwife 3M**

> *...I attended one LSS Reproductive Health training long time ago, it lasted 2 weeks, we had theory sessions for most of the day then went for practicals in the labour ward...this only happened when there were suitable cases...* **Nakuru PGH Midwife 3M**

> *"I attended a 3 day in-service training in new-born care although it had a similar methodology; I felt the duration was too long for one subject. It could have been done in a shorter time like this training (LSTM LSS EOC & NC), so that we return to work...* **Embu PGH Nurse-midwife 3M**

> *The EOC training I attended was 2 weeks long (MoH) and was basically lectures and no practicals. The LSS training (LSTM) was better because it had lots of practical's"* **Mombasa PGH** Midwife **3M**

All professional cadres of maternity care providers were trained together (nurses/midwives, clinical officers, non-specialist medical doctors and obstetricians). This was viewed positively, especially by non-physician clinicians in terms of improving communication within their teams, building their confidence to provide quality EmONC and reduction of treatment delays. Medical doctors appeared to have had reservations about training with non-physician clinicians. However those who were convinced to attend found out that *"there was a lot to learn*". Prior to the training it was critical to get the buy-in of senior medical doctors (obstetricians), who could influence younger and less experienced medical doctors to attend the trainings and support midwives to improve their practice after the training.

> *The mix was good because we are now all on the same level, I did not feel anxious during the training and I think all other training should be like this."* **Mombasa PGH Midwife 3M**

> *I was skeptical attending training with midwives but I attended because I was told to do so by the consultant. However, midway into the first day I realized I have a lot to learn and this has really improved my practice. The sessions on eclampsia, shock and unconscious patients, assisted vaginal delivery and difficult caesarean sections were most useful to me. I wish sessions on fetal distress, augmentation of labour could be included in the programme"* **Embu PGH Non specialist Medical officer 6M**

> *The obstetrician has been very supportive; he supervises us (Midwives) to perform vacuum extraction and even teaches those who could not attend the training. This would not have happened if we were not trained together.* **Machakos L5GH Midwife 3M**

Training of health care workers from 2 hospitals together (within a cluster) was viewed positively by maternity care workers, they reported that it provided a good opportunity to share experiences between the hospitals.

> *I liked the practical sessions; it really makes things easier to understand. I also liked the idea of mixing us with medical doctors and midwives from other hospitals. We got to share and learn from each other's experiences* **Embu PGH Midwife 6M**

However, some maternity care providers were unsatisfied with the duration of training in the LSS-EOC & NC course: they wanted the course delivered over 5 days; this way, trainees reported, there would be sufficient time for the skills breakout sessions. They explained that there was too much to take in within such a short time. This compact training brings up a lot of challenges for midwives who are older and have not had any in-service training or updates for a very long time. However, some of the midwives thought the duration of the training (3 days) was adequate; they explained that the method of training, and materials provided, which can be used to refresh knowledge after training against the background that there are severe staff shortages, makes 3 days adequate. Additionally they reported that more HCPs could be trained in 3 days with minimal stress to the health system. Longer training, they explained, puts further stress on their colleagues who are not attending training. Those who would prefer 5-day training, however, would be prepared to return to work immediately after the training if there were staff shortages or overwhelming workload in the labour ward. Otherwise, they would prefer a 2-day rest before resuming duties after 5 days of training. Overall, extending the course length was the most called-for change, though it was recognized that this might not be feasible for practical reasons. This was also consistent with written feedback by the trainees immediately after the training (**Chapter 4**):

> *...The LSTM LSS-EOC & NC course is intensive, it should be increased to 5 days to allow for more time during the breakout sessions and more time to take in the information. We have been out of school for long now...* **Nakuru PGH Midwife 3M**
>
> *I will recommend that the LSS-EOC & NC course be increased from 3 to 5 days to allow for longer practical/demonstration sessions, an average of 40 minutes per practical session.* **Mombasa PGH** Midwife **6M**
>
> *...Due to staff shortages, the training duration should be 3 days, this is because we*

are given so many materials we can go back and refer to. Some colleagues who were on night duty the day the training ended found it hectic... **Embu PGH Midwife 3M**

...This training (LSTM LSS-EOC & NC) was the best, it was completed with a short time and I acquired a lot of knowledge during lectures and during the breakout sessions.... **Kakamega PGH Midwife 12M**

5.3. Impact of supportive supervisors (master trainers) post training

Trainees appreciated the on-the-job support they received from master trainers/supportive supervisors. Logbooks were introduced after the training as a tool to facilitate the supportive supervision process and each trained trainer/supervisor was allocated a number of trained maternity care workers to supervise/mentor (Also see **Section 3.3.2**).

5.3.1. Usefulness of support from master trainers/supportive supervisors

Trained maternity care workers reported positive benefits of the supportive supervision process, they felt supported in a non-threatening way and were comfortable with the use of logbooks emphasizing that it was a good opportunity to document their experiences for discussion with their supervisors.

My team leader (trained supervisor) is very understanding and supportive, I remember once he noticed the partograph was not properly filled, he said to me do you remember how we were taught, you should have done it like this" I did not feel intimidated, this type of approach helps to improve our confidence to provide better care for our patients Nakuru **PGH Supervisor 3M**

'I have found the supportive supervision process very useful, it allows me to carry out self-assessment, I can identify areas of weakness using the logbooks and work with the supervisor to address them' **Kisii L5GH Midwife 3M**
...The use of outcomes analysis has been great, the staff are frank when they are not confident about performing a skill... **Nakuru PGH Supervisor 3M**

I feel comfortable with the use of the logbooks and meetings with the supervisors. Although this is new to us, it allows us to reflect on our practice and identify areas where we need help and support **Nakuru PGH Midwife 12 months**

Supervision was seen as beneficial as it allowed staff to improve skills and clarify issues, ask questions and address queries. There was a great amount of enthusiasm around supportive supervision by both supervisors and trained maternity care providers. The tools and processes introduced were used to ensure that trainees were supported to change practice, and retain knowledge and skills post intervention.

Trainees also reported that supervisors usually work during the day shift and occasionally they are needed at night when difficult cases present, such situations could potentially result in intervention/treatment delays or poor quality of care.

The supportive supervisors and trained trainers reported improved techniques to supervising post intervention

> *In supportive supervision you find that when you are correcting somebody you do it in a certain way, it's not when you start shouting across, you are correcting them in a good way, and also you find that you keep, it is something continuous it's not something to do once and forget about it, it's something you are supposed to do. And very important to me is the time you can, maybe you can write somewhere and maybe you call that person later, you may not have time at that time, maybe they are doing something and you wait for them to finish and then you sit down with them and go through it.* ***PMH Trained Supervisor/TOT 3M***

> *The obstetrician has been encouraging us to use the partograph since the training, constantly reminding us of what we have learnt. I think the SS and TOT training has enhanced this...* **Mombasa PGH Midwife 6M**

5.3.2. Improved record keeping

The training on supportive supervision and training of trainers includes a component on improved record keeping. Trained staff reported improved quality of records after the training from most of the sites; this was consistent with the observations made during quantitative data collection at those sites. There has been improved 'charting' of patient observations, drugs and use of the partograph. The matron in charge and other supportive supervisors, ensuring that the correct information is recorded, is reviewing the maternity register regularly. When there is increased patient load, proper record keeping becomes a challenge because of staff shortages. The standard maternity ward

register does not have enough columns to record all obstetric complications and actions taken to manage them, so staff have had to improvise registers to collect relevant information.

> *We have assigned different members of staff to ensure the various records are properly kept"* **Garissa PGH Midwife in-charge Labour Ward and TOT/SS 3M**

Following supportive supervision training and M&E visits, study sites without MoH registers requested for and received new ones from the MoH. Additional columns have been added to improve the quality of information available from routinely used registers (such as EmOC complications).

> *I observed changes in our record keeping immediately after the training, a new register was acquired from the MOHS and everyone was encouraged to record the relevant information. This was checked by the supportive supervisors who corrected us when there were mistakes.* **Nakuru PGH Midwife 3M**

> *We used to have government registers, which lacks a lot of information on EOC & NC. We now have a dedicated register for EOC & NC complications, this would not have happened without the training we received from LSTM.* **Neyri PGH Midwife 3M**

5.4. Impact of provision of EmONC equipment on practice post training

Lack of equipment is one of the reasons for non-performance of EmONC even after training. Several items of equipment required to provide emergency obstetric and newborn care were found to be lacking at baseline, were provided to all hospitals included in this study, immediately after the training.

In one instance the equipment did not make its way to the maternity ward for use until this was picked up during data collection 3 months after the intervention. During the visit the equipment was made immediately available to trained staff for use following feedback on the findings of the visit to maternity ward managers.

Some of the hospital had faulty equipment for vacuum extraction, and others had equipment that was difficult to assemble but as part of the intervention simple user-friendly equipment was provided.

> *Patient monitoring was difficult because we had bad BP machines but we*

now have good ones to use. **Machakos L5 DGH Midwife 3M**

The MVA set we had was worn out now we have a new set from Liverpool. This makes the work easier **Machakos L5 DGH Midwife 3M**

We have been doing vacuum extraction since the training but have not seen the new equipment donated. We find the old one difficult to assemble. **Mombasa PGH Midwife 3M**

Trained maternity care workers reported that the training along with provision of this equipment has improved monitoring of treatment to women, provision of EmOC signal functions such as MVA and assisted vaginal delivery.

We have been using the vacuum extractor and the patella hammers provided to manage and monitor patients, we have not received equipment from other programmes. **Neyri PGH Midwife 3M**

The EmONC training was catalytic, resulting in the development and introduction of an eclampsia/severe pre-eclampsia treatment-monitoring tool in the course of implementing this intervention (Ameh, Ekechi & Tukur 2012). Improved treatment monitoring using the partograph and the eclampsia/severe pre-eclampsia treatment-monitoring tool was repeatedly discussed across all sites and throughout the period of follow-up. The eclampsia/severe pre-eclampsia has been reported to be simple to use by midwives and medical doctors including medical interns, also to improve the monitoring of women on treatment.

The magnesium sulphate treatment monitoring chart helps us to monitor the specific effects of toxicity, everything is on paper, and you can see the patient's progress at a glance. The chart is a lot better than what we had previously. ***Pumwani MH Midwife 3M***

One thing that has made a real difference to management of eclampsia patients is fluid restriction" we were taught 80 mls per hour and this really works!" **Mombasa PGH Midwife 3M**

The new eclampsia monitoring form is self-explanatory and the new medical interns have found it easy to use. **Garissa PGH Midwife 6M**

Our knowledge of severe PET and eclampsia management has really improved; we now know that the IM route can be used, this has made

> *treatment better and outcomes better. The eclampsia monitoring forms have also help use to do better, it reminds us of what to do, when to do it."* **Embu PGH Midwife 6M**

> *"The training has improved the management of eclampsia, Midwives can now start treatment before the doctor comes and the monitoring chart makes monitoring easier, few sheets to use, reminds use of dosages, checking reflexes and amount of IVFs to use. The patients come out better than they used to before the training"* **Kisii L5 GH Midwife 6M**

A senior midwife from a Cluster 2 hospital discussing sustained change in practice and behavior of maternity care providers 12 months after the intervention said

> *'We have found the charts produced for us on monitoring treatment of severe pre-eclampsia and eclampsia very useful. It reminds us of the correct dosages, how to make 20% solution from 50% and what observations we have to make before the next dose of Magnesium Sulphate. We are happy with the outcomes of the patients and their babies'*

Trainees reported on the benefits of the electronic fetal heart monitor (Sonicaid) equipment supplied after the training. Both midwives and medical doctors have used this equipment to make diagnosis quicker and allow them to commence treatment earlier than they did before the training. In cases when fetal viability is in question, the standard approach would have been to send the patient for ultrasounds scan usually outside the labour ward or outside the hospital. The patient usually had to pay for ultrasound scan service and had to wait her turn, which created significant delays in commencing treatment. Midwives found the handheld fetal monitoring equipment (Sonicaid) easy to use and reported that they improved patient satisfaction. The trainees have taken additional cost effective steps to maintain the handheld fetal monitoring equipment by procuring rechargeable batteries to use with them.

> *Prior to the training and supply of the hand-held fetal monitoring device, when we were unsure of the fetal heart, patients had to be sent out of the hospital for an ultrasound scan, this costs money and results in lots of delay in proceeding with treatment, waiting for an ultrasound scan can take up to 2 weeks! All this has been cut short by the use of these device"* **Embu PGH Midwife 6M**

We have found the electronic fetal heart monitor very useful; patients who we need to use this one do not have to be taken for ultrasound anymore. This is free, results are instant, delays are avoided and decisions taken promptly'.
Kisii L5 DGH Midwife 6M

The electronic fetal heart monitor provided has really helped us and our patients a lot, they are easy to use, the patient is immediately reassured, it saves her time and money going to an ultrasound, it helps reassures us all is well and if not we can take action quickly. This has made a lot of differences'
Machakos L5 DGH Midwife 6M

Before the training and supply of the fetal heart monitors, if we were unsure of the fetal heart the patient had to travel to Kenyatta National hospital, pay KES2500 and wait for an ultrasound scan. This was expensive and delayed decision-making and treatment. Now a midwife or doctor can use the Sonicaid quickly and at no extra cost. We have procured rechargeable batteries to use on the machines, further reducing the cost of maintaining them ***Mbagathi GH Midwife 12M***

5.5. Impact of training

In **Chapter 4,** trained maternity care workers were seen to have improved knowledge and skills immediately after the training. The qualitative aspect of this research explores the impact of the training on knowledge and skills months afterwards the training. New skills were learnt during the training and this persisted up to 12 months after. Maternity care providers also discussed improved confidence into providing EmONC and communications within their teams and with women they care for.

5.5.1. Impact on pre-service midwifery education

26 midwifery tutors/educators were trained from nursing/midwifery schools affiliated with each training site. Since the primary objective of the intervention was in-service training, only a few tutors from each Kenya Medical Training College (KMTC) or midwifery school were invited to participate, this was part of an agreement that allowed the in-service trainings to be delivered within the KMTC facilities at no cost. Also EmONC training equipment left behind at each site (sometimes within the affiliated KMTC/midwifery school) was accessible to the trained tutors. The training provided an opportunity for midwifery educators to update their knowledge in teaching techniques and EmONC.

> Most *of the midwifery tutors have not had updates for a long time, and do not have access to the type of materials we received during the LSS-EOC & NC training. We have been able to share with them as they come to the wards with their students or as they join us for CME activities in the hospital. They have found this very useful.* **KMTC Nyeri Midwifery Tutor, 3M**

> *There is a lot of information of the CD ROM given to us during the training, I use it to prepare for lectures to midwifery students and gather facts for management meetings.* **Pumwani Maternity School, Midwifery tutor 12M**

> *I feel the training has been of so much help, to the training school were we have to produce so many nurses/midwives, they now go to that clinical area confidently and if they get a breech delivery they will be assisted by the midwives on the ground because they have also been trained.* **Mombasa KMTC Midwifery Tutor 6M**

> *"We have found the use of manikins and models very useful in teaching our students, it helps improve their confidence before they get to the labour ward"* **Pumwani Maternity School, Midwifery Tutor 12M**

Trained midwives and midwifery educators responsible for teaching nurses/midwives and/or clinical officers in the classroom/clinical areas discussed the benefits of the training. Teaching at these schools was reported to have become more interactive, a variety of teaching methods are used to improve the learning experience of the students (workshops, scenarios and hands-on practical teaching) and students can practice using manikins to achieve a good level of confidence before going to the wards. Midwifery tutors reported that the improved method of teaching reduces the risk of substandard care or what they referred to as 'mistakes' with patient care that were commonplace prior to the use of these improved techniques.

> *Our teaching sessions are more interactive. The student is able to make their mistake, corrected in the class before they go to the wards, in the past mistakes can be made on several patients before they understand the skill* **KMTC Nakuru Midwifery Tutor, 3M**
>
> *And by the end of the day the student will go to work and have a lot of confidence that they are able to manage a patient with PPH because it has been instilled in them from working with trained tutors and midwives.* **KMTC Embu Midwifery tutor 6M**

On the wards midwives who have been trained are able to carry out quality supervision of students. Trained midwifery tutors reported sharing the materials/resources provided as part of the training (such as training video, manuals, guidelines and lectures) with their colleagues who were unable to attend the EmONC training sessions.

> *Our method of teaching the partograph has improved greatly; we have borrowed heavily from the LSTM EmONC course. They (our students) are able to detect any patient having obstructed labour on time, because they have a qualified midwife and a trained one on the ground, who is also giving them a lot of support, so I feel my colleagues were also happy to hear that they have also been involved in the training,.."* **KMTC Kakamega, Midwifery tutor 3M**

> *Having been trained as a TOT I also appreciate my colleagues at the clinical area (...), even students appreciate the improved support they are receiving since the training, from the people who are already trained.* **KMTC Garissa Midwifery Tutor 6M**

5.5.2. Improved knowledge and skills

No single module from the training was seen as most useful, instead maternity care providers commented on different aspects of the training, often listing several components of the intervention and their impact several months later. The top 5 most discussed topics were: 1) vacuum extraction, 2) partograph use, 3) (pre-) eclampsia, 4) breech delivery, and 5) newborn resuscitation.

Some of the EmONC procedures were previously perceived to be procedures to be performed by medical doctors only (AVD, MVA, and manual removal of placenta and prescription/administration of Magnesium Sulphate), although none of the staff could cite any supporting documentation. However, since the training, midwives reported increased knowledge, skills and confidence to successfully perform these skills with good outcomes.

1) Vacuum extraction

Trained maternity care providers also reported that the improved capacity to perform assisted vaginal delivery by vacuum extraction has helped to reduce treatment delays and increase the management options for women. Midwives from the north eastern region of Kenya reported that, given the high resistance to caesarean sections in that region, vacuum extractions when indicated

was becoming a popular and acceptable option for delivery. Performing vacuum extraction has not been without difficulties for midwives; they discussed reviewing the indicators and procedure when it failed and how prompt decisions for caesarean section was taken with good outcomes on several occasions.

> *Before the LSS training only medical doctors-gynaecologist could perform vacuum extraction, but I have successfully performed one since the training Labour ward.* **Machakos L5DGH Midwife 3M**

> *Vacuum extraction was a doctor's procedure before the training but since the LSS course Midwives have been doing it successfully.* **Mombasa PGH Midwife 3M**

> *The vacuum extraction training and equipment provided has helped us give women other options to caesarean section because in this part of the country there is a strong opposition to caesarean section because it is associated with death*. **Garissa PGH Midwife 3M**

> *Before the training, I would not think of attempting a vacuum extraction as a Midwife, since the training I have successfully done 3 and vacuum extraction is mostly done by Midwives now.* **Garissa PGH Midwife 6M**

> *Before the training most patients who should have had vacuum delivery were taken for CS but since the training we midwives had done more vacuum extractions, even more than the doctors. I can recall only one failed recently but the indication was incorrect. She had a CS and the baby did well.* **Embu PGH Midwife 6M**

2) Partograph use

The lecture covering the use of the partograph (preventing obstructed labour) and the related practical session was found to be the most useful sessions especially by nurse/midwives (n=272, **MS=9.7**, SD=0.579) and non-specialist medical doctors (n=22, **MS=9.7**, SD=0.5)-**(Chapter 4 Sections A1 and A2).** Trained midwives reported that partographs were not correctly used prior to the training but this had improved significantly following the training. They emphasized 2 components of good partograph use that has improved; these are proper charting and interpretation resulting in timely and evidence-based actions. The adapted WHO composite partograph provided by the MoH had decent of the fetal head on the right vertical axis, this resulted in some confusion amongst trainees learning to use the WHO modified partograph. With support from master

trainers/supportive supervisors trained maternity care workers became increasingly confident using the WHO modified partograph

> *Before the training partographs were not completely filled in, this has change since the training because we know how to fill it in correctly and interpret. Some people however find charting of the descent confusing; this may be because of the difference in the old Kenyan partograph and the modified WHO partograph.* **Machakos L5DGH Midwife 3M**

> *Before the training we did not know how to use the partograph, now we can use it better, interpret and take appropriate measure.* **Nyeri PGH Midwife 3M**

> *Since the training (6months ago) we now enjoy using the partograph for monitoring patients in labour...* **PMH Midwife 6M**

> *Before the training most patients did not have a partograph opened and even if they had one they were not completely filled in most of the time. Since the training every patient is 'partographed' completely unless she comes in the second stage***...Kisii L5GH 6M**

> *...Since the training partographs are now complete and Midwives know when to intervene...we even received congratulations from the departmental head for improved monitoring of patients in labour following the training.* **Mombasa PGH Midwife 6M**

3) Manual removal of placenta, manual vacuum aspiration and eclampsia treatment

Performing manual removal of placenta (MRP), manual vacuum aspiration (MVA) and commencing of magnesium sulphate are 3 other EmONC procedures usually only carried out by medical doctors only in Kenya. With improved knowledge and skills from the training, midwives have been able to remind doctors (who did not attend the training or could not recall) of the correct doses for magnesium sulphate and also commence treatment earlier in the absence of medical doctors. Midwives also reported improved confidence in performing MRP and MVA after the training.

> *I had a patient with Eclampsia; I reminded the doctor of the correct dosage of magnesium sulphate...the Doctor had not been on the LSS-EOC & NC training...* **Neyri PGH Midwife 6M**

The training has improved the management of eclampsia, Midwives can now start treatment before the doctor comes and the monitoring chart makes monitoring easier, few sheets to use, reminds us of dosages, checking reflexes and amount of IVFs to use. The patients come out better than they used to before the training. **Garissa PGH Midwife 6M**

Manual removal of placenta used to be a doctors procedure but I have been able to perform it since the training. The training improved my knowledge and confidence to carry out this procedure. **Mombasa PGH Midwife 3M**

...Before the training we (midwives) could not attempt manual removal of placenta, we would have to wait for the doctor to come. Since the training we resuscitate the patient, remove the placenta before the doctor arrives. Garissa **PGH Midwife 3M**

I work in the Gynaecology Ward and before the training I had only assisted the clinical officer or medical officer during MVA, since the training I have been confident to perform the procedure...and I have done several successfully. **Machakos L5DGH Midwife 3M**

4) Breech vaginal delivery

Trained maternity care workers discussed their fear of conducting vaginal breech deliveries prior to the training, they disclosed that those that were performed usually had poor outcomes and in some hospitals almost all breech presentations had caesarean sections. The training has brought about new knowledge, skills and confidence to successfully conduct breech delivery vaginally. The results in **Chapter 6** also show a significant increase in the number of vaginal breech deliveries performed in most study sites.

We can now successfully perform vaginal breech delivery, before the training most breech presentations had caesarean section and there were few properly performed vaginal deliveries with good outcomes. Since the training we know all the manoeuvres and have used them successfully and we are happy with the outcome. **Nyeri PGH Midwife 3M**

Before the training, people (HCP) feared breech presentation; they were all sectioned (Caesarean section). Now we can confidently deliver breech-presenting babies successfully with good outcomes. I had one last night

which I delivered vaginally, and resuscitated the baby successfully, it did not require NBU care. This will not have been possible before the training. **Nakuru PGH Midwife 3M**

5) Newborn resuscitation and maternal resuscitation

Birth asphyxia is one of the top 3 causes of newborn deaths; effective monitoring of pregnancy and labour, and prompt newborn resuscitation are likely to reduce newborn mortality. Health care providers were taught how to perform effective newborn resuscitation in addition to monitoring labour with the use of the partograph. Midwives improved knowledge and have practiced effective newborn resuscitation within the labour ward and maternity operation theatre with good outcomes. Overall there was a 48% reduction in the number of babies admitted to newborn unit for birth asphyxia **(Chapter 6).**

The newborn resuscitation I think has contributed to reduced admissions in labour NBU (Newborn Unit). The correct stepwise approach is used successfully now and our worn out newborn ambu bag has been replaced by Liverpool after the training. **Kisii L5 GH Midwife 3M**

Prior to the training we routinely took newborns to the newborn unit for resuscitation, now resuscitation is performed in the labour ward and we are pleased with the outcome. **Embu PGH Midwife 3M**

The newborn resuscitation I think has contributed to reduced admissions in labour NBU. The correct stepwise approach is used successfully now but our ambu bag in NBU is worn-out. NBU **Mombasa PGH Midwife 3M**

Since the training we no longer rush babies to NBU, we resuscitate and settle them here, we now only admit the bad ones to NBU. **Machakos L5DGH Midwife 3M**

Since the training, I can now resuscitate babies correctly; I cannot recall admitting any newborn during my shift to NBU due to asphyxia or persistently low APGAR scores. **Nakuru PGH Midwife 3M**

I work in the maternity theatre and I learnt the correct skills to resuscitate the

newborn, we have used this since the training and appreciate the good outcomes of the babies. **Machakos L5 GH Clinical Officer Anesthetist 3M**

...New-born resuscitation has really improved since the training, we now have less babies admitted for birth asphyxia in the new-born unit" Garissa **PGH Midwife 6M**

"I used to be scared to resuscitate flat babies but since the training I can do this with confidence using improved techniques and we have seen better responses from the babies. **Kakamega Midwife 6M**

There has been a lot of difference since the LSS training; I now resuscitate babies successfully with poor APGAR score and with a lot of confidence. **Nyeri PGH Midwife 6M**

*I have observed that most of us (midwives) know how to resuscitate babies correctly and only the serious cases are admitted to new born unit...***Kisii L5GH Midwife 12M**

Midwives described how new knowledge and skills learnt were used to perform more effective maternal resuscitation, using a structured approach with good outcomes. With the new knowledge and skills midwives reported that they could commence treatment before medical doctors arrive, thus improving outcomes.

We have acquired new skills and knowledge with the LSS-EOC training, we had a patient who came in with ante partum haemorrhage, we resuscitated the patient using ABC approach and she survived in the past we had to wait for the doctor and we always have bad outcomes...this patient survived. **PMH Midwife 3M**

PPH cases are common and I have used the ABC approach I learnt during the training to stabilize the patient before the doctor arrives and the outcomes have been good. **Mbagathi GH Midwife 3M**

Before the training, we were not structured in our approach to unconscious women; we just go straight to resuscitation. Now we use the ABC approach and the results are good. **Mombasa PGH Midwife 3M**

We managed a case of ante partum haemorrhage with one of our doctors, the baby was already dead, and we stabilized the patient and achieved vaginal delivery with a good outcome for the mother. In the past we would have taken her for caesarean section. I was so happy because what we did in this case would have

not been possible without this training. Mbagathi GH **Medical Officer 3M**

6) Episiotomy /perineal repair

The midwives also shared their experience with regard to using an improved technique to repair episiotomies and minor perineal tears associated with delivery. They reported that the new technique required less suture material, was faster to perform and that very few women come back with complications.

> *I have been using the techniques for episiotomy repair we learnt from the LSS course, it is faster to perform, uses less suture material, restores the perineal anatomy and we have less breakdowns.* **Mombasa PGH Midwife 3M**

> *Since the training I have enjoyed repairing episiotomies, it is quicker to perform using the technique we were taught and it is less painful for the women. We no longer have them coming back with breakdowns.* **Garissa PGH Midwife 3M**

> *Since the training I received in LSS-EOC & NC, I know enjoy repairing perineal repairs and lacerations. The technique taught is better than what we use to do and the outcome is better.* **Kakamega PGH Midwife 6M**

7) Shoulder dystocia

Medical doctors and midwives trained discussed how they have used improved knowledge and skills to recognize and successfully manage shoulder dystocia. One of the medical doctors recounted his experience within 3 months of the training, comparing it to one prior to the training. Trained staff was satisfied with their ability to manage shoulder dystocia successfully.

> *I have managed 2 cases of shoulder dystocia, one before the training one and the other after. The first one I was not called early also I could not manoeuvre successfully and the outcome was poor. The one after the training help was sort on time, we worked as a team with the midwives, applied the manoeuvres we were taught during the LSS-EOC training, the outcome was good and we successfully resuscitated the baby.* **Mbagathi GH Medical Doctor 3M**

> *The training we received has made a lot of difference for example shoulder dystocia was a problem however since the training we are recognising and managing shoulder dystocia with good outcomes"* **Kakamega PGH Midwife 3M**

8) Surgical skills

11 obstetricians were trained from all the study sites; they played an active role in bringing about change in behaviour and practice after the training. Also they themselves learnt new lifesaving skills. One obstetrician at 12 months post intervention (Cluster 2) reported with excitement his use of the B-Lynch suturing technique successfully. The B-Lynch posters were part of the facility improvement equipment and resources supplied to hospitals after the training.

> *"A junior doctor performing a C/S called me a few weeks ago, he had problems with controlling the haemorrhage. I used the B-lynch suturing technique I learned from the LSS EOC training for the first time with the aid of the poster provided which hangs on the theatre wall. It was successful!"*

9) Maternity care provider skills at 12 months post-training

Overall following the intervention there has been improved capacity of both medical doctors and midwives to manage obstetric and newborn complications. The findings at 3 and 6 months were similar to those at 12 months post intervention.

Skills persisting 12 months after the intervention; an example of effective and timely resuscitation led by midwives, with a successful outcome was reported by one key informant from Cluster 2, and an obstetrician trained reported in a 12 month post training interview that;

> *"I recently participated in the resuscitation of a critically ill pregnant woman. The midwives led the resuscitation and I was impressed at their stepwise approach, calmness and confidence. The patient was successfully resuscitated and referred to Kenyatta, we followed up and she made a good recovery"*

This observation was consistent with the reports from midwives from all clusters

> *The technique used for newborn resuscitation has improved remarkably, we no longer panic on seeing a flat baby, we resuscitate them fully without assistance from the NBU, use the stepwise approach we were taught during the LSS training.* **Mbagathi GH Midwife 12M**

Midwives have the confidence of conducting breech vaginal delivery and we use this opportunity to teach midwifery and medical students. **PMH Midwife 12M**

Since we started using the new protocol from the LST EmONC training to treat patients with eclampsia, administering the correct doses of Magnesium Sulphate, our patients do not have recurrent convulsions anymore and their outcome has improved. **PMH Midwife 12M**

Mothers used to have caesarean section and macerated stillbirth would be found because the midwife could not pick the fetal heart but since we received the hand held electronic fetal heart monitor from MIH we can monitor the fetal heart rate better, helping us to avoid unnecessary interventions. **PMH Midwife 12M**

Management of patients in shock has improved significantly and the outcome is good...women brought on a stretcher, now walk out of labour ward. We now know the correct type of intravenous fluids to use and the correct steps to take. **Kisii L5GH 12M**

5.5.3. Improved confidence to perform EmOC

Generally health care providers reported feeling more **confident** performing EmOC procedures. Prior to the training midwives discussed their fear prior to the EmONC training with respect to performing EmONC procedure due to lack of knowledge, and skills, and fear of complications. The training has resulted in increased confidence to perform these skills; this is complemented by the support from medical doctors, trained master trainers/supportive supervisors and the availability of equipment to perform some of these skills. Trained midwives had observed improved health outcomes, which they attributed to the training. These observations at 3 and 6 months post intervention were similar to those at 12 months post intervention.

I was afraid of performing breech vaginal delivery because I thought the head will get stuck or other complications could arise and I will be blamed. Before the training, most breech presentations were sectioned. Since the LSS training, I have confidence to maneuver the breech successfully. I have delivered several since the training with very good APGAR scores... **Embu PGH Midwife 3M**

I used to fear giving magnesium sulphate, to fear the side effects, we thought they were bad, and maybe they can kill the patient, but I think now we are doing it, and we have been having a really good outcome using the magnesium sulphate. **Neyri PGH Nurse 3M**

Before the training I was afraid of the side effects of magnesium sulphate and was unsure of the correct dosage, since the training I can now administer the right doses and monitor the patient's urine output, patella reflexes and breathing. **Mbagathi GH Midwife 6M**

"We are now confident to initiate Intravenous antibiotics and do vacuum extraction before the doctor prescribes it" **Machakos GH Midwife 6M**

5.5.4. Improved capacity of non-physician clinicians to perform emergency obstetric Care

Procedures such as breech vaginal delivery, prescription of magnesium sulphate, vacuum extraction and manual removal of placenta were only performed by medical doctors, and some of the procedures (breech and vacuum extraction) were only performed by consultant obstetricians only in some of the hospitals prior to the intervention.

In hospitals where assisted vaginal delivery and breech delivery were performed at baseline, the number of cases performed and the success rates improved after the training.

We were unsuccessful in assisted vaginal delivery in the past because of wrong cup application, since the training our technique has improved; the procedure is more successful and no longer messy. Generally vacuum extraction is still doctor's work but midwives can perform it if the consultant approves. **PMH Midwife 3M**

Mothers used to have caesarean section and macerated stillbirth would be found because the midwife could not pick the fetal heart but since we received the hand held electronic fetal heart monitor from MIH we can monitor the fetal heart rate better, helping us to avoid unnecessary interventions. **Kakamega PGH Midwife 6M**

We are delivering a lot of women with breech presentation successfully and this may be contributing to reduced caesarean section rates. **Neyri PGH Midwife 6M**

The chart for eclampsia management is being used actively and is user friendly. It captures FHR and level of consciousness. **Garissa PGH Midwife 6M**

Since we started using the new protocol from the LSS training to treat patients with eclampsia, administering the correct doses of magnesium sulphate, our patients do not have recurrent convulsions anymore and their outcome has improved. **PMH Midwife 12M**

The midwives have been able to carry out assisted vaginal deliveries using the vacuum extractor with very good outcomes. This has prevented unnecessary C/S and long delays with the risk of further complications. **PMH Medical Officer 3M**

We midwives are now doing the vacuum with confidence and successfully, the last 6 vacuum extractions were carried out by midwives successfully while the doctor was busy in the operation theatre'.... **Kisii L5GH 6M**

*...We do not wait for the doctors to come, if there is an indication for assisted vaginal delivery. The TOTs/SS have trained and supervised the medical officer to use the vacuum extractor with good outcomes...***Kakamega PGH Midwife Supervisor 12M**

*"We (midwives) can now confidently deliver breech babies, before the training we have to wait for the doctor and the women will go for a C/S. Now we confidently go ahead and deliver successfully before the doctor arrives"...***Kakamega PGH Midwife 12M**

Non-physician clinicians such as nurses/midwives and clinical officers learnt new skills during the training, they reported using these skills at 3 and 6 months and it can be concluded based on qualitative data at 12 months and quantitative data at 3, 6 and 12 months (**reported in Chapter 6**), that the newly acquired skills persisted at 12 months after the intervention. Several vivid accounts of change in practice and improved capacity to confidently and successfully perform EmOC signal such as assisted vaginal delivery with a vacuum extractor are as follows.

My experience after the training has been very interesting, and I have seen

> *a drastic change in patient management, especially the management of obstructed labour. Before the training, I had not seen a successful vacuum extraction, but now the babies are doing well and the number of caesarean sections in second stage has reduced. When you go to the management or pre-eclampsia and eclampsia patients, the management and monitoring of patients have improved, we use the correct dose of magnesium sulphate now; our patients are no longer fitting. We also now have calcium gluconate in the ward and know when to use it.* **PMH Midwife 3M**

> *Before the training, I would not think of attempting a vacuum extraction as a Midwife, since the training I have successfully done 3 and midwives mostly do vacuum extraction now.* **Garissa PGH Midwife 6M**

5.5.5. Improved communication and teamwork

Improved relationships within the multi-disciplinary teams recognised not only through improved communication for example between medical doctors and non-physician clinicians, but also through improved recognition of the skills of non-physician clinicians, giving a strong perception of empowerment and autonomy. Midwives also reported that they could commence treatment they were trained to administer but had the responsibility to keep the doctors informed in case they required help. Improved knowledge and skills, especially using a structured evidenced based approach to caring for pregnant women and new-born, contributed to the new found confidence while enabling them to provide better quality of care.

> *The training has made doctors trust the judgment (decision) of midwives in the management of obstetric emergencies.* **Embu PGH Midwife 6M**

> *We do the procedures but inform the doctor that we are doing it so that in case of anything we say we informed the doctor you are doing the procedure so you are covered. (...) We are not supposed to attend it alone you have to call for help if there is a complication.* **Embu** PGH **Nurse-midwife 3M**

Midwives reported having good discussions with doctors about the patient care and take collective decisions with them on patient management. Those who attended the training from each site (usually 7 or more out of 10 maternity care providers) were able to share their knowledge, skills and training materials with colleagues who did not.

The doctors are comfortable that we can perform procedures without waiting for their arrival. For example we now initiate magnesium sulphate treatment. **Garissa PGH Midwife 3M**

Because we attended the training with the doctors, we can now sit down and talk! We are able to complement each other's knowledge, skills and ideas generally to the benefit of our patients. **Machakos L5GH Midwife 3M**

Due to the LSS EOC training we received we can identify complications promptly, we can discuss with the doctors how best the patient can be managed. **Kisii L5GH Midwife 6M**

Since the training there has been an improved working relationship with doctors, which improves our care to the patients. We teach new medical interns and clinical officer interns, they are happy with this and it is not a problem...they want to learn from us and thanks to the training we have new knowledge and information to share. **Garissa PGH Midwife 6M**

The training has empowered me to speak without fear of not knowing, now we can work without always waiting for the consultant...the impact has been positive and patient care has improved... **Nyeri PGH Midwife 6M**

The ease in communication between midwives and medical doctors seems to have been largely facilitated by the multidisciplinary approach to training, resulting in improved teamwork, on the job support and improved quality of discussions aimed at improving patient care.

Yeah now we can discuss more freely because we understand the problem, we went through the training together so challenging one another when it comes to live situations. It has become much easier. **Embu PGH Nurse-midwife 3M**

We have observed improved teamwork and coordination since the training, in the past we could not attend to some emergencies because we lacked the skills and confidence. We also did not have the support of

> *our doctors but this has all changed due to combined training of doctors and midwives* **PGH Nyeri Midwife 3M**

> *I have observed improved supervision, training and on the job support, our ward rounds are richer in terms of depth of discussions.* **Machakos L5GH Obstetrician 3M**

Based on observations of improved teamwork and its benefits for quality of patient care has, midwives recommended that the approach of training of medical doctors and midwives should be sustained. Another benefit of up-skilling non-physician clinicians was that patients can receive care promptly and the workload of medical doctors can be reduced.

> *Because we (midwives) can now perform a lot of LSS-EOC & NC skills doctors have a reduced workload and they are pleased with us, appreciating our work better. Teamwork has improved because of that training. Midwives, doctors (interns, medical officers and consultants) should continuously be trained with midwives to sustain this relationship.* **Nakuru PGH Midwife 3M**

The reported improved communications between medical doctors and non-physician clinicians and up-skilling has not been without some level of dissatisfaction from the non-doctors. For example while the medical doctors have accepted the use of the partograph (in fact the session on obstructed labour including the use of the partograph was very popular amongst medical doctors), they will not complete them due to the perception that this is a nursing role

> *...Since the training we have started using the modified WHO partograph and the hospital has printed copies for us. We use the partographs to collectively make decisions but the doctors are reluctant to fill them in, they think it is a midwifery duty.* **Garissa PGH Midwife 6M**

Improved communication with patients

The training had an entire module on communication referral and triage, this focused on improving communication within teams managing obstetric and newborn emergencies as well as communication with women they care for and their families/relatives. It is likely that the improved

quality of care and communication observed at the study sites contributed to the number of women seeking delivery at these hospitals.

> *We have improved on our communication skills since the training, this way we have gain the confidence of patients and their relatives.* **Kisii L5DGH Midwife 3M**

> *"Patients have noticed that good things are happening at PGH Embu and we are receiving more patients than before the training"* **Embu PGH Midwife 12M**

5.5.6. Change in attitude and behaviour post intervention

The training was associated with change in attitude, behaviour and practice. Midwives/nurses and clinical officers reflected on the reasons for this, they reported that this was strongly associated with improved confidence and support from medical doctors.

> *Before used to panic if we had a mum with PPH, after training we manage PPH properly with colleagues.* **Kisii L5GH Nurse 3M**

> *We (midwives) are more confident in performing manual removal of placenta and active management of 3rd stage of labour (managing and preventing post-partum haemorrhage)... there is now less need to call the doctors.* **Mbagathi GH Midwife 6M**

> *Before the training whenever I encountered a breech presentation, I panicked, but since the training I am now confident because I know all the manoeuvres to use in delivering the baby...* **PMH Midwife 6M**

5.6. Improved organisation of care

Updating practice and procedures was the key change in the organisation of care. This was particularly the case regarding drug administration and improved patient monitoring practices. Additionally, new equipment (Sonicaids, ambu bags) received following the training was seen as helpful in improving the delivery of EmOC services at the facilities.

5.6.1. Improved treatment response time

Most of the skilled health care workers available round the clock in maternity/labour wards are midwives, medical doctors (longer duration of training) are fewer in number and not readily available. When midwives have the necessary skills and knowledge, and are empowered they can reduce treatment delays, improving health outcomes. After the training within all the study sites midwives consistently reported improved knowledge, skills and confidence and ability to commence treatment prior to arrival of medical doctors. They also reported the positive impact on the quality of patient care and improved job satisfaction it gives them.

> *Before the training we could wait for the doctor to come but after training we do the procedure before the doctors come and this is because the doctors know what we were taught and were also part of the training.* **Midwife L5DGH Machakos 3M**

> *We used to wait for the doctors before commencing resuscitation but now the midwife takes the lead pending the arrival of the doctor; this has improved the outcomes of patients.* **Mombasa PGH Midwife 3M**

> *Before the training we had to wait for the doctor to come before we start any treatment but now we started treatment using the structured approach...this has improved the outcome of our patients and gives us satisfaction...* **Nyeri PGH Midwife 6M**

> *We have acquired new skills and knowledge with the LSS-EOC training, we had a patient who came in with APH, we resuscitated the patient using the ABC approach and she survived in the past we had to wait for the doctor and we always had bad outcomes...this patient survived.* **PMH Midwife 12M**

5.6.2. Organization of resources for care

The intervention served as a catalytic process, improving the responsiveness of the management of health care facilities to the need for provision of essential equipment required for EmONC. At 3 months post training, the Garissa province general hospital management provided elbow-length gloves, printed modified WHO partographs and severe pre-eclampsia/eclampsia treatment charts;

similarly, staff at Kakamega PGH, Mbagathi DGH and Pumwani PGH advocated for and got their hospital management to print modified WHO partographs.

At Pumwani Maternity Hospital, immediately after the training staff requested that calcium gluconate be provided as part of the emergency tray. Calcium gluconate is an antidote for magnesium sulphate that is used in the treatment of severe-pre-eclampsia/eclampsia. The provision of the drug incurred no cost to the hospital as it was available at the hospital pharmacy but had never been requested by maternity care providers and therefore not supplied to, the labour ward.

> *Since the training we have started using the modified WHO partograph and the hospital has printed copies for us. We use the partographs to collectively make decisions but the doctors are reluctant to fill them in, they think it is a midwifery duty.* **Garissa PGH Midwife 6M**

5.7. Maximizing the benefits of the intervention

Although most midwives reported that the medical officer-interns had benefited from the training indirectly, they advised that a greater impact would be achieved if all MO-interns were trained in EmONC prior to their rotation in obstetrics. Another related recommendation was that the medical intern rotation should overlap, so that the outgoing, more experienced interns can teach the incoming interns before they move on to their next rotation.

> *Medical officer-interns should be well oriented prior to OBGYN rotation because they do not know how to manage most cases and are afraid to consult their seniors*. **Mombasa PGH Senior Midwife Labour Ward 3M**

> *We had a case of haemorrhagic shock and I could not do the cut down, the doctor called could not either because he was not at the training, we had to look for an anaesthetist, this resulted in a lot of delay. If only the doctor had been trained, the management and outcome would have been better.* **Nakuru PGH Midwife 3M**

Staff rotation/retention policies and late arrival of patients who are not properly triaged or resuscitated contribute to poor health outcomes. If every maternity care staff member is trained and staff are retained in sufficient numbers in the maternity ward, there are likely to be sustained improvements in maternal and newborn health.

Quantitative data from Nakuru PGH, where all maternity staff were trained, showed that at 3 months after the intervention only 39% (10) of maternity staff trained were retained in the maternity ward; this further went down to 23% (6) at 12 months post training (Chapter 4) and it was also observed that there was no improvement in DOCFR or SBR at 12 months compared to baseline **(Chapter 6).** Both outcome indicators had improved in the other hospital in that cluster – Mbagathi Maternity Hospital (80% of maternity staff trained at baseline and 50% retained at 12 months post intervention).

Trained maternity care workers recognized the negative impact of the current staff rotation polices and the impact of not training maternity care providers from lower-level health care facilities.

> *Our mortality so far this year is disturbing; we received bad cases particularly from 2 health centers. Perhaps we need to use our TOTs to train them in LSS-EOC & NC to improve the outcomes*. **PMH Medical Doctor 6M**

> *It will help if all staff coming to the unit (labour ward) can be trained in LSS-EOC before they start work, this will help them to work well.* **Machakos L5 DGH Midwife 12M**

During the course of data collection, I observed that trained trainers from Clusters 2, 3, 4 and 5 had mapped out the health care facilities where poorly resuscitated or managed obstetric and newborn cases were referred from. They went ahead, with the support of their hospital management teams, using resources provided during the training (training manikins, lectures, manuals) to organize EmONC training at those health care facilities. They reported that the impact of this has been that referred patients arrived earlier and were better resuscitated.

> *Patients referred from other out stations are now more stable than they used to be, I mean from district hospitals where MIH has trained maternity staff.* **Garissa PGH Senior Midwife 6M**

5.8. Barriers to provision of care

Staff shortages and staff retention policies

In addition to staff shortages, staff turnover was recognized as a problem – with midwives/nurses on regular rotation, those trained were not able to practise or pass their knowledge on to new colleagues. Much time was spent discussing administrative and policy barriers (national and/or

hospital level) for new skills implementation, especially whether nurses and midwives were allowed to, and whether they did, perform certain procedures, whereas relatively few respondents talked about not being able to perform 'doctors' procedures' (especially vacuum extraction, assisted vaginal delivery, venous cut down). Although midwives generally had improved skills following the training, they were less confident performing 'doctors' procedures.

> *Monitoring of patients since the training 6 months ago has improved, especially eclampsia and severe PI-pre-eclampsia patients; monitoring of patients in labour still remains difficult due to staff shortages and lack of essential equipment such as BP machines and fetal heart monitors.* **Nyeri PGH Midwife 6M**

> *Training the majority of the staff was good, when there is a changeover they should consider transferring only half of the trained staff so that those remaining can mentor the new ones.* **Nakuru PGH Midwife 6M**

Scope of professional practice and policy

Some midwives were not sure that the hospital would support them performing vacuum extraction; others thought the problem was with the senior doctors not taking the lead and others had doubts whether they were permitted to do this by the Kenyan Midwifery Council. There was, however, a consensus across all sites that there were no policies restricting midwives from carrying out these procedures and that they were within the nursing/midwifery scope of practice. Nurses/midwives felt they had enough knowledge and could carry out the procedures with the support of the doctors and the hospital administration. In emphasizing the importance of support from doctors to facilitate performing new skills they identified the multidisciplinary training of both cadres as a crucial part of gaining trust and support from doctors.

> *The hospital was aware of the training, they permitted us to attend, and so they are aware of our new skills and have never raised any objection to midwives performing traditional doctor skills.* **Nakuru PGH Midwife 3M**

In one of the Cluster 2 hospitals, trained medical officers and midwives did not get the support of the obstetrician to perform assisted vaginal delivery within 6 months of the training. The

obstetrician did not participate in the training. That obstetrician was replaced just before 6 months post intervention, and was trained in EmONC along with Cluster 4 maternity care providers. This facilitated performance of vacuum extraction by younger doctors and midwives in that hospital. A **trained medical officer** from that hospital reporting at **6 months post intervention** described the effect of support from senior doctors on practice following training:

> *"We can now perform vacuum extractions, since the obstetrician was replaced. This reduces the need for unnecessary second-stage caesarean sections... we are performing more vacuum extractions and support each other and our confidence is growing."* **Mbagathi GH**

Late referrals

Late arrival of patients and lack of consent for life-saving EmONC procedures were reported as limitations to practice post intervention. This was a problem particularly in the north-eastern part of Kenya where there are large distances between health care facilities that are also poorly staffed. Early recognition, improved resuscitation and early referral of women with complications are likely to significantly reduce the risk of death. In the north-eastern province of Kenya, some maternity care workers from district hospitals were trained; this was reported to have resulted in better-resuscitated patients who arrived at the province general hospital in better conditions.

> *Some patients still come in very late from other out stations; those coming from district hospitals where some staff has been trained arrive earlier and in a more stable condition than before the training.* **Garissa PGH Midwife 3M**

> *Due to the culture, the woman's family makes a lot of decisions about her care, for example obtaining consent for caesarean section can take up to 3 days, by the time they accept the baby is dead.* **Garissa PGH Midwife 3M**

Even with improved knowledge, skills, supervision and provision of essential EmONC equipment, changing practice may also depend on the availability of key supplies. An example is the availability of urine dipstix for bedside or antenatal clinic urine protein testing; one trained midwife in Cluster 5 identified this as a limitation to practising fully what she had learnt from the training regarding diagnosis and management of severe pre-eclampsia/eclampsia

> *Erratic supply of materials like urine dipstix makes it challenging to monitor proteinuria.* **Garissa PGH Midwife 3M**

Lack of pregnancy monitoring tools

The WHO introduced the modified partograph in 2000 (has no latent phase, active phase starts at 4 cm and no key for charting uterine contractions-reference point of symbols for the various strengths of contractions charting uterine contractions) to reduce the frequency of unnecessary interventions and difficulties encountered by health care workers using it (World Health Organization 2000). At the time implementation started in Cluster 1, most health care facilities in Kenya were using the WHO composite partograph (has a latent phase and uterine contraction key-a guide on how to chart the strength of uterine contractions). The intervention provided an opportunity to introduce the WHO-modified partograph to the main Kenya CEmONC health care facilities and train maternity care providers on how to use it. Generally, the trained maternity care providers enjoyed the training sessions on partographs and found them most useful – midwives more than medical doctors (**see Chapter 4 Sections A1 and A2**). This was consistent with observations of increased use of the partograph at 3 and 6 months post intervention. However, there have been challenges with the reintroduction of the partograph; these include lack of modified partographs, and the absence of a key on the forms to guide the charting of contractions. At the end of the 3-month follow-up visits in Cluster 1, an electronic version of the modified WHO partograph with a key for charting uterine contractions was provided to trained health care providers and also to trainees from other clusters at the time of their training. This facilitated the advocacy and production of sufficient quantities of the WHO-modified partograph at hospital level.

Another challenge reported by trained maternity care workers with the use of the partograph was staff shortages; this was reported at 6 months post training at some of the health care facilities. Some explained that it is difficult for few staff members to attend to many women in during labour; this makes adequate use of the partograph difficult in such circumstances.

Safety of equipment

Trained staff and key informants at Garissa PGH reported that staff shortages and frequent loss of small items of equipment, and patients refusing care and presenting very late, were some of the key challenges to providing care in that hospital. Usually, there is only 1 staff member on afternoon and night duty shifts with several nursing/midwifery students covering all the units of the maternity ward; this creates a problem in trying to ensure a good quality of care and tracking equipment. The morning shift is better staffed: 2–3 experienced midwives and medical officers are readily available.

Equipment is frequently missing and has to be handed over from shift to shift to ensure its safety.

5.9. Summary of enablers and barriers to performing EmOC post intervention

Overall there was a positive change in behaviour, practice, and attitude to provision of EmONC following the training in EmONC reported. Trained maternity care workers could provide better quality of care (evidence based and in a timely manner); they could see the impact of change in practice on the health outcomes of women. The following conclusions can therefore be drawn on factors that enabled change in practice/quality of care provision and those that act as barriers.

5.9.1. Enabling factors

a. **Method of EmONC training intervention:** Maternity care workers reported that they found the **interactive, mixed teaching methods and multidisciplinary** nature of the training package effective. This is consistent with reported usefulness of the training, in written comments reported immediately after the training **(Chapter 4).** However, several trainees wanted more time for the hands-on training component of the training package.

   Training medical doctors and midwives together improved the confidence of midwives, and their capacity to perform 'traditional' EmONC procedures/skills such as **manual removal of placenta, manual vacuum aspiration, assisted vaginal delivery with vacuum extractors, and venous cut down** successfully. This also enabled non-physician clinicians trained to commence treatment promptly, and led to improved communication (constructive discussions and dialogue) with medical doctors, improved appreciation of their contribution to patient care and improved job satisfaction.

b. **Availability of equipment for EmONC:** Trained maternity care providers reported on the impact of available EmONC equipment immediately after training. In Cluster 1 there was a short lag between training and equipment supply; this contributed to non-availability of key EmONC signal functions 1 month after the training, and subsequently all equipment was made available immediately after the training of other clusters. So the identification and timely supply of missing EmOC equipment were key factors to improved availability of EmOC after the training.

c. **Supportive supervision and follow-up:** Supervisors with several years of experience, who were given additional training to provide day-to-day support to less experienced colleagues, found it very useful and an important component of behaviour change. The supervisory staff also reported that this was a very useful step for the full transfer of knowledge and skills

acquired into practice. In this regard, the content, method of delivery and implementation of the new supervisory skills following the intervention was important from the perspective of both trained supervisors and maternity care. Trained maternity care providers found the follow-up visits to be a vote of confidence and support to change behaviour/improve practice or sustain positive changes made.

5.9.2. Barriers

Trained health care workers and their supervisors/managers identified several factors that reduced the impact of the intervention; poor staff deployment and retention policy post training, lack of equipment to perform EmONC, lack of support from obstetricians and nursing/midwifery administrators, lack of training for all maternity care providers (including medical interns, medical officers and staff from lower-level health care facilities) and lack of clarity on the scope of practice for nurses/midwives.

5.10. Summary of findings

Prior to this intervention In-service EmONC training for maternity care providers was reported to be infrequent and very few staff had participated – usually only those in management positions (at all study sites). It was also usual for the various cadres of staff to be trained separately (for example, medical doctors trained separately from nurses/midwives).

- This programme provided multidisciplinary, interactive training to almost all of the maternity care providers in major public health referral hospitals in Kenya, and evaluated its impact.
- Maternity care providers were very satisfied with the content and methods of training.
- Training of medical doctors and non-physician clinicians together appears to have made a significant contribution to changes in behaviour and practice; the process of supportive supervision has also helped to achieve this.
- Improved communication within teams is also reported to be a direct effect of the multidisciplinary training approach.
- Availability of training equipment, and follow-up and supportive supervision, also contributed to behaviour change.
- There was evidence of up-skilling; non-physician clinicians were supported by medical doctors and senior midwives to change their practice and perform EmONC signal functions usually provided, prior to the intervention, by medical doctors only. The direct impact is reduction in treatment delays, improved availability of quality EmONC, improved maternity care worker and increased patient satisfaction.

- Lack of supervisors at night, late arrival of patients with severe complications, lack of clarity on scope of nursing/midwifery practice, and non-involvement of obstetricians and senior midwives were factors identified as limiting change in behaviour and practice.
- Maternity care providers recommendations on improving the effectiveness and impact of the intervention;
    - Training of medical interns who are first on call and do 3-monthly obstetric rotations,
    - Involving senior nurses/midwives and hospital administrators at the planning stage to ensure that the correct target population was trained and retained in maternity wards afterwards and
    - Extending the training to lower-level health care facilities, this appeared to have resulted in prompt referrals and better-resuscitated patients observed at the study sites.

The next chapter will present the level 4 quantitative data results.

Chapter 6: Results

Level 4 (Health outcomes)

This chapter presents the results of quantitative data analysis at level 4. Data for 7 outcome and 3 'up skilling' measures were collected at 3 monthly intervals. Comparisons of change in outcome and up-skilling measures before and after the intervention was made using paired T-test at 95% confidence interval with alpha level of 0.05% (one tailed). Trends in outcome measures is also presented and discussed.

6.1. Introduction

Baseline data (3 months pre-training) was collected from all training clusters (**Table 11)** and the intervention at each cluster was implemented at 3 monthly intervals. Thereafter data was collected at 3 monthly intervals until 12 months post intervention in each site (health care facilities included in the study). The data collected at each data collection point corresponded to the period 3 months preceding that point (WHO et al. 2009). Data was collected at each of the study sites for 3 'up-skilling' indicators, 5 indicators to evaluate any change in availability of skilled birth attendance and EmOC and 3 health outcome indicators. All the health care facility indicators collected are listed below;

Up-skilling' indicators

1. Proportion of all deliveries by breech vaginal delivery
2. Proportion of all deliveries by assisted vaginal delivery (vacuum extraction)
3. Proportion of all AVDs by non-physician clinicians

Availability of skilled birth attendance and EmOC indicators

1. Number of deliveries
2. Institutional caesarean section rate (CSR)
3. Number of obstetric complications recorded and managed
4. Proportion of expected EmOC signal functions available
5. Proportion of newborn unit admissions for birth asphyxia

Health outcome indicators

1. Direct obstetric case fatality rate
2. Stillbirth rate (SBR)
3. Fresh stillbirth rate (FSBR)

The percentage change in all indicators from baseline compared to 6 and12 months after the intervention was also calculated and the significance of mean difference determined using the t-test distribution. The assumption of normality of the mean difference for each measure is presented along with t-test results based on the null hypothesis (Ho) that the mean difference is zero: EmONC training intervention is ineffective, the alternative hypothesis is that the mean of differences is positive: EmONC training is effective.

The trend in all outcome measures from baseline to 12 months post intervention is also presented as line graphs for each intervention site.

Based on the assumption that a minimum of 80% of trained (and retained at 3 and 12 months) maternity staff will be required to improve health outcomes, additional analysis excluding study sites that did not meet this assumption is also presented (using 3 indicators; Direct obstetric case fatality rate, stillbirth rate and fresh stillbirth rate **(Table 15).**

Table 33: List of study sites and clusters

Site	Name of hospital included	Cluster number
A.	Pumwani Maternity Hospital Nairobi	1
B.	Province General Hospital Nyeri	
C.	Province General Hospital Nakuru	2
D.	Province General Hospital Mbagathi	
E.	Province General Hospital Kakamega	3
F.	Kisii Level 5 General Hospital Kisii	
G.	Province General Hospital Embu	4
H.	Province General Hospital Garissa	
I.	Province General Hospital Mombasa	5
J.	Level 5 General Hospital Machackos	

The next section presents an overview of baseline level 4 indicators from all study sites.

6.2. Baseline up-skilling indicators and health outcome indicators

6.2.1. Baseline up-skilling indicators

Three indicators based on routinely collected data at the study sites were collected to assess the effect of the training on up-skilling of maternity care workers: 1) Proportion of all vaginal deliveries that are breech vaginal deliveries 2) Proportion of deliveries by AVD (Vacuum extraction) and 3) Proportion of AVD deliveries by non-MDs.

Table 34 presents an overview of the baseline data for 3 'up-skilling' indicators. 1.29% and 0.15% of all the vaginal deliveries conducted at the study sites were by breech vaginal delivery and vacuum extraction respectively at baseline.

Medical doctors exclusively performed AVD in hospitals where this SF was available at baseline; this finding is consistent with qualitative findings presented in Chapter 5. Most of the assisted vaginal deliveries were conducted at Garissa PGH (1%) and no AVD was performed in clusters 1 and 2 at baseline. Cluster 4 had the highest proportion of AVD performed at baseline (0.5%).

Table 34: Baseline data for 'up-skilling' indicators

Cluster No.	Hospital	Proportion of all vaginal deliveries that are breech	Proportion of deliveries by AVD-VE (%)	Proportion of AVD deliveries by non MDs (%)
1	Pumwani Maternity Hospital Nairobi	0.8	0	0
	Nyeri Province General Hospital	2.2	0	0
	Cluster mean	**1.5%**	**0**	**0**
2	Nakuru Province General Hospital	2.3	0	0
	Mbagathi General Hospital	0.8	0.1	0
	Cluster mean	**1.55%**	**0**	**0**
3	Kakamega Province General Hospital	0.1	0.1	0
	Kisii Level 5 General Hospital	1	0	0
	Cluster mean	**0.55%**	**0%**	**0**
4	Embu Province General Hospital	1.1	0	0

Cluster No.	Hospital	Proportion of all vaginal deliveries that are breech	Proportion of deliveries by AVD-VE (%)	Proportion of AVD deliveries by non MDs (%)
	Garissa Province General Hospital	1.8	1%	0
	Cluster mean	**1.4%**	**0.5%**	**0**
5	Mombasa Province General Hospital	1	0.2	0
	Machakos Level 5 General Hospital	1.8	0.1	0
	Cluster mean	**1.29%**	**0.15%**	**0**

AVD: Assisted Vaginal Delivery, **VE:** Vacuum Extraction

6.2.2. Baseline outcome indicators

Baseline outcome indicators are presented by health care facilities and by clusters, presented in tables and graphs.

Table 35 provides an overview of baseline data for availability of skilled attendance at birth and EmOC, and health outcomes from all study sites.

Table 35: Baseline data for SBA, EmOC availability and health outcome indicators

Cluster No.	Hospital	Annual no. of deliveries	CS rate* (%)	Emergency obstetric complications recorded * (% of total births)	DOCFR* (%)	% of expected EmOC SF available*	% babies admitted to NBU for birth asphyxia*	SBR* (%)	FSBR* (%)
1.	Pumwani Maternity Hospital Nairobi	16, 966	19.2	128 (3%)	1.8	87.5 (7/8)**	15.5	3.7	1.8
	Nyeri Province General Hospital	5,204	22.8	67 (1.5%)	3	88.9 (8/9)	6.8	3.5	1.2
	Cluster mean	**11, 085**	**21%**	**98**	**2.4%**	**88.2%**	**11.2%**	**3.6%**	**1.5%**
2.	Nakuru Province General Hospital	9, 348	17.1	218 (9.3%)	1	88.9 (8/9)	-	4.7	1.8
	Mbagathi General Hospital	2, 238	17	15 (3.7%)	6.7	88.9 (8/9)	23.7%	4.3	2
	Cluster mean	**5, 793**	**17.1%**	**117**	**3.9%**	**88.9%**	**23.7%**	**4.5%**	**1.9%**
3.	Kakamega Province General Hospital	5, 144	17.2	130 (10.1%)	3.1	100 (9/9)	4.7	4.2	1.2
	Kisii Level 5 General Hospital	6, 068	34.9	154 (10.2%)	1.9	100 (9/9)	6.4	4	2.2
	Cluster mean	**5, 606**	**26.1%**	**116**	**2.5%**	**100 (9/9)**	**5.6%**	**4.1%**	**1.7%**
4.	Embu Province General Hospital	5, 360	26.3	74 (5.5%)	4.1	88.9 (8/9)	8.1	2.6	1.3
	Garissa Province General Hospital	3, 016	8.8	93 (12.3%)	4.3	100 (9/9)	3.8	6.8	2.3
	Cluster mean	**4, 188**	**17.6%**	**84**	**4.2%**	**88.9%**	**6%**	**4.7%**	**1.8%**
5.	Mombasa Province General Hospital	7, 864	23.6	109 (5.5%)	2.8	100 (9/9)	5.1	8.2	5.1
	Machakos Level 5 General Hospital	5, 489	21.5	158 (11.5%)	1.3	100 (9/9)	6.2	8.2	1.8
	Cluster mean	**6, 677**	**22.6%**	**134**	**2.1%**	**88.9%**	**5.7%**	**8.2%**	**3.5%**
Average mean per site		**3, 335**	**16.7%**	**55 (6.6%)**		**94.3%**	**5.2%**	**2.5%**	**2.1%**

***Based on 3 months data,**

****Hospital provides only obstetric services.**

– missing data/incomplete hospital record

The estimated average number of women delivering at each study site per annum was 3,335 (SD 1676). The average number of deliveries per cluster per year was 6,670 ranging from 4,188 (13%) in cluster 4 to 11,085 (33%) in cluster 1 (**Figure 13 and Figure 14).**

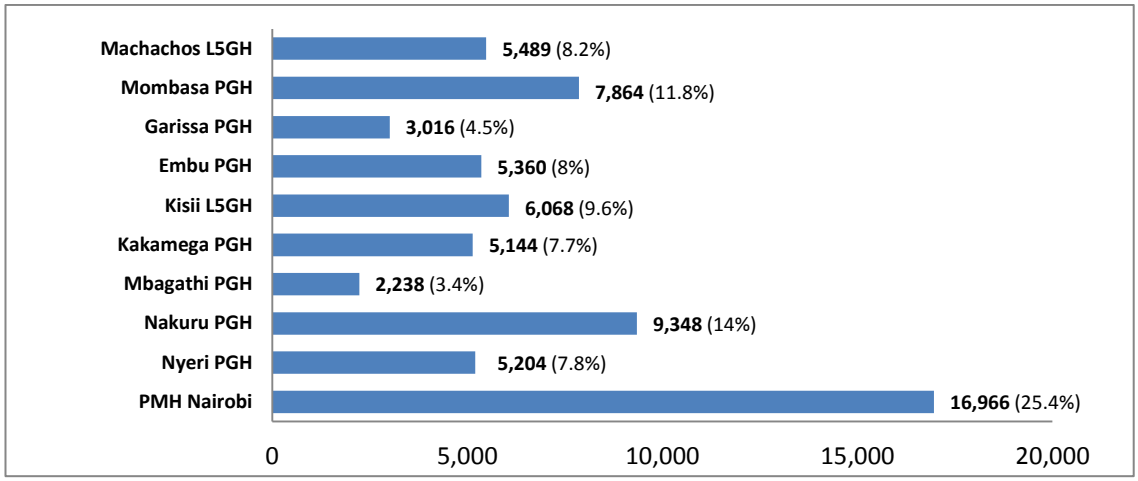


Figure 13: Estimated number of women receiving SBA per study site per year

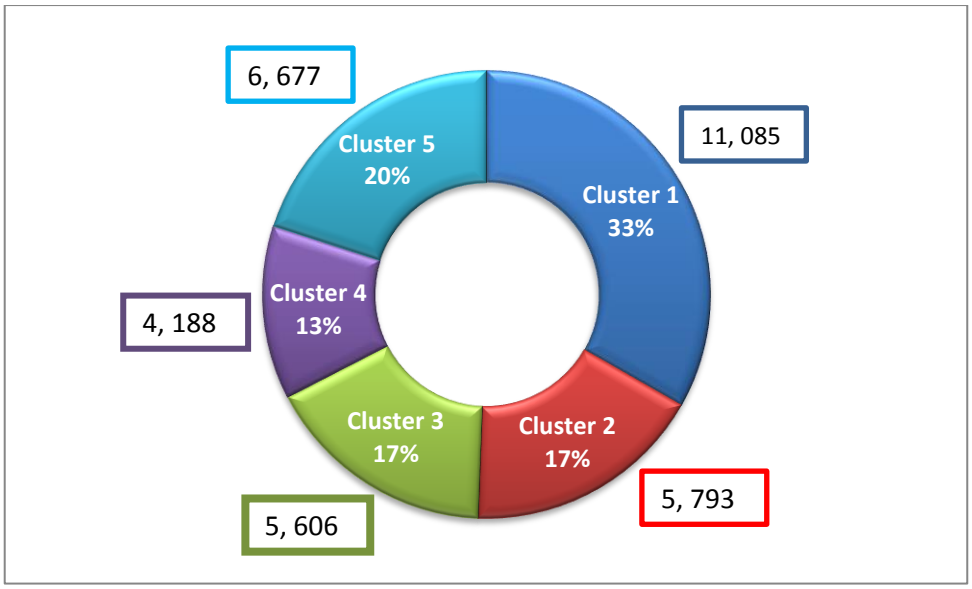


Figure 14: Average proportion of all annual deliveries per cluster

Amongst all clusters, cluster 4 had the lowest proportion of all deliveries per annum (13% or 4, 188 deliveries). 33% (11,085) and 13% (4,188) of the estimated annual deliveries were in cluster 1 and cluster 4 respectively **(Figure 14)**

All the hospitals included in the research were designated in principle to provide all EmONC signal functions except Pumwani maternity hospital (PMH). PMH only provides obstetric services, so the

EmONC signal function 'remove retained products (e.g. manual vacuum extraction, dilation and curettage)' is in principle not available at this hospital.

At baseline only 50% of the study sites could provide all the expected EmONC signal functions. Assisted vaginal delivery was unavailable in 5 study sites **(Table 35).** Also at baseline AVD was only performed by obstetricians in the hospitals where this SF it was available and performed.

An average of 5.2% (SD: 4.48%) of all admissions into each newborn care unit (NBU) at baseline was for birth asphyxia at all study sites. The proportion of newborn admitted into NBU for birth asphyxia was lowest in cluster 3 (5.6%), and highest in cluster 2 (23.7%). The smallest proportion of newborn admission into NBU at baseline was 3.8% at Garissa PGH while the highest was in Mbagathi General Hospital, 23.7%. There was no reliable baseline data from Nakuru PGH **(Table 35).**

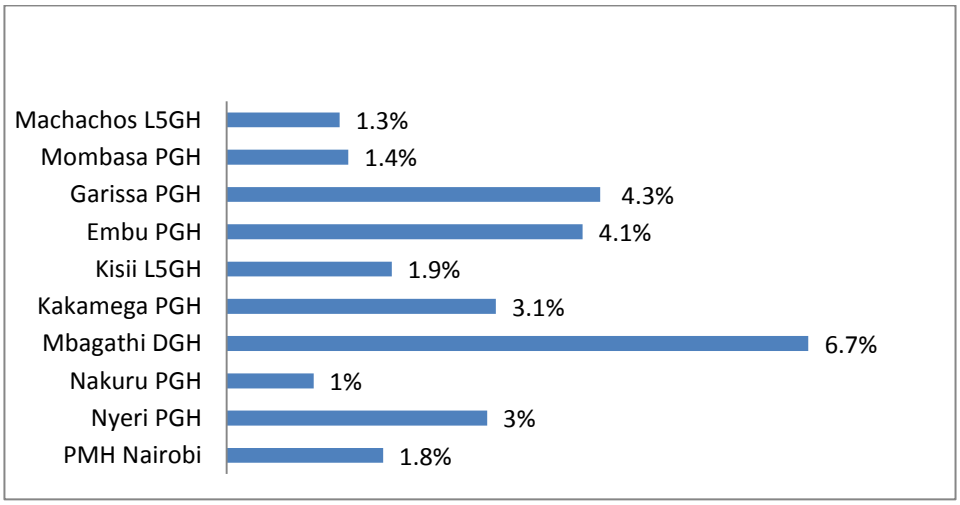


Figure 15: Baseline DOCFR

An average of 1.5% (SD: 1.72) of women with obstetric complications recorded died in all included hospitals, the lowest direct obstetric case fatality rate was 1% at Nakuru PGH and the highest of 6.7 % was at Mbagathi DGH at baseline. The DOCFR ranged from 2.1% in cluster 5 to 4.2% in cluster 4 **(Figure 15 and Figure 16)**

PGH Nakuru had the lowest DOCFR at baseline 1% but contributes to 14% (9, 348) of annual deliveries from all study sites **(Table 35)** Mbagathi hospital provides skilled attendance at birth to only 3.4% (2,238) of all women potentially benefitting from the intervention in a year but has the highest DOCFR 6.7% at baseline, while PMH Nairobi provides SBA to 25.4% (16, 966) of all women and has DOCFR of 1.8%.

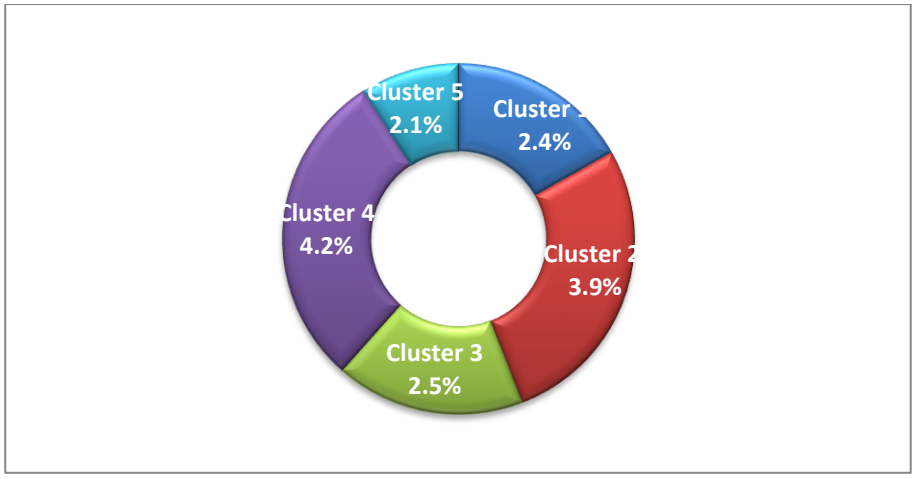


Figure 16: Mean DOCFR per cluster

Cluster 5 had the lowest mean DOCFR per cluster and 20% (6, 677) of annual estimated number of women receiving SBA while cluster 4 had the highest DOCFR 4.2% with and 4,188 deliveries per annum.

The average stillbirth rate (SBR) at each site was 2.5%, (SD: 2.01%) it was lowest at Embu PGH (2.6%) highest in Machakos GH and Mombasa PGH (8.2%)-**Figure 17.**

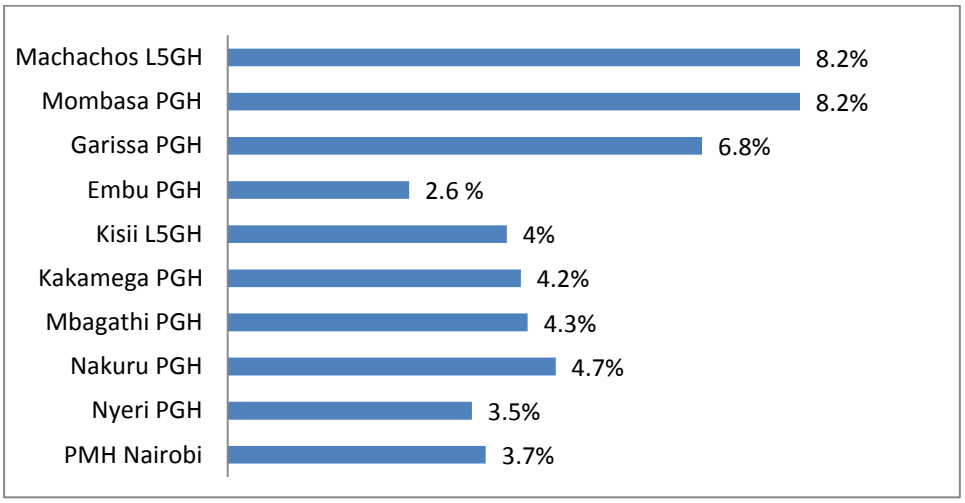


Figure 17: Baseline SBR

The lowest SBR per cluster was in cluster 1 (3.6%) while cluster 5 (8.2%) had the highest SBR at baseline. Both clusters however had the highest estimated number deliveries per annum (Cluster 1: 22, 170 (33%) and Cluster 5: 13, 354 (8.2%)) **(Figure 17 and Figure 18).**

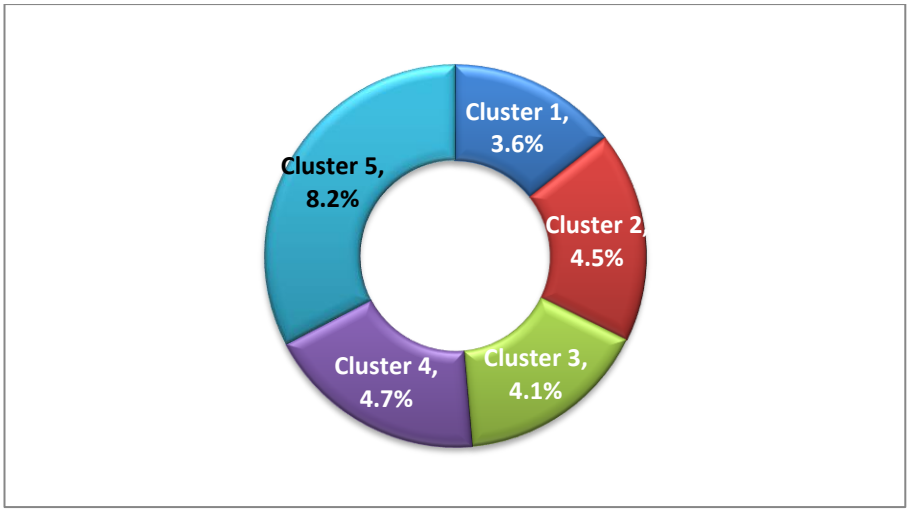


Figure 18: Mean SBR per cluster

6.3. Level 4 results: Overall change in 'up-skilling', availability of SBA and EmOC, and health outcome indicators

6.3.1. Proportion of breech vaginal deliveries conducted

There was a 53.8% mean increase in the proportion of breech vaginal deliveries conducted at 12 months post intervention compared to baseline, but the increase observed at 6 months was about 6 times more than that observed at 12 months post training (294%). There was no increase observed in Nakuru PGH and Nyeri PGH. The largest increase was observed at Kisii level 5 GH (300%) **(Table 36**).

The distribution of the mean difference in proportion of breech deliveries conducted before and after the intervention was normally distributed and most of the values were positive.

The mean difference in proportion of the proportion of breech deliveries (M= 0.68, SD=1.04, N=10) was significantly greater than zero, t (9) =2.07, one tailed p=0.03, and the 95% confidence interval (-0.06; 1.42) included zero.

Table 36: Proportion of breech deliveries conducted

Cluster No.	Hospital	Baseline (%)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	0.8	0.5	-38%	1.4	+75%
	Nyeri Province General Hospital	**2.2**	**1.5**	**-32%**	**2**	**-9%**
2.	**Nakuru Province General Hospital**	**2.3**	**2**	**-13%**	**2.1**	**-9%**
	Mbagathi General Hospital	0.8	0.7	-13%	2	+150%
3.	Kakamega Province General Hospital	0.1	3.1	3000%	0.1	0%
	Kisii Level 5 General Hospital	1	1.1	10%	1.4	+40%
4.	Embu Province General Hospital	1.1	1.8	64%	1.5	+36%
	Garissa Province General Hospital	1.8	2.5	39%	5.1	+183%
5.	Mombasa Province General Hospital	1	0.7	-30%	2.1	+110%
	Machakos Level 5 General Hospital	1.8	0.9	-50%	2	+11%
	Mean	**1.3**	**1.5**	**294%**	**2**	+53.8%
Significance of mean difference P<0.05					**p=0.03**	

6.3.2. Proportion of deliveries by assisted vaginal delivery (vacuum extraction)

There was 80% mean increase in the proportion of vacuum extractions performed at 12 months post intervention compared to baseline **(Table 37).**

The distribution of the mean difference in the proportion of vacuum extractions performed before and after the intervention was normally distributed and most of the values were positive.

The mean difference in the proportion of vacuum extractions performed (M= 0.88, SD=1.25, N=9) was significantly greater than zero, t (9)=2.23, one tailed p=0.03, the 95% confidence interval (-0.01,1.77) included zero.

Table 37: Change in proportion of deliveries using vacuum extractions

Cluster No.	Hospital	Baseline (%)	6 months post intervention (%)	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi*	0	0.5	100%	3.1	100%
	Nyeri Province General Hospital	0	0.1	100%	0.2	100%
2.	Nakuru Province General Hospital	0	0.1	100%	0.1	100%
	Mbagathi General Hospital	0	0.5	100%	0.2	100%
3.	**Kakamega Province General Hospital**	**0.1**	**0.4**	**75%**	**0.1**	**0%**
	Kisii Level 5 General Hospital	0.1	0.4	75%	0.4	75%
4.	Embu Province General Hospital *	0	0.4	100%	0.2	100%
	Garissa Province General Hospital	1	2.6	62%	2.7	63%
5.	**Mombasa Province General Hospital**	**0.2**	**3.6**	**94%**	**0.2**	**0%**
	Machakos Level 5 General Hospital *	0.1	3.1	97%	3.1	97%
	Mean	**0.2**	**1.2**	**500%**	**1.0**	**400%**
Significance of mean difference P<0.05					**P<0.001**	

* no 12M data

6.3.3. Change in proportion of all vacuum extractions by non-physician clinicians

There was 100% mean increase in the proportion of vacuum extractions performed by non-physician clinicians at 12 months post intervention compared to baseline. There was some increase in all facilities **(Table 38)**.

The distribution of the mean difference in the proportion of vacuum extractions performed by non-physician clinicians before and after the intervention was normally distributed and most of the values were positive.

The mean difference in the proportion of vacuum extractions performed by non-physician clinicians (M= 75, SD=35.11, N=10) was significantly greater than zero, t (9) =6.76, one tailed p<0.001, and the 95% confidence interval (49.9, 100.2) did not include zero.

Table 38: Change in proportion of vacuum extractions by non-physician clinicians

Cluster No.	Hospital	Baseline (%)	6 months post intervention (%)	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	0	33.3	100	27.6	100
	Nyeri Province General Hospital	0	100	100	100	100
2.	Nakuru Province General Hospital	0	50	100	100	100
	Mbagathi General Hospital	0	66.7	100	100	100
3.	Kakamega Province General Hospital	0	0	100	100	100
	Kisii Level 5 General Hospital	0	50	100	66.7	100
4.	Embu Province General Hospital	0	100	100	100	100
	Garissa Province General Hospital	**0**	**76**	**100**	**0**	**0**
5.	Mombasa Province General Hospital	0	91	100	80	100
	Machakos Level 5 General Hospital *	0	76.7	100	76.7	100
	Mean	**0.0**	**64.4%**	**100**	**75.1%**	**100%**

Cluster No.	Hospital	Baseline (%)	6 months post interventio n (%)	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
Significance of mean difference P<0.05					**p**<0.001	

*No 12 M data

6.3.4. Change in number of total deliveries conducted

There was no increase in the number of deliveries at 6 months and only 3.8% mean increase at 12 months post intervention compared to baseline. There was no reduction observed in Nakuru PGH, Kisii L5 DGH and Mombassa PGH. The highest increase in the number of women receiving skilled birth attendance was observed at Mbagathi General Hospital (58.2%) **(Table 39).**

The distribution of the mean difference in the number of deliveries before and after the intervention was normally distributed and most of the values were positive.

The mean difference in number of deliveries (M= 64, SD=204, N=10) was not significantly greater than zero, t (9) =0.99, one tailed p=0.17 (95% confidence interval -82; 210) included zero.

Table 39: Change in number of deliveries conducted

Cluster No.	Hospital	Baseline	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	4287	4141	-3%	4577	+7%
	Nyeri Province General Hospital	1301	1245	-4%	1347	+4%
2.	**Nakuru Province General Hospital**	**2337**	**2221**	**-5%**	**2312**	**-1%**
	Mbagathi General Hospital	498	671	35%	788	+58%
3.	Kakamega Province General Hospital	1308	1499	15%	1473	+13%
	Kisii Level 5 General Hospital	**1554**	**1581**	**2%**	**1491**	**-4%**
4.	Embu Province General	1158	1268	9%	1340	+16%

Cluster No.	Hospital	Baseline	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
	Hospital					
	Garissa Province General Hospital	742	642	-13%	740	0%
5.	**Mombasa Province General Hospital**	**2278**	**1825**	**-20%**	**1883**	**-17%**
	Machakos Level 5 General Hospital	1301	1381	6%	1453	+12%
Mean		**1676.4**	**1647.4**	**-2%**	-2%	**3.8%**
Total		**16, 764**	**16, 474**		**17, 404**	
Significance of mean difference P<0.05					**p=0.17**	

6.3.5. Change in caesarean section rate

There was no change in the mean caesarean section rate at 12 months (21.5%) post intervention compared to baseline (21.5%) **(Table 40).** The distribution of the mean difference in the number of women receiving caesarean section rate before and after the intervention was normally distributed and most of the values were positive.

The mean difference in caesarean section rate (M= 64, SD=204, N=10) was not significantly greater than zero, t (9) =0.99, one tailed p=0.17 (95% confidence interval -82, 210)

Table 40: Change in caesarean section rate

Cluster No.	Hospital	Baseline (%)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	19.7	21.5	9%	23.6	+19.7
	Nyeri Province General Hospital	22.8	25.5	12%	24.2	+6.1
2.	Nakuru Province General	17.1	15.9	-7%	21.2	-21.2

Cluster No.	Hospital	Baseline (%)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
	Hospital					
	Mbagathi General Hospital	20.7	12.1	-42%	13.3	-35.6
3.	Kakamega Province General Hospital	18.5	17	-8%	15.2	-17.8
	Kisii Level 5 General Hospital	29.4	27.4	-7%	30.7	+4.7
4.	Embu Province General Hospital	26.3	26.4	0%	26.2	-0.4
	Garissa Province General Hospital	14.5	8.4	-42%	12	-17.2
5.	Mombasa Province General Hospital	24.8	25.6	3%	29	+16.9
	Machakos Level 5 General Hospital	21.5	22	2%	19.2	-10.7
	Mean	**21.5%**	**20.18%**	**-6%**	**21.5%**	**0**

6.3.6. Change in the number of obstetric complications recorded and managed

More obstetric complications were recognised and treated in all hospitals at 6 months (1989) and 12 months (1911) compared to baseline (1146). There was 73.6% and 66.8% increase in obstetric complications recorded and managed at 6 and 12 months post training respectively (**Table 41**).

Table 41: Change in the number of obstetric complications recorded and managed

Cluster No.	Hospital	Baseline (n)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (n)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	128	216	+69	209	+63
	Nyeri Province General Hospital	**67**	**81**	**+21**	**65**	**-3**
2.	**Nakuru Province General**	**218**	**196**	**+10**	**167**	**-23**

Cluster No.	Hospital	Baseline (n)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (n)	% change at 12 months post intervention
	Hospital					
	Mbagathi General Hospital	15	158	+953	141	+840
3.	Kakamega Province General Hospital	130	233	+79	277	+276
	Kisii Level 5 General Hospital	154	598	+288	641	+113
4.	Embu Province General Hospital	74	81	+9	92	+316
	Garissa Province General Hospital	**93**	**60**	**-35**	**83**	**-11**
5.	Mombasa Province General Hospital	109	206	+89	160	+47
	Machakos Level 5 General Hospital	**158**	**160**	**+1**	**76**	**-52**
	Total	**1146**	**1989**	**73.6%**	**1911**	**66.8%**

The distribution of the mean difference in number of obstetric complications recorded and treated before and 12 months after the intervention was normally distributed (1 extreme outlier-Mbagathi GH). The mean difference in number of obstetric complications recorded and managed (M= 76.5, SD=161.61, N=10) was not significantly greater than zero, t (9) =1.50, one tailed p=0.08 (95% confidence interval -39.1, 192.1).

Analysis without PGH Nakuru; There was 93.2% and 87.9% increase in the number of obstetric complications recorded and treated at 6 and 12 months post intervention respectively.

Overall there was increased recording of number of obstetric complications over time **(Figure 19).**

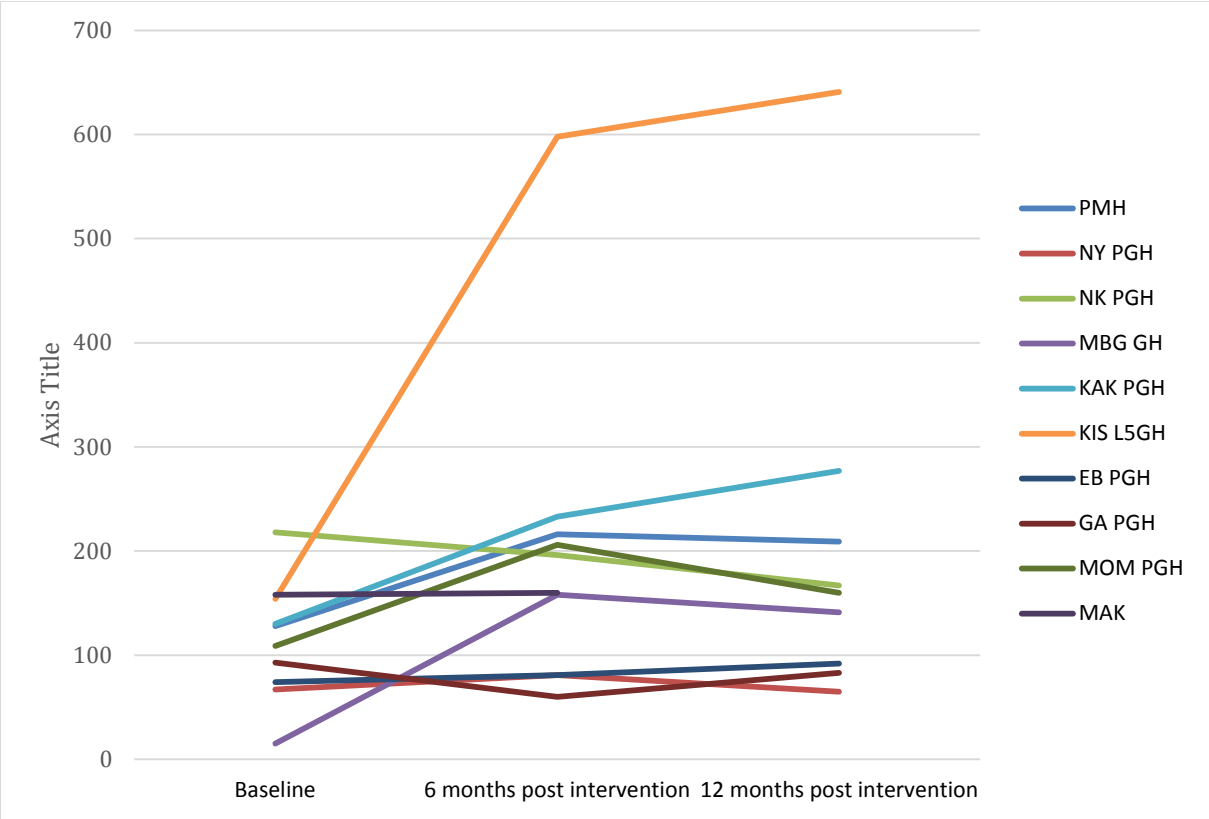


Figure 19: Trend in number of obstetric complications recorded and treated

From **Figure 19** the results at 6 and 12 months post intervention from Kisii L5GH appear to be outliers, excluding these results from the analysis shows a reduction in the proportion of obstetric complications recorded at 6 months from 73.6% to 40.2% at 6 months and from 66.8% to 28% at 12 months post intervention.

6.3.7. Change in availability of expected EmOC signal functions

Of the 5 health care facilities not providing all the EmOC SF at baseline, all improved by 1 SF at 6 months and 4 improved by 1 SF at 12 months post intervention. There was improvement in the performance of EmOC in health care facilities in Cluster 1 and 2, no change in Cluster 3 and 4 health care facilities and Mombasa PGH **(Table 42).**

Table 42: Change in availability of expected EmOC signal functions

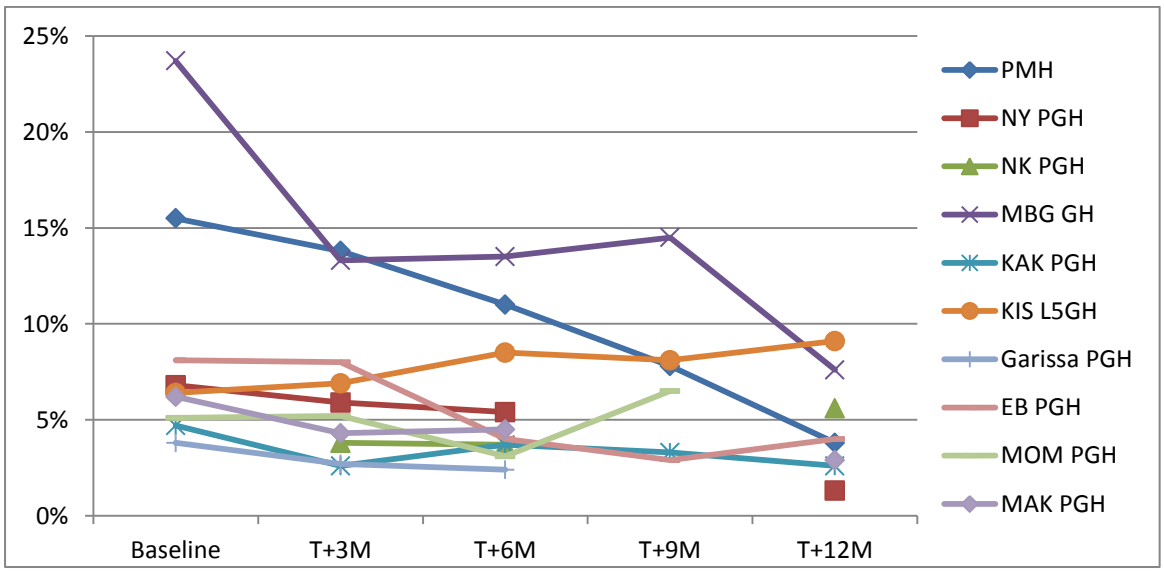
Cluster No.	Hospital	Baseline (%)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	7/8 (87.5)	100	+33	100	+33
	Nyeri Province General Hospital	8/9 (88.9)	100	+12.5	100	+12.5
2.	Nakuru Province General Hospital	8/9 (88.9)	88.9	0	100	+12.5
	Mbagathi General Hospital	8/9 (88.9)	88.9	0	100	+12.5
3.	Kakamega Province General Hospital	9/9 (100)	100	0	100	0
	Kisii Level 5 General Hospital	9/9 (100)	88.9	-12.5	100	0
4.	Embu Province General Hospital	8/9 (88.9)	100	12.5	88.9	0
	Garissa Province General Hospital	9/9 (100)	100	0	100	0
5.	Mombasa Province General Hospital	9/9 (100)	100	0	100	0
	Machakos Level 5 General Hospital	**100**	**100**	**0**	**88.9**	**-12.5**
	Mean	**94.3%**	**96.7%**	**4.6%**	**97.8%**	**3.5%**
Significance of mean difference P<0.05					**p=0.19**	

There was no reduction in the availability of EmOC SFs from based line in Cluster 3 and 4, and at Mombasa PGH. Although all signal functions were available in principle (trained staff and functional equipment available) Machakos level 5 GH could not perform assisted vaginal delivery at 12 months post intervention. The overall there no significant difference in the change in signal functions at 6 and 12 months post intervention compared to baseline.

The mean change in performance of EmOC provided at 12 months post training (M=3.5%, SD=7.7, N=10) was not significant (t=1.43, df =9, p=0.19, CI -2.01-9).

6.3.8. Change in proportion of newborns admitted to newborn unit for birth asphyxia

Figure 20 presents the trend in proportion of newborns admitted into NBU at all study sites. Although there was missing data at 9 months in 4 sites (PGH Nakuru, Mbagathi DGH, Garissa PGH and Mombassa PGH, there was a downward trend across all sites except Kisii level 5 GH.



There was no data at baseline and 9M post intervention at Nakuru PGH, at 9 months post intervention at Nyeri PGH, and at 9M in Machakos L5GH.

Figure 20: Trend in proportion of babies admitted for birth asphyxia

There was a 21% and 48% mean reduction in the proportion of newborns admitted to newborn care unit at 6 and 12 months respectively post intervention compared to baseline. There was no reduction observed in Nakuru PGH and Kisii L5 GH but reductions were observed in hospitals they

were paired with to receive the intervention. The largest change was observed at Pumwani maternity hospital (75.5%) **(Table 43).**

The distribution of the mean difference in proportion of newborns admitted for birth asphyxia before and after the intervention was normally distributed and most of the values were positive.

Table 43: Change in proportion of newborns admitted to NBU for birth asphyxia

Cluster No.	Hospital	Baseline (%)	6 months post intervention (%)	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	15.5	11	-29%	3.8	-75%
	Nyeri Province General Hospital	6.8	5.4	-21%	1.3	-81%
2.	Nakuru Province General Hospital **	3.8	3.7	+3%	5.6	+47%
	Mbagathi General Hospital	16	14.4	-10%	4.5	-72%
3.	Kakamega Province General Hospital	4.7	3.7	-21%	2.6	-45%
	Kisii Level 5 General Hospital	6.4	8.5	-33%	9.1	+42%
4.	Embu Province General Hospital	8.1	3.5	-57%	4.4	-46%
	Garissa Province General Hospital*	3.8	2.4	-37%	2.4	-37%
5.	Mombasa Province General Hospital	5.1	3.1	-39%	3.1	-39%
	Machakos Level 5 General Hospital	6.2	4.5	-27%	2.9	-53%
	Mean	**7.6%**	**6%**	**21%**	4%	**48%**
Significance of mean difference P<0.05					**p=0.03**	

**Nakuru no baseline but showed improvements from 3months

The mean difference in proportion of newborns admitted for birth asphyxia (M= 3.3, SD=4.8, N=10) was significantly greater than zero, t (9) =2.13, one tailed p=0.03, the 95% confidence interval (-0.2; 6.7) included zero.

6.3.9. Change in direct obstetric case fatality rate (DOCFR)

There was a 35% mean reduction in the direct obstetric case fatality rate at 12 months post intervention compared to baseline. There was no reduction observed in Nyeri PGH, Nakuru PGH, Embu PGH and Mombassa PGH **(Figure 21).** The largest reduction was observed at Mbagathi DGH, Garissa PGH and Machakos L5 GH (100%) **(**

Table 44**).**

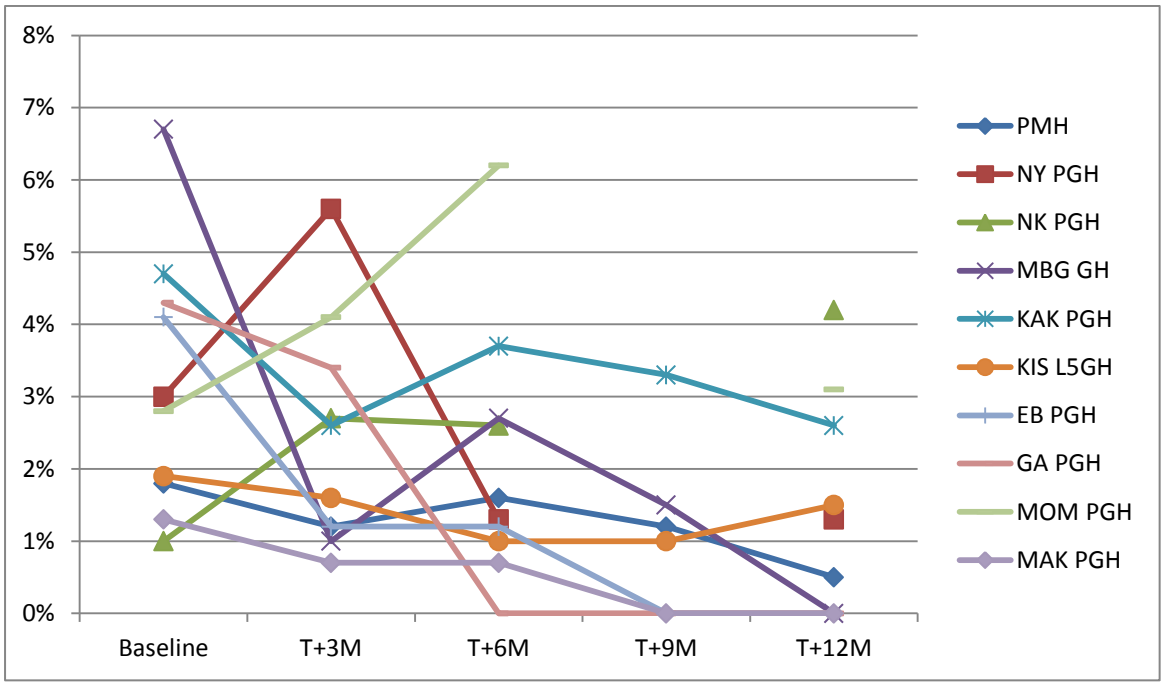


Figure 21: Trend in DOCFR at all study sites

Overall there was a downward trend in the DOCFR. In Nakuru PGH and Nyeri PGH the DOCFR increased from baseline however there was an opposite trend within their respective clusters (cluster 1 and 2)- Pumwani MH and Mbagathi GH. Nyeri PGH had 60% decrease in CFR at 6 months post training but this increased by 157% compared to baseline at 12 months post training. At 6 months post training Nakuru and Mombassa PGH had no reduction in DCOFR.

The distribution of the mean difference in direct obstetric case fatality rate before and 6 months after the intervention was normally distributed (1 extreme outlier) and most of the values were

positive. The mean difference in direct obstetric case fatality rate (M= 0.95, SD=2.65, N=10) was not significantly greater than zero, t (9) =1.13, one tailed p=0.14 (95% confidence interval -0.9, 2.8).

The distribution of the mean difference in direct obstetric case fatality rate before and 12 months after the intervention was normally distributed and most of the values were positive. The mean difference in direct obstetric case fatality rate (M= 0.61, SD=3.26, N=10) was not significantly greater than zero, t (9) =0.59, one tailed p=0.28 (95% confidence interval -1.7-2.9) suggestive that EmONC.

Table 44: Change in direct obstetric case fatality rate (DOCFR)

Cluster No.	Hospital	Baseline (%)	6 months post intervention (%)	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
1.	Pumwani Maternity Hospital Nairobi	1.6 (2/128)	1.4 (3/216)	-12.5%	0.5% (1/209)	-69%
	Nyeri Province General Hospital	**3 (2/67)**	**1.2 (1/81)**	**-60%**	**7.7 (5/65)**	**+157%**
2.	**Nakuru Province General Hospital**	**1 (2/218)**	**2.7 (5/196)**	**+170%**	**4.2 (7/167)**	**+320%**
	Mbagathi General Hospital	6.7 (1/15)	2.7 (1/158)	-59.7%	0 (0/141)	-100%
3.	Kakamega Province General Hospital	3.1 (4/130)	1.6 (6/233)	-48.4%	2.5 (7/277)	-19%
	Kisii Level 5 General Hospital	**1.9 (3/154)**	**1 (6/598)**	**-47.4%**	**1.5 (13/641)**	**+21%**
4.	Embu Province General Hospital	4.1 (3/74)	1.2 (2/81)	-70.7%	0 (92)	-100%
	Garissa Province General Hospital	4.3 (4/93)	0 (60)	-100%	0 (83)	-100%
5.	**Mombasa Province General Hospital**	**2.8 (3/109)**	**7.3 (15/206)**	**+160.7%**	**3.1 (5/160)**	**+11%**
	Machakos Level 5 General Hospital	1.3 (2/158)	1.2 (2/160)	-84.6%	0 (76)	-100%
	Mean	**3% (115)**	**2% (199)**	**33.3%**	**2 % (191)**	**+35%**
Significance of mean difference P<0.05					**p=0.28**	

Performing the same analysis without Nakuru PGH (less than 80% of trained staff were retained in maternity services of that hospital at 3 and 6 months post training) shows a progressive decline in DOCFR from 3.2% at baseline, to 2% at 6 months and 1.7% at 12 months. This represents 39% decrease at 6 months and 47% decrease at 12 months compared to baseline. Although excluding PGH Nakuru from this analysis shows improved reduction in DOCFR at 6 and 12 months post intervention, this did not reach statistical significance (M=1.5%, STD-3.2, CI -1.01, 4.01, t=1.38, 1 tailed=0.21).

6.3.10. Change in stillbirth rate (SBR)

There was a 34% mean reduction in the stillbirth rate at 12 months post intervention compared to baseline. There was no reduction observed in Nakuru PGH and Kisii L5 GH but also no reductions in the proportion of babies admitted to newborn care unit with birth asphyxia observed at both hospitals (**Figure 22)**. The largest reduction in stillbirth rate was observed at Machakos L5 GH (79.3%) **(Table 45).**

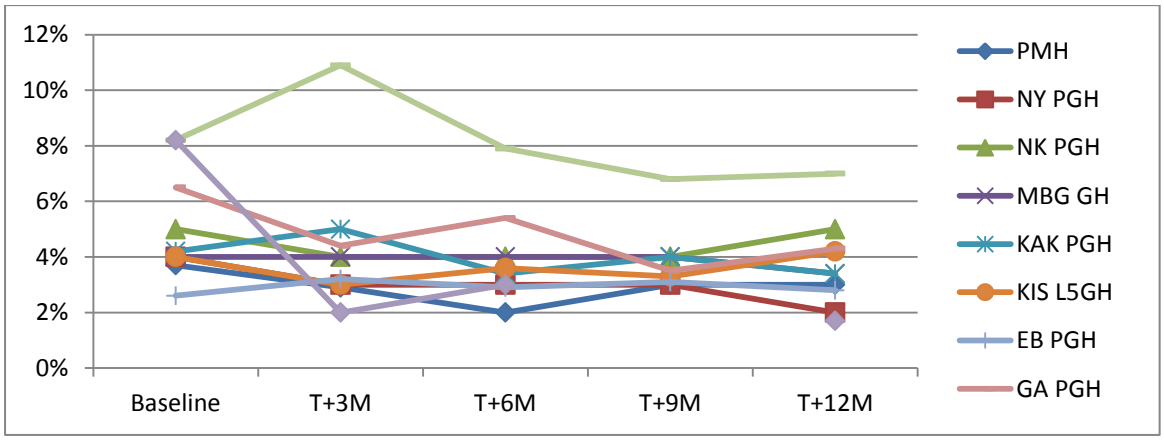


Figure 22: Trend in SBR at all sites

The distribution of the mean difference in stillbirth rate before and 12 months after the intervention was normally distributed and most of the values were positive. The mean difference in stillbirth rate (M= 1.6, SD=2.35, N=10) was significantly greater than zero, t(9)=2.26, one tailed p=0.03 (95% confidence interval 0, 3.6) suggestive that EmONC training intervention effective in reducing SBR at 12 months post intervention.

Performing the same analysis without Nakuru PGH (less than 80% of trained staff were retained in maternity services of that hospital), there is a progressive decrease in SBR from 5.1% at baseline, to

4% at 6 months and 1.7% at 12 months. This represents 19% decrease at 6 months and 66% decrease at 12 months in SBR compared to baseline.

The distribution of the mean difference in stillbirth rate before and 12 months after the intervention with Nakuru PGH excluded was normally distributed and most of the values were positive. The mean difference in stillbirth rate (M= 1.5, SD=2.27, N=9) was significantly greater than zero, t (8) =2.26, and one tailed p=0.04 (95% confidence interval -0.21, 3.3) but includes zero.

The reduction in SBR at 12 months post training was more with Nakuru PGH excluded (34% vs. 66%).

Table 45: Change in stillbirth rate (SBR)

Cluster No.	Hospital	Baseline (%)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post interventio n
1.	Pumwani Maternity Hospital Nairobi	**3.7**	1.8	51%	2.7	-27%
	Nyeri Province General Hospital	**3.5**	2.7	23%	1.7	-51%
2.	**Nakuru Province General Hospital**	**4.7**	**4.1**	**13%**	**5.3**	**+13%**
	Mbagathi General Hospital	**4**	4.3	-8%	3.4	-15%
3.	Kakamega Province General Hospital	**4.2**	3.5	-17%	3.4	-19%
	Kisii Level 5 General Hospital	**4**	3.6	-10%	4.2	-5%
4.	Embu Province General Hospital	**2.6**	2.9	-12%	2.8	-8%
	Garissa Province General Hospital	**6.3**	3.6	-43%	4.3	-32%
5.	Mombasa Province General Hospital	**8.5**	11	-29%	3.4	-60%
	Machakos Level 5 General Hospital	**8.2**	3	-63%	1.7	-79%
Mean		**5%**	**4.1%**	**19%**	**3.3**	**-34%**
Significance of mean difference					**p=0.03**	

Cluster No.	Hospital	Baseline (%)	6 months post intervention	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post interventio n
P<0.05						

6.3.11. Change in fresh stillbirth rate (FSBR)

There was 10% mean reduction in the fresh stillbirth rate at 12 months post intervention compared to baseline. There was no reduction observed in Nakuru PGH and Kakamega PGH. The largest reduction in stillbirth rate was observed at Machakos L5 GH (44.4%) **(Table 46).**

The distribution of the mean difference in fresh stillbirth rate before and 12 months after the intervention was normally distributed and most of the values were positive. The mean difference in stillbirth rate (M= 0.2, SD=0.64, N=10) was not significantly greater than zero, t(9)=0.99 and one tailed p=0.17 (95% confidence interval -0.25, 0.65) included zero.

Table 46: Change in fresh stillbirth rate (FSBR)

Cluster No.	Hospital	Baseline (%)	6 months post intervention (%)	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post interven tion
1.	Pumwani Maternity Hospital Nairobi	**1.8**	**1.2**	**-33**	**1.2**	**-33**
	Nyeri Province General Hospital	**1.2**	1.1	-8	1	**-17**
2.	**Nakuru Province General Hospital**	**1.8**	**2.2**	**-22%**	**2.4**	**+33%**
	Mbagathi General Hospital	**2**	1.9	5%	2	**0%**
3.	**Kakamega Province General Hospital**	**1.2**	**1.8**	**+50%**	**2.4**	**+100%**
	Kisii Level 5 General Hospital	**2.2**	2	9%	1.7	**23%**
4.	Embu Province General Hospital	**1.3**	1.4	+8%	0.8	**-38%**

Cluster No.	Hospital	Baseline (%)	6 months post intervention (%)	% change at 6 months post intervention	12 months post intervention (%)	% change at 12 months post intervention
	Garissa Province General Hospital	**2.3**	1.9	-17%	1.8	**-22%**
5.	Mombasa Province General Hospital	**5.1**	5.9	+16%	4.4	**-14%**
	Machakos Level 5 General Hospital	**1.8**	1.2	-33%	1	**-44%**
	Mean	**2.07%**	**2.06**	**-1%**	**1.9%**	**-10%**
Significance of mean difference P<0.5					**p=0.17**	

Performing the same analysis without Nakuru PGH (less than 80% of trained staff were retained in maternity services of that hospital), there was 3% decrease in FSBR at 6 months (FSBR=2%) and 14% decrease at 12 months (FSBR=1.8%) compared to 2.1% at baseline.

Excluding Nakuru PGH from the analysis did not make any difference on the effect of the intervention on FSBR at 12 months post training compared to baseline.

6.4. Effect of EmONC training intervention on health outcomes with PGH Nakuru excluded

Most hospitals had 76% or more of trained staff retained at the maternity wards at 3 months post training except Nakuru PGH (38.5%). At 12 months the average rate of trained maternity staff retained in the maternity ward was 83% but PGH Nakuru had a retention rate of 23% and Mbagathi DGH 50%.

Based on the assumption that a critical number of trained maternity health care providers is required to change health outcomes and considering the results from Nakuru PGH **(Table 49), Figure 23** presents a comparison of improvement (extent of reduction from baseline) in health outcome indicators (DOCFR, SBR, FSBR and proportion of babies admitted to NBU for birth asphyxia) from baseline at 6 and 12 months.

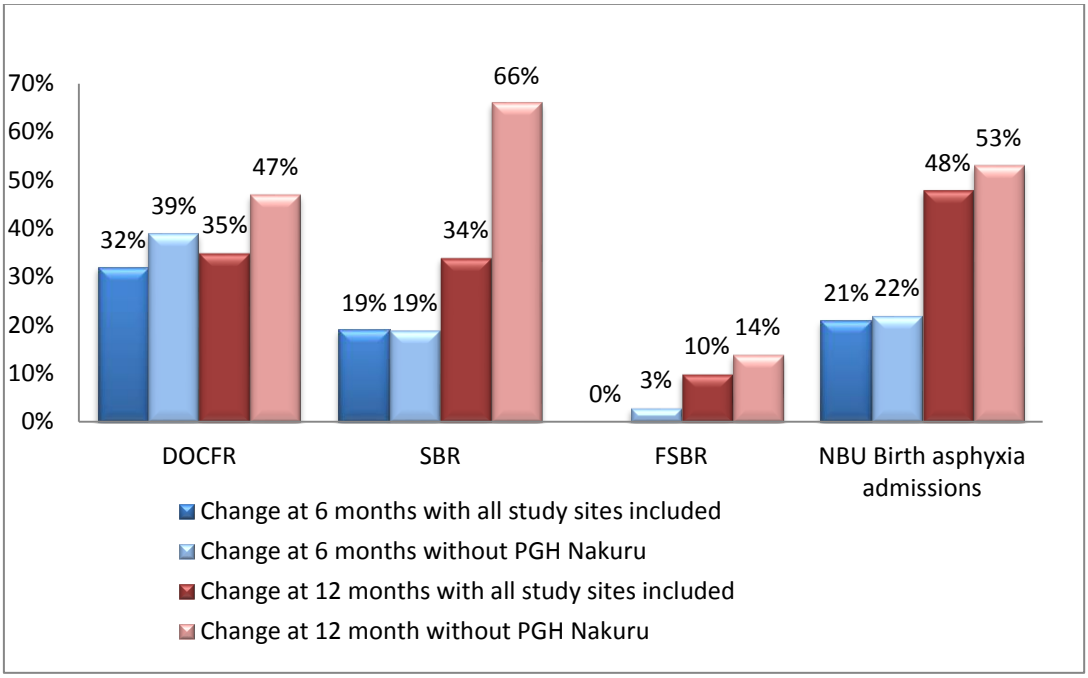


Figure 23: Improvements in health outcome indicators at 6 and 12 months post EmONC training intervention compared to baseline, with and without PGH Nakuru included.

Overall the reduction at 12 months was more than at 6 months. There was no difference for % change in SBR at 6 months with or without PGH Nakuru included. There was no change in FSBR at 6 months with PGH Nakuru included and only 3% change with PGH Nakuru excluded.

The smallest difference at 12 months with change in indicators with PGH Nakuru included or excluded was with the FSBR rate indicator (4% difference) while the largest differences were with the SBR (32% difference) and DOCFR (12% difference)-(**Figure 23).**

6.5. Level 4 results: Site specific change in outcomes

6.5.1. Pumwani Maternity Hospital Nairobi

a. Change in health outcomes:

At baseline all expected signal functions except assisted vaginal delivery were performed, this became available and performed at 3 months post intervention and remaining so at 12 months after **(Table 47**). There was a 75.5% reduction in the number of babies admitted to newborn care unit for birth asphyxia at 12 months post intervention compared to baseline. Similarly the results suggest improved quality of care for mothers based on 72% and 27% reduction in DOCFR and SBRs respectively. The 60% reduction in fresh stillbirths may reflect an improvement in the quality of monitoring of labour and newborn resuscitation following the intervention; this is consistent with reduced admissions for birth asphyxia observed. The number of women receiving SBA and caesarean section rate increased by 6.8% and 19.7% respectively at 12 months post intervention compared to baseline.

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at PMH Nairobi increased from 0.8% at baseline to 1.4% at 12 months post intervention, thus representing 75% increase. Assisted vaginal delivery was not performed before the intervention by medical doctors or midwives, the proportion of deliveries by vacuum extraction increased as well as the proportion performed by non-physician clinicians **(Table 47**).

Table 47: Change in level 4 indicators: PMH

S/No.	Outcome/up skilling measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	87.5% (7/8)	100%	100%	100%	100%	+ 14.3%
2.	Proportion of newborns admitted for birth asphyxia	15.5%	13.8%	11%	7.8%	3.8%	-75%
3.	Direct Obstetric Case Fatality Rate	1.6%	1.2%	1.6%	1.2%	0.5%	-72.2%

S/No.	Outcome/up skilling measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
4.	Stillbirth rate	3.7%	2.9%	1.8%	2.6%	2.7%	-27%
5.	Fresh stillbirth rate	1.8%	1.6%	1.2%	1.2%	1.2%	-60%
6.	Number of women receiving SBA	4287	4214	4141	4324	4577	+6.8%
7.	Caesarean section rate	19.7%	20.6%	21.5%	24%	23.6%	+19.7%
8.	Proportion breech vaginal deliveries conducted	0.8%	0.8%	0.5%	0.6%	1.4%	+75%
9.	Proportion of deliveries by vacuum extraction	0%	0.2%	0.7%	0.7%	1%	+100%
10.	Proportion of vacuum extractions by non-physician clinicians	0%	37.5%	33.3%	19.4%	27.6%	+100%

6.5.2. Nyeri PGH

a. Change in health outcomes:

Similar to PMH, all expected signal functions except assisted vaginal delivery were performed at baseline, this became available and performed at 3 months post intervention and remaining so at 12 months after **(Table 48**). There was 80.9% reduction in the number of babies admitted to newborn care unit for birth asphyxia at 12 months post intervention compared to baseline. Similar improvements were observed for stillbirth rate-51.4% reduction (3.5% to 1.7%) and fresh stillbirth rate-25% reduction (1.2-1%). However the DOCFR increased from 3% at baseline to 7.7% at 12 months post intervention, the number of women receiving skilled attendance at birth and caesarean section rate increased by 3.5% and 6.1% respectively.

Table 48: Change in level 4 indicators Nyeri PGH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	88.9% (8/9)	100%	100%	100%	100%	+12.5%
2.	Proportion of newborns admitted for birth asphyxia	6.8%	5.9%	5.4%	-	1.3%	-80.9%
3.	Direct Obstetric Case Fatality Rate	3%	5.6%	1.3%	-	7.7%	+156.7%
4.	Stillbirth rate	3.5%	3.1%	2.7%	2.8%	1.7%	-51.4%
5.	Fresh stillbirth rate	1.2%	1.2%	1.1%	1%	1%	-25%
6.	Number of women receiving SBA	1301	1308	1245	1335	1347	+3.5%
7.	Caesarean section rate	22.8%	26.4%	25.5%	23.7%	24.2%	+6.1%
8.	Proportion breech vaginal deliveries conducted	2.2%	2.1%	1.5%	1.5%	2%	-9.1%
9.	Proportion of deliveries by vacuum extraction	0	0.3%	0.1%	0.1%	0.2%	100%

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
10.	Proportion of vacuum extractions by non-physician clinicians	0	75%	100%	100%	100%	100%

-missing data

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Nyeri PGH did not improve 12 months post intervention. Assisted vaginal delivery was not performed before the intervention by medical doctors or midwives, the proportion of deliveries by vacuum extraction increased as well as the proportion performed by non-physician clinicians **(Table 48).**

6.5.3. Nakuru PGH

a. Change in health outcomes:

Similar to cluster 1 study sites, all expected signal functions except assisted vaginal delivery were performed at baseline, this became available and performed from 6 months post intervention and remaining so 12 months after the training **(Table 49).** However there were no improvements in the number of babies admitted to newborn care unit for birth asphyxia, stillbirth rate, fresh stillbirth rate and DOCFR at 12 months post intervention compared to baseline. This result is not surprising because over 60% of trained staff were posted to other units/ward within the first 3 months post intervention.

Table 49: Change in level 4 indicators Nakuru PGH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	88.9% (8/9)	88.9%	100%	100%	100%	+12.5%
2.	Proportion of newborns admitted for birth asphyxia	-	3.8%	3.7%	-	5.6%	--

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
3.	Direct Obstetric Case Fatality Rate	1%	2.7%	2.6%	3.7%	4.2%	+320%
4.	Stillbirth rate	4.7%	4.1%	4.1%	-	5.3%	+12.8%
5.	Fresh stillbirth rate	1.8%	2.1%	2.2%	1.9%	2.4%	+33.3%
6.	Number of women receiving SBA	2337	2336	2221	2221	2312	-1.1%
7.	Caesarean section rate	17.1%	16.4%	15.9%	22.8 %	21.2%	+33.3
8.	Proportion breech vaginal deliveries conducted	2.3%	2.4%	2%	2.1%	2.1%	+8.7%
9.	Proportion of deliveries by vacuum extraction	0	0	0.1%	0.1%	0.1%	+100%
10.	Proportion of vacuum extractions by non-physician clinicians	0	0	50%	100%	100%	+100%

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Nakuru PGH improved 12 months post intervention by only 8.7%. Assisted vaginal delivery was not performed before the intervention by medical doctors or midwives, the proportion of deliveries by vacuum extraction increased as well as the proportion performed by midwives **(Table 49).** Only 23% of maternity ward staff trained were retained in the maternity ward at 12 months post training. There were 5 experienced midwives and obstetricians and 1 junior midwife, the experienced staff are only available during the morning shift. So there is a limit to what impact they will have on the quality of services.

Training for newly maternity ward staff was organised 12 months post intervention and the hospital management agreed to review the staff deployment policy in light of the evidence suggesting its negative impact on the quality of maternal and newborn care.

6.5.4. Mbagathi GH

a. Change in health outcomes:

Similar to Nakuru PGH, all expected signal functions except assisted vaginal delivery were performed, this became available and performed at 3 months post intervention and remaining so at 12 months after **(Table 50).** There was a 71.9% reduction in the number of babies admitted to newborn care unit for birth asphyxia at 12 months post intervention compared to baseline. Similarly the results suggest improved quality of care for mothers based on 100% and 4.8% reduction in DOCFR and SBRs respectively. However there was no reduction in fresh stillbirth rate but a 58.2% increase in the number of women receiving SBA and 35.6% increase in caesarean section rate at 12 months post intervention, compared to baseline.

Table 50: Change in level 4 indicators Mbagathi GH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	88.9% (8/9)	88.9%	100%	100%	100%	+12.5%
2.	Proportion of newborns admitted for birth asphyxia	16%	15.5%	14.4%	7.5%	4.5%	-71.9%
3.	Direct Obstetric Case Fatality Rate	6.7%	1%	2.7%	-	0	-100%
4.	Stillbirth rate	4.0%	3.8%	4.3%	3.4%	3.8%	-4.8%
5.	Fresh stillbirth rate	2%	2.2%	1.9%	2.4%	2%	0%
6.	Number of women receiving SBA	498	567	671	609	788	+58.2%
7.	Caesarean section rate	20.7%	14.3%	12.1%	19%	13.3%	-35.6%
8.	Proportion breech vaginal deliveries conducted	0.8%	1.1%	0.7%	1.8%	2%	+153.8%
9.	Proportion of deliveries by vacuum extraction	0	0.2%	0.5%	0.4%	0.2%	+100%

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
10.	Proportion of vacuum extractions by non-physician clinicians	0	100%	66.7%	100%	100%	+100%

– missing data/incomplete hospital records

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Mbagathi GH improved 12 months post intervention by 153.8%. Assisted vaginal delivery was not performed before the intervention by medical doctors or midwives, the proportion of deliveries by vacuum extraction increased as well as the proportion performed by non-physician clinicians **(Table 50).**

6.5.5. Kakamega PGH

a. Change in health outcomes:

Unlike study sites in cluster 1 and 2, all expected signal functions were performed at baseline **(Table 51).** There was a 44.7% reduction in the number of babies admitted to newborn care unit for birth asphyxia at 12 months post intervention compared to baseline. Similarly the results suggest improved quality of care for mothers based on 19.4% and 7.1% reduction in DOCFR and SBRs respectively. There was also 100% reduction in fresh stillbirth rate and the number of women receiving SBA increased by 23.6% while the caesarean section rate decreased by 11.2%.

Table 51: Change in level 4 indicators Kakamega PGH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	100%	100%	88.9%	100%	100%	0%
2.	Proportion of newborns admitted for birth asphyxia	4.7%	2.6%	3.7%	2.7%	2.6%	-44.7%
3.	Direct Obstetric Case Fatality Rate	3.1%	1.6%	1.7%	0.7%	2.5%	-19.4%

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
4.	Stillbirth rate	4.2%	4%	3.5%	3.4%	3.9%	-7.1%
5.	Fresh stillbirth rate	1.2%	1.2%	1.8%	1.5%	2.4%	+100%
6.	Number of women receiving SBA	1308	1408	1499	1502	1473	+11.2%
7.	Caesarean section rate	18.5%	17%	17%	15.6%	15.2%	-17.8%
8.	Proportion breech vaginal deliveries conducted	2%	2.4%	3.1%	-	5%	+150%
9.	Proportion of deliveries by vacuum extraction	0.1%	0.1%	0.4%	0.1%	0.1%	0%
10.	Proportion of vacuum extractions by non-physician clinicians	0	100%	0	100%	100%	100%

– missing data/incomplete hospital records

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Kakamega PGH improved 12 months post intervention by 150% from baseline. Assisted vaginal delivery was performed before the intervention only by medical doctors, the proportion of deliveries by vacuum extraction increased as well as the proportion performed by non-physician clinicians **(Table 51**).

6.5.6. Kissi level 5 GH

a. Change in health outcomes:

Similar to Kakamega PGH, all expected signal functions were performed at baseline **(Table 52**). There was 42.2% reduction in the number of babies admitted to newborn care unit for birth asphyxia at 12 months post intervention compared to baseline. There was no improvement in stillbirth rate but fresh stillbirth rate reduced by 22.7%. The number of women receiving SBA decreased by 24.2% while the caesarean section rate increased by 4.7%.

Table 52: Change in level 4 indicators Kisii L5 GH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	100%	88.9%	100%	100%	100%	0%
2.	Proportion of newborns admitted for birth asphyxia	6.4%	6.9%	8.5%	8.1%	9.1%	+42.2%
3.	Direct Obstetric Case Fatality Rate	1.9%	1.6%	1%	1.5%	1.5%	-21.1%
4.	Stillbirth rate	4%	3%	3.6%	3.3%	4.2%	+4.8%
5.	Fresh stillbirth rate	2.2%	1.9%	2%	1.4%	1.7%	-22.7%
6.	Number of women receiving SBA	1554	1686	1581	1568	1491	-24.2%
7.	Caesarean section rate	29.4%	26.4%	27.4%	29.7%	30.7%	+4.7%
8.	Proportion breech vaginal deliveries conducted	1%	1.2%	1.1%	1.2%	1.4%	+40%%
9.	Proportion of deliveries by vacuum extraction	0.1%	0.2%	0.4%	0.3%	0.4%	+300%
10.	Proportion of vacuum extractions by non-physician clinicians	0	0	50%	100	66.7%	

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Kisii L5 GH improved 12 months post intervention by 40% from baseline. Assisted vaginal delivery was only performed by medical doctors before the intervention, the proportion of deliveries by vacuum extraction increased as well as the proportion performed by non-physician clinicians **(Table 52).**

6.5.7. Embu PGH

a. Change in health outcomes:

Similar to study sites in cluster 1 and 2, all expected signal functions except assisted vaginal delivery were performed, this became available and performed at 3 months post intervention and remaining so 12 months after (**Table 53**). There was a 45.7% reduction in the number of babies admitted to newborn care unit for birth asphyxia at 12 months post intervention compared to baseline. The SBR did not improve but the fresh stillbirth rate reduced by 38.5%. The reduction in proportion of babies admitted to newborn unit may be consistent with that observed with FSB although the SBR did not change significantly, it may be affected by deaths of newborns delivered outside the hospital and causes of stillbirths such as congenital abnormalities and prematurity, conditions that are not likely to be significantly affected by the intervention.

Table 53: Change in level 4 indicators Embu PGH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	88.9% (8/9)	100%	100%	100%	88.9%	0
2.	Proportion of newborns admitted for birth asphyxia	8.1%	7.8%	3.5%	2.9%	4.4%	-45.7%
3.	Direct Obstetric Case Fatality Rate	4.1%	1.2%	1.2%	-	0	-100%
4.	Stillbirth rate	2.6%	3.2%	2.9%	2.9%	2.8%	+7.7%
5.	Fresh stillbirth rate	1.3%	1.6%	1.4%	1.9%	0.8%	-38.5%
6.	Number of women receiving SBA	1158	1269	1268	1308	1340	+15.7%
7.	Caesarean section rate	26.3%	25%	26.4%	24.3%	26.2%	-0.4%
8.	Proportion breech vaginal deliveries conducted	1.1%	1.3%	1.8%	1.9%	1.5%	+36.4%
9.	Proportion of deliveries by vacuum extraction	0	0.4%	0.4%	0.2%	-	0

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
10.	Proportion of vacuum extractions by non-physician clinicians	0	50%	100%	100%	0	0

1-4: Primary outcome measures, 6&7: Secondary outcome measures, 8-10: Indicators of 'up-skilling', – missing data/incomplete hospital records

Similarly the results suggest improved quality of care for mothers based on 100% reduction in DOCFR. At 12 months post intervention, 15.7% more women received skilled attendance at birth from Embu PGH. The caesarean section rate reduced by less than 0.5% at 12 months post intervention, compared to baseline.

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Embu PGH improved 12 months post intervention by 36.4% from baseline. Assisted vaginal delivery was not performed before the intervention by medical doctors or midwives, the proportion of deliveries by vacuum extraction increased as well as the proportion performed by non-physician clinicians **(Table 53).**

6.5.8. Garissa PGH

a. Change in health outcomes:

Similar to cluster 3 study sites, Garissa PGH performed all expected signal functions at baseline **(Table 54).** There was unreliable data at 9M and 12M but 3 and 6M data indicate a down ward trend in the number of babies admitted to newborn care unit for birth asphyxia. The DOCFR and SBR decreased by 100% and 31.7% respectively from baseline. There was also a reduction in the fresh stillbirth rate of 21.7% from the baseline value, however there was no increase in the number of women receiving SBA. The caesarean section rate increased from 14.5% at baseline to 17.2% at 12 months post intervention

Table 54: Change in level 4 indicators Garissa PGH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	100%	100%	100%	100%	100%	100%
2.	Proportion of newborns admitted for birth asphyxia	3.8%	2.7%	2.4%	-	-	-
3.	Direct Obstetric Case Fatality Rate	4.3%	3.4%	3.3%	0	0	100%
4.	Stillbirth rate	6.3%	3.9%	3.6%	1.9%	4.3%	-31.7%
5.	Fresh stillbirth rate	2.3%	1.6%	1.9%	2.4%	1.8%	-21.7%
6.	Number of women receiving SBA	742	748	642	948	740	+0.3%
7.	Caesarean section rate	14.5%	15.1 %	8.4%	8.6%	12%	17.2%
8.	Proportion breech vaginal deliveries conducted	1.8%	2.3%	2.5%	2.4%	5.1%	183.3%
9.	Proportion of deliveries by vacuum extraction	1%	1.9%	2.6%	1.9%	2.7%	+170%
10.	Proportion of vacuum extractions by non-physician clinicians	0	50%	76%	50%	0	

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted increased from 1.8% at baseline to 5.1%, 12 months post intervention compared to baseline. Assisted vaginal delivery was performed before the intervention (by medical doctors only) but the proportion of deliveries by VE increased from 1% to 2.7% at 12 months post intervention. Midwives started performing AVD after the training, providing 76% of all AVD by vacuum extraction by 6 months post intervention Table 54

6.5.9. Mombassa PGH

a. Change in health outcomes:

Similar to Garissa PGH, Mombassa PGH could perform all expected signal functions at baseline and 12 months post intervention **(Table 55).** There was no 12 month post intervention data for the number of babies admitted to newborn care unit for birth asphyxia but there was no reduction at 9 months post training compared to baseline.

Table 55: Change in level 4 indicators Mombasa PGH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	100%	100%	100%	100%	100%	0
2.	Proportion of newborns admitted for birth asphyxia	5.1%	5.2%	3.1%	-	-	
3.	Direct Obstetric Case Fatality Rate	2.8%	4%	7.3%	-	3.1%	+10.7%
4.	Stillbirth rate	8.5%	9%	11%	10.1%	3.4%	-60%
5.	Fresh stillbirth rate	5.1%	6%	5.9%	4.4%	-	*-13.7%*
6.	Number of women receiving SBA	2278	1719	1825	2586	1883	-2.9%
7.	Caesarean section rate	24.8%	28%	25.6%	24.2%	29%	+16.9%
8.	Proportion breech vaginal deliveries conducted	1%	2%	0.7%	-	2.1%	+110%
9.	Proportion of deliveries by vacuum extraction	0.2%	0.5%	3.6%	-	0.2%	0
10.	Proportion of vacuum extractions by non-physician clinicians	0	0	91%	-	80%	+100

DOCFR increased by 10.7% but stillbirth rate and fresh stillbirth rate both reduced by 60% and 13.7% respectively at 12 months post intervention compared to baseline. There was no increase in the number of women receiving SBA but the caesarean section rate increased from 24.8% at baseline to 29% at 12 months post intervention **(Table 55).**

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Mombassa PGH increased from 1% at baseline to 2.1%, 12 months post intervention. Assisted vaginal delivery was only performed by medical doctor before the intervention, by 12 months post interventions 80% of the vacuum extractions were performed by midwives (**Table 55**). The significant increase in AVD observed at 6 months post training is related to the availability of the equipment for use at the labour ward from 3 months post intervention. Due to administrative reasons, essential equipment for performing EmONC provided to the hospital immediately after the training was not made available to trained staff in the maternity wards.

6.5.10. Machakos L5 GH

a. Change in health outcomes:

At baseline all expected signal functions were available and performed. There was a 53.2% reduction in the number of babies admitted to newborn care unit for birth asphyxia at 12 months post intervention compared to baseline. Similarly the results suggest improved quality of care for mothers based on 100% and 79.3% reduction in DOCFR and SBRs respectively. The 44.4% reduction in fresh stillbirths may reflect an improvement in the quality of monitoring of labour and newborn resuscitation following the intervention; this is consistent with reduced admissions for birth asphyxia observed. The number of women receiving SBA and caesarean section rate increased by 11% and 10.7% respectively at 12 months post intervention compared to baseline **(Table 56).**

Table 56: Change in level 4 indictors Machakos L5 GH

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
1.	Proportion of expected EmOC signal function performed	100%	100%	100%	100%	88.9%	-12.5%

S/No.	Outcome measure	Baseline (BL)	3M	6M	9M	12 M	% BL/12M change
2.	Proportion of newborns admitted for birth asphyxia	6.2%	4.3%	4.5%		2.9%	-53.2%
3.	Direct Obstetric Case Fatality Rate	1.3%	0.7%	0%		0	-100%
4.	Stillbirth rate	8.2%	2%	3%		1.7%	-79.3%
5.	Fresh stillbirth rate	1.8%	0.8%	1.2%		1%	-44.4%
6.	Number of women receiving SBA	1301	1354	1381		1453	+11.7%
7.	Caesarean section rate	21.5%	19.7%	22%		19.2%	+10.7%
8.	Proportion breech vaginal deliveries conducted	1.8%	1.5%	0.9%		2%	+11%
9.	Proportion of deliveries by vacuum extraction	0.1%	0.2%	3.1%		-	-
10.	Proportion of vacuum extractions by non-physician clinicians	0	0	76.7 %		-	-

b. Change in measures of up-skilling:

The proportion of breech vaginal deliveries conducted at Machakos L5 GH increased from 1.8% at baseline to 2% at 12 months post intervention, thus representing 11% increase. Medical doctors only performed assisted vaginal delivery before the intervention, midwives conducted 76.7% of all vacuum extractions at 9 months post training. There was no reliable data at 12 months post training **(Table 56).**

6.6. Summary of results

a. All study sites were **level 5 comprehensive emergency obstetric care health care** facilities and could perform **most (94.3%) EmOC signal functions** prior to implementation of the intervention. **Assisted vaginal delivery was the least available** EmOC signal function.

b. There was only **4.6% and 3.5% increase** in the performance of EmOC signal functions at **6 and 12 months respectively post training**. This change **did not reach statistical significance**.

c. Most of the hospitals could provide all signal functions at baseline, but the critical EmONC signal functions such as MVA, AVD and MRP were performed by only by medical doctors before the intervention. There was **statistically significant up-skilling of non-physician clinicians** after 12 months of the intervention. These results are consistent with qualitative results presented in Chapter 5.

d. There was a **21% and 48% mean reduction** in the proportion of **newborns admitted** to newborn care unit for **birth asphyxia at 6 and 12 months** respectively post intervention compared to baseline across all sites but there was no reduction observed in Nakuru PGH and Kisii L5 GH.

e. The **reduction** in the proportion of newborns **admitted for birth asphyxia** was **statistically significant at 12 month**s but not at 6 months.

f. **66.8% more obstetric complications** were managed in all hospitals at 12 months **(1911)** compared to baseline (1146).

g. **73.6% more obstetric** complications were managed in all hospitals at 6 months (1989) compared to baseline.

h. The **highest reduction in DOCFR** observed was in cluster 3 and 4, both DOCFR and SBR decreased at PMH Mbagathi GH, Kakamega PGH, Garissa PGH, and Machakos GH. Cluster 2 had the least reduction in SBR and DOCFR.

i. At **12 months DOCFR reduced** in Embu PGH (100%) and Kisii GH (21%) but SBR slightly increased at by 8% and 5% respectively from baseline. The proportion of babies admitted for birth asphyxia reduced by 46% at Embu PGH while it increased by 42% at Kisii L5 GH.

j. DOCFR increased by 320% and SBR by 13% at Nakuru PGH at 12 months post intervention compared to baseline. This hospital had the least retention of trained staff at 3 (38.5%) and 12 (23%) months post training **(Table 18 Chapter 4**).

k. There was **32% and 35% mean reduction in the direct obstetric case fatality rate at 6 and 12 months** respectively post intervention compared to baseline. There was no reduction in DOCFR observed in Nyeri PGH, Nakuru PGH, Embu PGH and Mombassa PGH at 12 months post intervention.

l. The change in DOCFR was not significant at 6 or 12 months post intervention.

m. **Excluding PGH Nakuru** (less than 80% of trained staff were retained after training) from this analysis shows **improved reduction in DOCFR at 6 months (39% vs. 32%) and 12 months (47% vs. 35%) post intervention,** however this did **not reach statistical significance**.

n. There was a **19% and 34% mean reduction** in the stillbirth rate at **6 and 12 months** respectively post intervention compared to baseline however this was **not statistically significant.** There was no reduction observed in Nakuru PGH and Kisii L5 GH but also no reductions in the proportion of babies admitted to newborn care unit with birth asphyxia at both hospitals.

o. Performing the same analysis without Nakuru PGH (less than 80% of trained staff were retained in maternity services of that hospital post training), there was **19% decrease at 6 months and 66% decrease at 12 months** in SBR compared to baseline. The change at 12 months was **statistically significant**.

p. The reduction in **SBR** at 12 months post training was more with Nakuru PGH excluded (34% vs. 66%), but there was no change in the extent of SBR reduction at 6 months post training (19%). A similar trend was observed with proportion of newborns admitted to NBU for birth asphyxia.

q. There was 10% mean reduction in the **fresh stillbirth rate** at 12 months post intervention compared to baseline but no reduction at 6 months post training. There was no reduction observed in Nakuru PGH and Kakamega PGH. The largest reduction in stillbirth rate was observed at Machakos L5 GH (44.4%).

r. The change in fresh stillbirth rate did not improve significantly with Nakuru PGH excluded from the analysis (3% vs. 0% at 6 months, 14% vs. 10% at 12 months).

s. There was no increase in the number of women receiving SBA at 6 months and only 3.8% mean increase at 12 months post intervention compared to baseline. There was no reduction observed in Nakuru PGH, Kisii L5 DGH and Mombassa PGH.

t. The highest increase in the number of women receiving skilled birth attendance was observed at Mbagathi General Hospital (58.2%).

u. There was a 6% reduction in the caesarean section rate at 6 months post intervention but the CSR was unchanged from baseline at 12 months post intervention.

v. There was a 53.8% mean increase in the proportion of breech vaginal deliveries conducted at 12 months post intervention compared to baseline, but the increase observed at 6 months was about 6 times more than that observed at 12 months post training (294%). The increase observed was statistically significant at 6 and 12 months post intervention.

w. There was no increase observed in the proportion of breech deliveries conducted in Nakuru PGH and Nyeri PGH. The largest increase was observed at Kisii level 5 GH (300%).

x. There was statistically significant increase in the number of assisted vaginal deliveries by vacuum extraction at 6 months and 12 months post intervention. This increase was observed

at all sites at 6 and 12 months post intervention except in Kakamega PGH at 12 months post intervention.

y. There was statistically significant increase in the proportion of assisted vaginal deliveries conducted by non-physician clinicians at 6 and 12 months post intervention. In three sites (Nyeri PGH, Kakamega PGH and Embu PGH midwives performed all assisted vaginal deliveries post intervention.

In conclusion there is evidence that the EmONC training intervention improved newborn health outcomes more (SBR and reduction in birth asphyxia) than maternal health outcomes (DOCFR). Training and retention of less than 80% of maternity care providers had a negative impact on key outcome indicators. Also the EmONC intervention significantly contributed to up-skilling of skilled health care workers and especially non-physician clinicians who perform critical obstetric skills such as vacuum extraction. These findings were consistent with qualitative results.

The next chapter will discuss the findings of this research in light of other studies presented in Chapter 2.

Chapter 7: Discussion

This chapter discusses the findings of this research in the light of existing evidence of effective EmONC training methods, designs for evaluating EmONC training and effective components of EmONC training programmes. The main findings are highlighted and discussed, the study strengths and limitations are discussed, and the implication of the study for policy, practice and future research are presented also presented.

7.1. Introduction

There is evidence that EmOC and skilled attendance at birth, usually provided by health care workers working within a functional health care system, can reduce the risk of maternal and newborn morbidity/mortality death (Bailey et al. 2006, Bullough et al. 2005, Paxton et al. 2005).

There is also evidence that health care workers who care for women during pregnancy, delivery and the puerperium lack appropriate skills and knowledge to do so effectively and that they require additional training and support to provide an improved standard of care during these periods (Harvey et al. 2007, Penny, Murray 2000).

A variety of EmONC training packages have being implemented in resource-poor settings to address this but it is unclear if these training packages are effective and if so, which of their components are most effective or what the most effective way of implementing this type of training is. Therefore it is important that EmONC training interventions should be well described and evaluated, findings disseminated widely to inform programmes and facilitate formulation of relevant in-service training policy. EmONC training interventions found to be effective can be replicated in similar settings and potentially contribute to accelerated progress towards MDGs 4 and 5.

In this research, I reviewed the various EmONC training packages currently available in low-resource settings, identified effective components of training programmes and evaluated the LSTM EmONC training package implemented in Kenya. The findings of this research will be discussed in this Chapter.

I will summarise the main findings by the 4 levels of the adapted evaluation framework used, discuss these in the light of literature review presented in Chapter 2, highlighting any important differences, and discuss limitations of the study, the implications of this study for policy and research.

7.2. Main findings

7.2.1. EmONC training packages in low resourced settings

20 EmONC in-service training programmes implemented in LMIC were identified. The content of 85% of the programmes identified includes EmOC signal functions. 25% or 5 of these training are designed for specific professional cadre (For example medical doctors, midwives or specialists trained separately) others involve training of mixed groups of health care providers. 13 or 65% of the course have duration of less than 7 days.

Training evaluation reports were available for only half of the training programmes identified and evaluation was mainly at Kirkpatrick's level 1, 2 or 3. There were only two studies evaluated at 3 levels (behaviour) and there were no evaluations at level 4 (health outcomes) amongst EmONC training programmes implemented in LMICs. Of the 33 training evaluation reports identified from resource-limited countries, two were RCTs and 23 were before/after studies.

7.2.2. Effective components of EmONC training packages

The characteristics of effective EmOC training courses identified that are potentially applicable are applicable to LMIC settings include the following

1. Use of competency-based approach with a combination of didactic and simulation-based teaching methods,
2. Use of adult learning techniques,
3. Multidisciplinary training (training various cadres of SBAs such as medical doctors and midwives together) and
4. On-site training

The impact of multidisciplinary training can be maximized if a critical mass of maternity care providers within the same maternity unit is trained. The content of any training package should be clear, have a strong focus on EmOC that reflects clinical practice and caseload in LMIC settings, and promotes evidence-based practice. A high-impact course of short duration is likely to be most beneficial and cost-effective, and ensures clinical services can be maintained even with the current

shortages in human resources (Gerein, Green & Pearson 2006, Penny, Murray 2000, World Health Organisation 2012b).

There is evidence that short courses in EmOC can result in improved knowledge, skills and confidence of health care providers. Multidisciplinary team training results in improved communication and teamwork in emergency obstetric situations but there is currently insufficient evidence to show that specific teamwork training with no obstetric skills training is beneficial. EmOC training is likely to improve clinical practice and availability of EmOC signal functions but the evidence for this is still weak.

Evaluation of some training programmes identified in this research – that are predominantly simulation based and have a component of peer support or master trainers/supportive supervisors being used to reinforce training including provision of refresher trainings or relevant continuous medical education sessions (Nelissen et al. 2014, Msemo et al. 2013, Osei et al. 2005, McDermott et al. 2001) – were effective at Kirkpatrick levels 3 and 4 (change in practice and health outcomes)

There is a need for more robust evaluation of the effectiveness of training in EmOC in isolation or in combination with other interventions (Black, Brocklehurst 2003, Van Lonkhuijzen et al. 2010). The role of strengthened supportive supervision to sustain retention of newly acquired knowledge and skills and translation into improved clinical practice needs further exploration.

7.2.3. Results of evaluation of EmONC training

The following are the main findings from the evaluation of EmONC training implemented in Kenya in this study.

A. Reaction to training (level 1)

Multidisciplinary teams of maternity care providers from 10 CEmOC health facilities were trained. Over 70% of all identified maternity care providers from all 10 hospitals were trained. 83% (328) of the 400 health care workers trained are midwives, 6% (26) were medical doctors, 2% (8) were clinical officers and 3% (11) were obstetricians. By 12 months post intervention an average of 83% of all maternity care staff except for Nakuru PGH (23%) and Mbagathi GH (50%) were trained.

Trainees reacted positively to all lectures, overall average score was 9.38/10, the highest score was in preventing obstructed labour module (N= 376, mean score: 9.48, SD: 0.71) and the lowest mean score was in the Shock and unconscious patients module (N= 369, mean score: 9.28, SD: 0.92)

Maternity care workers accepted the sort competency based multidisciplinary EmONC training.

B. Learning (Level 2)

375 (94%) trainees participated in the knowledge assessments. There was a statistically significant difference between the pre and post training knowledge scores in all modules except in the module; preventing obstructed labour (n=346, 373, mean difference 0.10, SE 0.08, CI **0.06-0.26) p<0.001.**

Between 32 and 38 trainees were assessed for skills per module, the **lowest mean difference** was in the **complications of abortions module** 2.77 CI (2.06-3.47), SD=1.99, p<0.001, while the **highest mean difference** was in the **Obstetric emergencies (Shoulder dystocia/breech) module** 4.56 (3.89-5.22), SD=1.95, p<0.001.

Maternity care workers showed statistically significant improvements in knowledge and skills immediately after the training compared to before.

C. Behaviour (level 3)

153 data sources were collected over 12 months and analysed; 73.2% (112) were focus group discussions, paired interviews or in-depth interviews and 26.8% (41) were key informant interviews 49% (184) and 34.5% (129) of trained maternity health care workers participated in the FGDs/PIs/IDIs at 3 and 12 months post intervention respectively while 20 key informants (medical superintendents, hospital administrators, nursing Officer in-charge/director of nursing services, maternity/labour ward in-charge, obstetrician/gynaecologists) were interviewed at 12 months post intervention and 11 at 3 months post intervention.

The findings at level 3 were consistent with those from level 1 and 2 for acceptability of the training package and, usefulness of the knowledge and skills.

The 8 themes that emerged from the data were; usefulness of the EmONC training, impact of supportive supervisors/ Master trainers, impact of provision of EmONC equipment on practice post training, impact of the training, improved organisation of care, maximizing the benefits of the intervention, barriers to provision of EmOC post intervention, enablers to performing EmOC post training, and barriers to providing EmONC post training.

Maternity care providers were very satisfied with the content and methods of training. Training of medical doctors and non-physician clinicians together appears to have made a significant contribution to changes in behaviour and practice; the process of supportive supervision has also helped to achieve this.

Improved communication within teams is also reported to be a direct effect of the multidisciplinary training approach. Availability of training equipment, and follow-up and supportive supervision, also contributed to behaviour change.

There was evidence of up-skilling; non-physician clinicians were supported by medical doctors and senior midwives to change their practice and perform EmONC signal functions usually provided, prior to the intervention, by medical doctors only. The direct impact is reduction in treatment delays, improved availability of quality EmONC, improved maternity care worker and increased patient satisfaction.

Barriers to behaviour change post training identified by level 3 evaluation participants were; lack of supervisors at night, late arrival of patients with severe complications, lack of clarity on scope of nursing/midwifery practice, and non-involvement of obstetricians and senior midwives.

Participants reported that non-training of medical interns was a missed opportunity given their role as first on call in maternity units. They also recommended that the intervention could have a greater effect if health care providers from lower level health call facilities were trained. Other factors likely to improve the effectiveness of the intervention are favourable staff retention policies and, support from hospital managers and senior clinicians and midwives.

Evaluation at level 3 shows that training intervention resulted in a positive change in behaviour and practice. The results on acceptance of the EmONC training programme content and training methods were consistent with those from level 2 evaluation.

D. Results (level 4)

Data for 3 'up-skilling' indicators, 5 indicators to evaluate any change in availability of skilled birth attendance and EmOC and 3 health outcome indicators were collected and analysed. A summary of the overall results, trends and analysis without PGH Nakuru (poor staff retention during the study) are presented as follows;

There was a 53.8% mean increase in the proportion of breech vaginal deliveries conducted at 12 months post intervention compared to baseline, but the increase observed at 6 months was about 6 times more than that observed at 12 months post training (294%). The increase at 6 months was statistically significant but not at 12 months post training. There was 80% mean increase in the proportion of vacuum extractions performed at 12 months post intervention compared to baseline.

There was statistically significant, 100% mean increase in the proportion of vacuum extractions performed by non-physician clinicians at 12 months post intervention compared to baseline.

There was no increase in the number of deliveries at 6 months and only 3.8% mean increase at 12 months post intervention compared to baseline. There was no change in the mean caesarean section rate at 12 months (21.5%) post intervention compared to baseline (21.5%). There were more obstetric complications recorded in all hospitals at 6 months (1989) and 12 months (1911) compared to baseline (1146). There was 73.6% and 66.8% increase in obstetric complications recorded and managed at 6 and 12 months post training respectively.

There was 34% mean reduction in the stillbirth rate at 12 months post intervention compared to baseline. There was 10% mean reduction in the fresh stillbirth rate at 12 months post intervention compared to baseline this was not statistically significant.

Of the 5 health care facilities not providing all the EmOC SF at baseline, all improved by 1 SF at 6 months and 4 improved by 1 SF at 12 months post intervention. The 5 HCF that had all EmOC SF at baseline maintained this at 6 months and 4 maintained this at 12 months. Assisted vaginal delivery by vacuum extraction was the least available EmOC SF and was only performed by medical doctors at baseline. At 12 months post intervention, non-physician clinicians performed this as well and in all facilities.

There was a 21% and 48% mean reduction in the proportion of newborns admitted to newborn care unit at 6 and 12 months respectively post intervention compared to baseline however this was not statistically significant.

There was a 35% mean reduction in the direct obstetric case fatality rate at 12 months post intervention compared to baseline, which was not statistically significant.

There was an expected increasing trend for number of complications recorded and treated, availability of SBA and EmOC. There was also an expected decreasing trend in the proportion of newborns admitted to NBU for birth asphyxia, DOCFR and SBR. There was no change in C/S rate or Fresh stillbirth rate.

For the health outcome indicators, when PGH Nakuru was excluded from the analysis, a non-statistically significant but greater effect at 12 months compared to baseline was observed for complications recorded and treated (87.9% vs. 66.8%), DOCFR (47% vs. 35%), SBR (66% vs. 34%) and FSBR (14 vs. 10%).

Overall the EmONC training intervention resulted in improved 'up-skilling' of maternity care providers, a trend towards improved availability of SBA and EmOC and improved health outcomes.

7.3. Discussion of results

One of the earliest in-service training packages was developed by the American College of Nurse-Midwives (ACNM) and was designed to be primarily competency based (emphasis on acquiring skills through repetition through hands-on practice) (Penny, Murray 2000). More recently, shorter competency-based courses, usually 1–5 days in duration, have been developed, including the Advanced Life Support in Obstetrics course (ALSO – 1990), Managing Obstetric Emergencies and Trauma (MOET – 1998), Advances in Labour and Risk Management (ALARM – 2003), Essential Surgical Skills with Emphasis on Emergency Maternal and Newborn Health (ESS-EMNH – 2007), Essential Steps in Managing Obstetric Emergencies (ESMOE– 2008), Practical Obstetric Multi-Professional Training (PROMPT– 2009), PRONTO (2009), Essential Newborn Care Course (ENCC – 2010), Helping Babies Breathe (HBB – 2011) and Helping Mothers Survive Bleeding after Childbirth (HMS-BAC – 2013).

EmOC in-service training such as ALARM, ALSO, MOET and PROMPT are mandatory for health care providers working in well-resourced countries, all delivered off site except for PROMPT (Sibanda et al. 2009). PROMPT has the additional advantage of training multidisciplinary maternity care teams together within their local setting. Such courses are usually tailored around the predominant causes of maternal deaths in those settings, which may be different from those in LMIC (Khan et al. 2006). The quality of pre-service training, clinical practice and patient caseload in these settings will also vary from that in LMIC countries. Some of these training programmes have had varying degrees of adaptation for delivery in LMIC countries (MOET, ALSO, PROMPT) (Johanson et al. 2002b, Sorensen et al. 2011, Blackwell-Smyth, Breen & Hinshaw 2004, Sibanda et al. 2009, Deering et al. 2009, Child health Advocacy international 2007), but have not been fully evaluated at all levels based on the adapted Kirkpatrick framework.

Some EmOC training courses designed specifically for a low-resource country setting include the Life Saving Skills Emergency Obstetric Care course (LSS-EOC & NC) (Ameh et al. 2012a, Grady et al. 2011, Van Den Broek 2007), Essential Steps in Managing Obstetric Emergencies (ESMOE) (Frank, Lombaard & Pattinson 2009), PRONTO (Walker et al. 2012), Essential Surgical Skills with Emphasis on Emergency Maternal and Newborn Health (ESS-EMNH) (Child health Advocacy international 2007), the Pacific Emergency Obstetric Course (PEOC), Helping Babies Breathe (HBB), and Helping Mothers Survive Bleeding After Childbirth (HMS-BAC). Since 2009 the PROMPT course has been adapted for

delivery in LMICs (Sibanda et al. 2009). The LSS-EOC & NC training package training package which specifically includes the nine signal functions of EmOC (WHO et al. 2009, Van Den Broek 2007) and was developed along with an evaluation framework, based on adaptation of the Kirkpatrick model described in 1952 (Kirkpatrick 1996a) was evaluated in this research.

Training evaluation studies have generally been limited to assessment of knowledge and skills of the health care provider, usually before and after the training. The assumption has been that increased skills and knowledge will translate into improved clinical practice and there is some evidence to suggest this does occur (Van Lonkhuijzen et al. 2010).

EmONC training evaluation study designs

Study designs recommended by the Cochrane Effective Practice and Organization of Care (EPOC) Group for inclusion in educational systematic reviews are randomized control trials (RCTs), non-RCTs, controlled before/after (CBA) studies and interrupted time series (ITS) (Cochrane Effective Practice and Organisation of Care Group 2013). 29 of the studies included in this review were ITS or before and after studies, and 1 qualitative study. 11 of the RCTs were conducted in high-income countries.

Many of the available reports and studies evaluating training programmes in LMIC have poor study designs and made limited use of qualitative methodology; this is consistent with reports from 2 earlier systematic reviews (Van Lonkhuijzen et al. 2010, Rabøl, Østergaard & Mogensen 2010).

The cross-sectional stepped wedge variant of cluster randomized study design was used in this study and cluster randomized study design has been used in other studies (Brown, Lilford 2006, Mdege et al. 2011, Woertman et al. 2013, Hemming, Girling 2013, Dumont et al. 2013, Dumont et al. 2013). The health care facility was the unit of randomisation while the patients were the units of analysis for outcome measures. The cross-sectional stepped wedge variant has the advantage of significant reduction in sample size (including fewer clusters) and implementation cost compared to a parallel cluster randomized control trial (Woertman et al. 2013, Hemming, Girling 2013). It also allows for improvements of the intervention or its method of delivery before the next implementation phase (Mdege et al. 2011). The step wedge design (SWD) also permits a before/after comparison within each cluster; this tends to limit the impact of cluster effects such as the intervention effect being confounded with time. The SWD is also preferred to and more efficient than the parallel CTR design when the ratio of the between-cluster variance to the total variance (intra-cluster correlation – ICC) is high (Hemming, Girling 2013). The disadvantages of this design are that it takes a longer time to

complete compared to traditional parallel design, especially if the effect is expected immediately after the intervention and there is a potential for contamination between those receiving the intervention and those waiting to receive it, challenges of information bias. This is likely to occur if those assessing the outcomes are not blind to the status of the participant (intervention or control group) at a particular stage (Brown, Lilford 2006). Also, the effect of the intervention on the first cluster may be reduced by the time the last cluster receives the intervention. The design effect corrects for clustering and the stepped wedge effect. There is an inverse relationship between the design effect and number of baseline measurements, number of steps and number of measurements after each step. Also, increasing the size of each cluster increases the design effect. The intra-cluster correlation (ICC) is the variation between clusters and its value depends on the population subjects, type of clusters and type of outcome measure. The ICC will increase with the design effect up to about 0.05 when it starts to decrease (Woertman et al. 2013, Hussey, Hughes 2007).

In this study, health care facilities were clustered conveniently based on geographical proximity, and the order in which each cluster received the intervention was determined randomly, due to the extent of variability within and between clusters, and extent of missing data pre-intervention (more missing data greater than 3 months pre-training compared to data from 3 months post training to 12 months post training), outcome analysis was conducted using a before/after approach by paired student t-tests. The before and after approach to analysis is less powerful because there are no matched controls. It is also weaker than RCTs with respect to establishing a cause/effect relationship.

To ensure that training translates into practice, good-quality operational research designs are required (Remme et al. 2010). This research was conducted as an operational study, one that was conducted within a functional health system, to generate evidence to improve EmONC training programmes and the quality of EmOC provided within the main referral hospitals in Kenya (Zachariah et al. 2009).

Routinely collected quantitative data was used for this study; following training of master trainers/supportive supervisors, it was expected that this quality of data will improve. This expectation is consistent with that reported from other operational research studies (Harries, Zachariah & Maher 2013). The quality of data collected from health care facilities was observed to have improved with time in this study; however, in a few instances the data for 9 and 12 months were missing for some outcome measures. This may suggest a reduced data quality in some sites

after 6 months, associated with reduced external visits (there was no external visit at 9 months post intervention).

Evaluation framework

In order to adequately answer the research questions and conduct a detailed evaluation of the training intervention, the technique for evaluation of training programmes described by Donald and James Kirkpatrick was adapted for use (Kirkpatrick 1996a).

The adapted Kirkpatrick evaluation framework used allowed for comprehensive evaluation of the training within an existing health care system. The use of mixed research methodology (qualitative and quantitative approaches) allowed for exploration and deep understanding of both quantitative and emerging qualitative data. This approach was complementary and appropriate since one method alone may not sufficiently address all the facets of a comprehensive evaluation, highlighting unique situations in a particular study site. It can be argued that it was difficult to isolate and evaluate a particular aspect of the training intervention – for example, was it the training alone or the training plus equipment supply or even the supportive supervision (presence of trained trainers within each sites, who actively supported their less experience colleagues to change behaviour and practice) that made a difference? What was the influence of the periodic visits by the researcher to study sites for data collection? Did these visits facilitate reflection on substandard practice and the resolution to improve by the next visit? Just like applied research, did the research process facilitate change in practice during the lifetime of the research? Will the improvements observed during this study be sustained after the 12-month follow-up/evaluation period?

Few emergency obstetric care training programmes have been evaluated at any level of Kirkpatrick's framework for evaluating training programmes. The results of this research show that most EmONC training evaluations have been at health care provider level and conducted around the time of the training (Kirkpatrick's level 1 and 2); just over half of the studies identified reported on evaluation that included Kirkpatrick's level 3, and no studies from low-resource settings were performed at all four levels described by Kirkpatrick **(Table 5**). These results are consistent with a 2010 systematic review by Van Lonkhuijzen et al. (2010) and a 2013 review by Calvert et al. (2013).

This is the only study evaluating a complete EmONC training package (covering every signal function of EmOC) in a resource-limited setting at all four levels of Kirkpatrick framework for evaluating training programmes.

The main reason for lack of evaluation of EmONC training at Kirkpatrick level 4 as identified in the literature is the several confounding factors that make it difficult to attribute the effect seen exclusively to training conducted. It is recognized that training alone has often been insufficient to improve health care services (Penny, Murray 2000). The WHO has promoted a broader approach to in-service training since 1993, one that focuses on complementary initiatives that provide greater support for health care workers and promotes job satisfaction (World Health Organization 1993). McAuliffe et al., in a cross-sectional descriptive study of 2,043 health care providers in EmOC from Tanzania, Malawi and Zimbabwe to determine factors affecting performance, motivation and staff retention, concluded that good supportive supervision and strong health care facility leadership and management were predictive of high levels of job satisfaction and low intentions to leave (McAuliffe et al. 2013)

Training interventions are not usually implemented as standalone interventions in low-resource settings. Nyamtema and colleagues in a systematic review on the impact of maternal health programmes in resource-limited countries reported that 52%–65% of the 54 programmes included in the review had multiple interventions, including EmONC training (Nyamtema, Urassa & van Roosmalen 2011).

Skilled health care workers require an 'enabling environment' (drugs, supplies, policies and referral system) and on-the-job support/mentoring to function optimally in order to impact positively on maternal health outcomes. Therefore, in-service training programmes have to be implemented in the context of an 'enabling environment' to be effective. Health care providers actually providing maternity care need to be trained in sufficient numbers, supported and retained within maternity services to make an impact on maternal morbidity/mortality.

The intervention used in this research had various components: training, support to trainees through trained trainers/supervisors, provision of essential equipment required to perform EmOC (if lacking) and monitoring/evaluation/follow-up. The design recognizes the complexity of improving maternal and newborn health is not uncommon (Kestler et al. 2013, Makuwani et al. 2010, Nyamtema et al. 2011, Ersdal, Singhal 2013, Ersdal et al. 2013, Msemo et al. 2013, Penny, Murray 2000).

Critical to the design and implementation approach used in this research was strict selection of trainees; this was to ensure that only maternity care numbers are trained. Also, it was important to train them in sufficient numbers, the rationale being that a critical mass of trained maternity workers is more likely to result in 'institutional' behaviour change, change in practice and improvement in health outcomes. Therefore, multidisciplinary teams of maternity care providers from each site were trained at the same time, thus allowing teams to reflect on and discuss context-specific challenges to providing quality maternity care (Black, Brocklehurst 2003). This approach is consistent with evidence of improved communication, knowledge, skills and teamwork found in the literature (**Chapter 2).**

In a recent review of interventions to improve quality of maternal and neonatal care interventions implemented in Asia and Europe since 2001, Bacci reported that challenges with high staff turnover limited the impact and sustainability of EmONC in-service training interventions (Bacci 2014). He also reported that the introduction of supportive supervision, peer–peer review and practice, and introduction of WHO guidelines on maternal and newborn care were strengths of the Making Pregnancy Safer strategy to improve maternal health implemented by the WHO Regional Office for Europe. This was used to complement the EmONC effective perinatal care training package and the introduction of maternal morbidity and mortality case reviews.

7.3.1. Evaluation of EmOC training

A. Reaction to training (level 1)

Most health care workers trained were midwives and these are the cadre of staff who are at the frontline of maternity care in Kenya. Medical interns who spend only four months in the maternity section during a one-year internship period, when available, are more likely to see/attend to obstetric emergencies alongside midwives are the first to be called by attending midwives. These interns have had limited obstetric training and are likely to benefit from the kind of EmONC training implemented in this study. Homaifar et al. (2013) in Rwanda demonstrated that final-year medical students significantly improved their knowledge and skills after an ALSO training course (Homaifar et al. 2013). Frank et al. (2009) demonstrated that the ESMOE training packages (adapted from the LSTM EmONC training package used in this study) improved knowledge and skills significantly in medical interns pre-obstetric-rotation compared to a group of medical interns who had completed the obstetrics rotation but did not have the ESMOE training (Frank, Lombaard & Pattinson 2009). Both studies strengthen the argument for both revised pre-service training methods and pre-obstetrics training of medical interns in EmONC. The impact of this study might have been greater if

medical interns had been trained but this did not get the support of the stakeholders at the study sites.

EmONC training evaluated in this research was conducted within the study sites using low-fidelity training equipment, located as close as possible (usually using medical training institutions located next to the study sites). This approach is sustainable within a resource-poor setting compared to training within a simulation centre. This approach is consistent with evidence on training location and equipment (Crofts et al. 2006, Crofts et al. 2007b).

The teaching methods used to implement the EmONC training course had both simulation and didactic teaching methods. Evidence from the level 1 and 2 feedback and qualitative findings show that the teaching approach contributed to the high positive reaction observed. Also consistent with other studies, trainees reported improved communication, teamwork, confidence, knowledge and skills (Crofts et al. 2006, Crofts et al. 2007b, Crofts et al. 2008b, Ellis et al. 2008, Cooper et al. 2011, Fisher et al. 2010, Daniels et al. 2010).

Level 1 assessment used self-administered questionnaires before and immediately after the training. The response rate was high (95%) and all forms had very little missing information; this can be attributed to the well-grounded training and evaluation protocol used. Participants were encouraged to complete the forms as soon as the relevant activity was completed and the completed forms were retrieved immediately after the training. Also, reassurance of anonymity encouraged unbiased and complete feedback. Other studies that were evaluated at level 1 but at longer intervals after the training had much lower response rates (Black, Brocklehurst 2003). The four areas relevant the level 1-evaluation forms as prescribed by Kirkpatrick covered training intervention areas: “the course, content, instructor (facilitator/trainer) and relevancy to the job” (Kirkpatrick 1996b).

The results of evaluation at level one of this study were consistent with those obtained from other studies with a similar evaluation framework (Walker et al. 2012, Grady et al. 2011, Evans et al. 2014, Nelissen et al. 2014, Black, Brocklehurst 2003)

As part of level 1 and level 3 evaluations, trained health care workers requested more time for hands-on learning; this is similar to findings from other studies (Nelissen et al. 2014, Grady et al. 2009, Grady et al. 2011, Ameh et al. 2012a). This may be because health care workers are not used to this method of training, where a lot is covered within a short time using a learner-centred approach and both didactic and simulation-based teaching methods (Penny, Murray 2000).

Although level 1 evaluations may be subject to 'courtesy' conventions, the data collection tool provided opportunities for comments and the qualitative evaluations at 3, 6 and 12 months with further opportunities to explore the level 1 results. The results at level 1 and 3 were consistent and complementary.

B. Learning (Level 2)

There was statistically significant improvement in both knowledge and skills required for newborn resuscitation in this study; this was similar to other studies in sub-Saharan Africa (Ersdal, Singhal 2013, Ersdal et al. 2013).

In the two studies that evaluated the Helping Mothers Survive training programme, pre-training knowledge test results increased significantly compared to post-training test results; however, there was no significant improvement in skills (both trainees and local trainers were tested in the Nelissen et al. 2014 study)(Nelissen et al. 2014, Evans et al. 2014). Also, the Evans et al. (2014) study reported that there was no significant improvement in knowledge scores for professional cadres who had high pre-training scores. In the current study, specialist medical doctors had the highest pre-training scores in both knowledge and skills, and there was statistically significant improvement in both post-training assessments. These results are interesting because the LSTM EmONC training package evaluated in this research has an obstetric haemorrhage module of two-hour duration compared to one full day in the Helping Mothers Survive training package. The difference in results may be related to the quality of facilitation. In their initial evaluation, Nelissen et al. reported on the quality of facilitation by local trained trainers and recommended an improved training of trainer's curriculum (Nelissen et al. 2014). The results are also consistent with the evaluation of the same training in other settings (Ameh et al. 2012a, Grady et al. 2011), as well as other studies conducted in both LMIC and well-resourced settings (Van Lonkhuijzen et al. 2010, Black, Brocklehurst 2003).

Evaluation of two models of in-service training programmes for midwives in Indonesia based on mixed research methods (quantitative: knowledge and skills, self-reported confidence, qualitative: interviews) concluded that longer, more expensive lifesaving skills in-service training programmes produced more competent midwives, especially in practical skills such as manual removal of placenta, bimanual compression, and newborn resuscitation. There was no statistical difference between the knowledge of midwives trained with a shorter, more intensive programme without peer review and CME compared to those who had longer training, peer review and CME (McDermott et al. 2001). The basis of this study was to help inform policymakers on the model of training to adopt; the study was inconclusive on its recommendations but suggested that the difference

between the two groups observed was probably associated with the number of training opportunities available. Also, the study indicated that improved pre-service training is likely to improve the competencies of midwives on graduation, reducing the need for long intensive in-service training programmes. Other studies have shown that SBAs may not be competent and that the pre-service training curriculum may be deficient (Harvey et al. 2007)

During the longer programme midwives were exposed to more clinical cases compared to those on the shorter programme. These results could have been different if the shorter programme also had a peer review and CME component (McDermott et al. 2001). In the current study the intervention was short hands-on training, with on-site supervision/peer review/support with CME, although there was no direct comparison with the modified MoH LSS programme (two–three weeks duration) which had been attended by very few health care providers; trained staff were more satisfied with the LSTM EmONC training intervention and reported improved confidence, and there was evidence of change in practice and improvement in health outcomes.

A descriptive cross-sectional study conducted in Nairobi before the intervention, to determine the utilisation of the partograph in the management of labour in nine health care facilities (including one of the study sites) reported low utilization. Reasons for these were poor knowledge, conflict in perception of roles, lack of basic tools for labour monitoring and lack of supervision (Ziraba et al. 2009). Multidisciplinary training like the EmONC training intervention evaluated in this research addressed all the problems identified in that study. The qualitative data showed how the catalytic effect of the training resulted in advocacy at hospital level for updating and printing of the modified WHO partograph; this facilitated the immediate use of the skills acquired, and change in practice was facilitated by medical doctors, obstetricians and trained supervisors (this includes senior midwives) at each site. An audit of partographs used before and after the intervention would have strengthened the evidence in favour of the impact of the training intervention. New EmONC signal functions proposed by Gabrysch et al. (2012) cover three dimensions of care (general requirements for health care facility, routine care, basic EmOC and CEmOC) including a specific function of "monitoring and management of labour using partograph" (Gabrysch et al. 2012). However, using this signal function to evaluate the effectiveness of a training intervention will involve developing a minimum standard expected to conclude that this signal function is available and that its correct use can be attributed to the training.

One of the key steps prior to implementation of the training package in all sites was engagement with both national and local stakeholders; this was consistent with the first 6 steps for effective

training evaluation recommended by Kirkpatrick (Kirkpatrick 1996b). This was important to allow for any local adaptation to the training programme and to ensure that there is good understanding and support for the intervention.

One of the key assumptions of this study was that training of 80% or more and retention of maternity care providers will result in improved quality of emergency obstetric care provided to pregnant women during pregnancy and childbirth, as well as improved quality of newborn care. Having a critical number of trained staff on every shift was expected to make a difference after the intervention.

The approach of critical mass training used in this study is different from the approach used by other EmONC training programmes designed for low-resource settings. In those programmes few members of each team are trained who are expected to train other team members on the job (Child health Advocacy international 2007, Osei et al. 2005). Based on evidence generated from level 3 qualitative data in this study, those selected for the Kenya MoH two-week training programme were the senior midwives in-charge.

Assumptions made in this study will likely affect health care facility outcome measures, for example very few trained staff are unlikely to make an impact, lack of equipment will restrict the provision of EmOC signal functions such as MVA, AVD and caesarean section, and low facility utilization will limit the performance of EmOC. The extent to which each of the assumptions affects the results was not determined in this study.

Engagement with key stakeholders during planning facilitated appropriate selection of trainees and provided an opportunity to advocate for staff retention post training; however, this was beyond the control of the intervention programme. The intervention sites were the main level 5 regional referral hospitals in Kenya, so other than during labour disputes involving health care providers, they are expected to have sufficient caseload. All sites were provided with EmOC equipment that was lacking immediately after the training (delay of one to two months in cluster 1).

Nakuru PGH only retained 38.5% of trained maternity staff at 3 months and only 23% at 12 months. This is reflected in these three indicators compared to the mean for all other study sites.

Although there was a national policy of annual staff rotation from a particular ward, with early and constant engagement with health care facility managers throughout the programme, a high level of staff retention was observed in all study sites except Nakuru Province Hospital (23%) and Mbagathi

General Hospital (50%). In both hospitals it was difficult to engage with the nursing officers in charge, who were eventually replaced during the follow-up period. The poor staff retention observed at the end of the evaluation at Nakuru PGH and Mbagathi may have been due to lack of appreciation of the potential benefits of the intervention, lack of policy on staff training and possibly poor leadership.

There have been several interventions with policies to ensure that skilled staff are equitably distributed in many low-resource settings, and this has worked in some settings like Sri Lanka and Malaysia; however, in a country like Nigeria that makes a significant contribution to global maternal mortality ratio, the gains have been uneven (Koblinsky 2003, Abimbola et al. 2012). Abimbola et al. (2012) reported that the midwifery service scheme set up to address poor availability of skilled attendance at birth faced major challenges that included difficulties with staff retention and availability and training of midwives, poor commitment from stakeholders and low demand for health care facility delivery (Abimbola et al. 2012).

The qualitative results show that maternity care providers had improved confidence to provide EmOC, and felt supported to do so by trained trainers/supportive supervisors and medical doctors. Health care providers also reported better job satisfaction associated with the intervention that appeared to be associated with their observation of improved health outcomes for women and their newborns.

In a cross-sectional descriptive study of 2,043 health care providers in EmOC from Tanzania, Malawi and Zimbabwe to determine factors affecting performance, motivation and staff retention, McAuliffe et al. concluded that good supportive supervision and strong health care facility leadership and management were predictive of high levels of job satisfaction and low intentions to leave (McAuliffe et al. 2013).

C. Behaviour (level 3)

Qualitative research methods were used to collect information (153 data sources) on behaviour/change in practice. Data from key informants, focus groups, paired interviews, level 1 evaluation results and quantitative data were triangulated to reach conclusions. The written comments about the training provided by trainees after the training were consistent with those obtained at 3, 6 and 12 months post training. In a before/after study to evaluation of HBB training in Kenya and Pakistan, Sighal et al. (2012) used focus group discussions to complement data obtained from Kirkpatrick level 1 (Singhal et al. 2012).

The qualitative research method provided an opportunity to explore the quantitative results further. The results suggest improved quality of care based on improved communication between medical doctors and midwives, improved communication with women seeking and receiving care, reorganisation of resources (printing of partograph forms, organising of emergency boxes, stocking of maternity units with emergency obstetric care drugs) required to provide care, and treatment response time. Quality of care has various dimensions and perspectives; only the perspective of trainees and their managers were sought in this research, and the evidence would have been strengthened if the perspectives of women who received care from these facilities had been explored.

Health care workers reported that the multidisciplinary nature of the training was critical to change in practice, attitudes and behaviour. This defined a new positive relationship between midwives and medical doctors that was associated with improved trust and improved confidence by the midwives.

Support by trained supervisors and senior medical doctors appeared to be important for behaviour change and change in practice. Three factors were identified in this study that facilitated change in behaviour and practice: the training methodology, availability of EmOC equipment and availability of supportive supervision. This finding was similar to that reported by Mavalankar (2009), through a qualitative study (17 medical doctors trained to provide obstetric anasesthesia) used to evaluate the effectiveness of EmONC training (Mavalankar et al. 2009). Mavalankar reported two factors that facilitate change in behaviour after training (support to trainees by specialists and working within an enabling environment).

Other methods that have been used to evaluate behaviour change were direct observation of practice (Opiyo et al. 2008, Ersdal et al. 2013, Opiyo, English 2010, Meaney et al. 2010, Soørensen et al. 2010, Child Health Advocacy International 2010), use of logbooks (Cole-Ceesay et al. 2010), postal survey post training (Black, Brocklehurst 2003, Child Health Advocacy International 2007), retrospective analysis of secondary data (Clark, Mitchell & Aboagye 2010, Dijkman et al. 2010) and assessment of achievement goals set by trainees after the training (Walker et al. 2012). All of these studies showed change in behaviour amongst trained health care providers post training except the Ersdal (2013) study.

Evans (2009) and Ameh (2012) used both qualitative and quantitative methods to establish change in EmOC signal functions following training (Evans et al. 2009, Ameh et al. 2012a). In a BAS using a mixed research methodology study, to evaluate the PRONTO training course, Walker et al. (2012) assessed the achievement of goals set by the institutional teams trained; this was an interesting

method to get teams trained in EmOC to agree on practice changes to implement post training. The researchers then evaluated the health care teams against these goals at three months post training (Walker et al. 2012).

Midwifery teachers/tutors reported integrating EmONC training materials into their pre-service training curriculum after the intervention resulting in improved understanding of EmOC by their students. Taylor (1995) reported similar results after two-week training in EmOC (LSS). The interactive, hands-on and simulation-based learning rather than largely didactic learning may have been responsible for the results observed in both studies (Taylor 2010).

Maternity care providers trained reported that lack of supervisors at night, late arrival of patients with severe complications, lack of clarity on scope of nursing/midwifery practice, and non-involvement of obstetricians and senior midwives were limiting change in behaviour and practice. The training methodology used, availability of EmOC training equipment and the availability of supportive supervisors were identified by trained maternity care providers as factors responsible for behaviour change/change in practice. These findings are relevant in scaling up this intervention in Kenya or similar settings in order to achieve expected results.

D. Results (level 4)

16,764 deliveries and 1, 146 obstetric complications (6.8%) at baseline, 16,474 deliveries and 1, 989 (12.1%) obstetric complications at 6 months, and 17,404 deliveries and 1,911 (11%) obstetric complications were recorded during the study. More obstetric complications were recorded in all hospitals at 6 months and 12 months compared to baseline.

The three outcome measures were crude measures of ‘quality of care’ for women and newborns; direct obstetric case fatality rate, stillbirth rate and fresh stillbirth rate.

The crude measures of quality of care appeared to be more sensitive to availability of a critical mass of trained maternity care workers compared to performance of EmOC signal functions and proportion of AVDs by non-physician clinicians. A single midwife performing one AVD in three months will show improvement of EmOC signal functions and % of AVDs by midwives; however, the higher the number of trained staff successfully treating obstetric and newborn complications, the lower the DOCFR, SBR and FBSR.

There was reduction in DOCFR and SBR but this did not reach statistical significance however EmOC SF performed and proportion of AVD by midwives improved. This was not surprising because

experienced midwives were retained in the maternity unit after the intervention and could perform these EmONC procedures usually performed by medical doctors. These midwives were usually only present during the morning shift; the night shift was covered by more inexperienced staff, who had not received the training. More in-depth investigations to understand the extent of availability of EmOC at HCFs and explore reasons for these will improve the usefulness of this indicator (WHO et al. 2009).

Change in Direct Obstetric Case Fatality Rate

The mean reduction in DOCFR for all hospitals was 32% and 35% at 6 and 12 months, respectively, compared to 170% increase and 320% increase at 6 and 12 months, respectively, for Nakuru PGH. The mean reduction in DOCFR at 6 and 12 months for all study sites excluding Nakuru PGH was greater than with PGH Nakuru included.

It is possible that baseline DOCFR rates were high due to poor recognition and documentation of obstetric complications and this reduced with time due to increased recording of obstetric complications.

Generally, the recording of obstetric complications was poor at baseline and this improved in the course of the study. Only complications that could be uniformly defined between sites were used. Data on number of maternal deaths are fairly accurate. (Several sources of data were used: routine HMIS data from the records office, maternity/ward registers, operation theatre records, nursing records and maternal death review records.) Also, because records were collected at short intervals (every three months), it was easily to recall and trace records of any maternal death within that facility during the period under review.

Change in stillbirth rate

There was a 34% mean reduction in the stillbirth rate at 12 months post intervention compared to baseline and this was statistically significant. Excluding Nakuru PGH from the analysis, there was 66% reduction in SBR at 12 months post intervention compared to baseline. The data used to calculate SBR is more reliable as records of deliveries and deaths (based on data retrieval from maternity registers, operation theatre and nursing reporting books within three months). An evaluation of the ALSO course implemented in Tanzania (Newborn resuscitation part of content but no supportive supervision) also did not show any significant difference in stillbirth rate three months after the training (Sorensen et al. 2010). A before/after study conducted in a low-risk first-referral Zambia

hospital to evaluate the WHO ENC training programmes reported a significant decrease in early neonatal deaths due to decrease in deaths from birth asphyxia and infection but no decrease in stillbirth rates. The ENC training programme did not have any component for monitoring labour compared to the EmONC intervention evaluated in this research; this may explain the difference in stillbirth rates observed.

Change in fresh stillbirth rate

It was observed that the data for stillbirths (all) was more reliable than for fresh stillbirths alone. Usually health care workers are required to record whether a stillbirth is fresh or macerated (based on the integrity of the skin). However most of the stillbirths recorded during this study where not classified into macerated or fresh stillbirth.

There was a 10% reduction in fresh stillbirth rate but this did not reach statistical significance at 12 months compared to baseline; however, a similar study using a competency-based training approach (short training duration, mixed learning methods, more simulation-based than didactic, both studies used trained trainers as supervisors, and intermittent refresher training by the supervisors) for newborn resuscitation implemented in eight referral hospitals in Tanzania showed a 24% reduction in fresh stillbirth rate; however, data was collected two months pre-intervention and 24 months post intervention (Msemo et al. 2013).

Change in proportion of newborns admitted to newborn unit for birth asphyxia

There was a 21% and 48% mean reduction in the proportion of newborns admitted to newborn care unit at 6 and 12 months, respectively, post intervention compared to baseline. There was no reduction observed in Nakuru PGH and Kisii L5 GH but reductions were observed in hospitals they were paired with to receive the intervention. There was also no reduction in stillbirth rates at either site.

The largest change was observed in Pumwani Maternity Hospital, probably because a neonatal resuscitation training intervention had been implemented in that hospital 5 months prior to implementing the current EmONC training intervention (Opiyo et al. 2008). The Opiyo (2008) randomized controlled study reported a statistically significant reduction in the frequency harmful practices per resuscitation performed in the trained group compared to the control group. It will appear that the EmONC training implemented during the current study was complementary to the newborn resuscitation implemented by Opiyo et al, the Carlo et al. (2010) before/after study in

Zambia reported additional benefit when ENC-trained health care workers received additional newborn resuscitation (further reduction in 7 day early neonatal mortality rate). This is not surprising because the EmONC training course implemented in the current study included pregnancy monitoring and care; this has the potential to reduce intra-partum asphyxia while both ENC and newborn resuscitation programmes did not.

Newborn resuscitation

There is clear evidence that prompt basic resuscitation interventions within 60 seconds in babies who have delayed initiation of spontaneous respiration reduces birth-asphyxia-related deaths (Ersdal et al. 2012b, Ersdal, Singhal 2013, Lee et al. 2011b, Conroy et al. 2014). The APGAR score is usually used to assess the respiratory efforts at birth in a newborn; it also used in the prognosis of birth asphyxia but its effectiveness has recently been put into doubt. APGAR scores of 7 or more ideally are suggestive of good outcomes but in a recent prospective observational study 50% of newborns with five-minute APGAR score of 7 or more died (Ersdal et al. 2012a); this is much higher than the global estimate of 27% (United Nations Inter-agency Group for Child Mortality Estimation 2013) Ersdal et al. (2012) concluded that, although 61% of the neonatal deaths were due to birth asphyxia, the five-minute Apgar score was a poor surrogate of birth asphyxia (Ersdal et al. 2012a).

The findings of change in practice (level 3), and results at level 4 – 34% reduction in SBR CI (0.25–0.65) p=0.03, 42.7% reduction in the proportion of newborns admitted for birth asphyxia CI (1.7–2.9) p=0.28 – indicate that the training was effective; similar results from short in-service newborn resuscitation training have been reported in low-income countries (Opiyo et al. 2008, Ersdal et al. 2013, Ersdal et al. 2012b). Soørensen et al. (2010) used a prospective before and after study design to evaluate the ALSO course implemented in a Tanzania, and did not find any difference in stillbirth rates, APGAR scores or frequency of resuscitation at 3 months post training but reported a significant decrease in neonatal mortality.

The assumption that training a critical number of health care providers is more likely to change practice within maternity units than training a few was put to the test in this study. In spite of the detailed preparation for the training, working with stakeholders to ensure proper participant selection and agreement in principle to ensure staff were retained within the maternity wards after training, 60% of the staff trained at Nakuru PGH were redeployed to other wards in the hospital within three months of the training. The result was that there was no ‘positive’ change in 7 of the 10 outcomes measures, including all measures of quality of care used in this study. The reduction in

DOCFR and SBR at 6 and 12 months post intervention was greater with PGH Nakuru excluded from the analysis; this reached statistical significant for SBR only.

Caesarean section rate

C/S rate can be a measure of hospital efficiency (institutional C/S rate), while C/S rate used as an EmOC indicator is a population-based indicator that gives an overview of the availability of this critical EmOC service to a population in a geographical area – the denominator is the total expected live births in that area while the numerator is the total number of caesarean sections performed in all hospitals in that geographical area (WHO et al. 2009).

There was no change in institutional C/S rates observed following this intervention; perhaps if this intervention involved other units that referred women to these hospitals, improved management of women in labour and increased use of assisted vaginal delivery may have resulted in reduced C/S rates. This result is similar to that obtained during a prospective before/after study conducted in Tanzania to evaluate the ALSO training course (Sorensen et al. 2010).

In other studies that used institutional C/S rate, where significant increase in health facility deliveries have been observed following training interventions, an increase in caesarean section rates was also observed. In such studies where the objective was 'up-skilling' of non-physician clinicians to perform C/S, this indicator will be expected to increase. However, in two studies where the EmONC training of medical doctors and midwives was evaluated, the C/S rates decreased (Walker et al. 2014, Berglund et al. 2010), probably due to improved management of labour and improved case selection. In the current research, the training was to improve case selection for C/S, peri- and post-operative care, and improve recognition and management of intra-operative complications by medical doctors who already performed C/S and midwives (provide peri-operative and post-operative care). The study sites were major referral hospitals. Further investigation to determine the impact of the training on C/S performed is required; this may involve a comparative retrospective audit of case notes to determine any significant change in indications for C/S, pre-operative care, operative techniques, blood transfusion rates, post-operative care and post-operative recovery time.

Assisted vaginal deliveries

Overall the number of assisted vaginal deliveries performed after the intervention in each site was small but more staff compared to before the intervention was performing the procedure.

There was statistically significant increase in the number of assisted vaginal deliveries by vacuum extraction at 6 months and 12 months post intervention. This increase was observed at all sites at 6 and 12 months post intervention except at Kakamega PGH at 12 months post intervention. Soørensen et al. (2010) did not find an increase in AVD after training health care workers in EmONC (ALSO) in Tanzania (Sorensen et al. 2010).

Since medical doctors performed this signal function exclusively prior to the intervention, this indicator will not demonstrate if midwives have acquired this skill and are performing it but it gives an indication that more deliveries are being conducted by vacuum extraction after the intervention. Midwives conduct most vaginal deliveries and, if not trained, supported and empowered, they will be unable to perform assisted vaginal deliveries.

A further study to look into the outcome of the assisted vaginal deliveries would have strengthened the evidence from this study.

Up-skilling of non-physician clinicians

There was a 53.8% mean increase in the proportion of breech deliveries conducted at 12 months post intervention compared to baseline, but the increase observed at 6 months was about 6 times more than that observed at 12 months post training (294%). The increase observed was statistically significant at 6 and 12 months post intervention. This demonstrates the enthusiasm and confidence available soon after a new skill has been acquired. However, practice diminishes with time; this may be as a result of the influence of new staff and/or reduced level of supervision; however, key influential members of the team can determine the standard practice within a team, these include the senior medical doctors, obstetricians or/and senior midwives.

From the qualitative results, the training resulted in improved confidence to manage breech presentations; midwives did not have to wait for medical doctors anymore and reported successful outcomes (qualitative findings at level 3). It would have been useful to audit the outcome of vaginal breech deliveries following the training to support this evidence. In resource-poor settings, women with breech presentation may present in advanced stages of labour and caesarean section may not be readily available (lack of skilled medical doctors, anaesthetists and cost of services), so this skill can be life saving for the baby. Kakamega PGH, Nyeri PGH and Nakuru PGH had no change in the

proportion of breech vaginal delivery by 12 months post intervention. Nakuru PGH had trained senior labour ward staff but no junior staff; the implication is that this skill will only be available for a third of the day. In Nyeri PGH the obstetrician was untrained and insisted on caesarean section for all breech presentations, so the midwives did not feel supported to change their practice. Kakamega PGH had a significant increase in breech vaginal deliveries up to 6 months post training; however, with a change in the obstetrician, the situation became similar to that of Nyeri PGH. In-depth audit of the cases presenting as breech, looking at how far advanced in labour they presented, the method of delivery, decision–caesarean section interval and maternal and newborn outcomes will have improved the understanding of the situation in all three hospitals.

This EmONC training intervention resulted in significant up-skilling of non-physician clinicians; midwives could not perform assisted vaginal delivery and manual vacuum aspiration due to lack of skills, and due to a perception that they will not be supported by medical doctors/they were not supported by policy to perform these critical EmOC signal functions. In some instances the lack of required equipment contributed to the inability of these frontline SBAs to function optimally.

The qualitative data on increase in the number of assisted vaginal delivery by midwives is consistent with quantitative results (100% increase in AVD performed by non-physician clinicians post intervention). The qualitative results explain quantitative trends observed at 6 and 12 months post intervention where midwives performed most assisted vaginal delivery procedures. Trained midwives identified the mixed training methodology, support from medical doctors and availability of AVD equipment as key reasons for this trend. Similar results were reported by Basnet et al. (2004) in Nepal and Clark et al. (2010) in Ghana, following training of midwives in post-abortion care (Basnet et al. 2004, Clark, Mitchell & Aboagye 2010). Although in both training programmes nurses/midwives and medical doctors were trained separately, the availability of training equipment and supportive policies nationally and within the health care facilities were factors associated with midwives providing post-abortion care. Nyamtema et al. (2011) conducted a before and after study to evaluate a three-month CEmOC for non-physicians in Tanzania and found a significant increase in manual removal of placenta, MVAs, anaesthetic procedures and obstetric surgeries (Nyamtema et al. 2011).

7.4. Study limitations and strengths

A. <u>Strengths</u>

The study design allowed for an ethical, cost-effective and politically acceptable approach to implement and evaluate the intervention. The intervention was considered to have potential for a positive impact on maternal health and could not be implemented at the same time to all health care facilities involved.

Seasonal variations in obstetric complications can affect the outcome measures; however, this is likely to occur in both control and intervention health care facilities in a SWD study. In a before/after study however seasonal variations in utilization of health care facilities possibly due to reduced access (adverse weather conditions affecting road transport) may affect the results (fewer cases but also late arrival of complications likely to be associated with adverse health outcomes).

With the before/after study design, it was also likely that the impact of the intervention on health outcomes will be stronger soon after the intervention has been implemented and that this will reduce with time. This is because there is a possibility that staff trained in each unit will not be retained within the maternity unit; once a critical mass of trained staff is lost from the service, it is likely that the quality of care will reduce. This study was able to monitor the attrition of trained staff at each data collection point (baseline, training, 3, 6, 9 and 12 months post training).

The assessment at level 4 used objective, routinely collected health facility data, thus minimizing the risk of information bias. The quality of records was a concern, so only uniformly defined variables, such as ante-partum haemorrhage, retained placenta, eclampsia, ectopic pregnancy and ruptured uterus, were used for the calculation of CFR. Other variables such as obstructed labour were not defined uniformly across or even within the same health care facility. Also records were triangulated from multiple sources such as maternity, operation theatre, maternal death registers, blood transfusion registers, records department monthly summary sheets, and qualitative data. Trustworthiness of the findings was assured by triangulation of data from key informant interviews, focus group discussions, paired interviews and level 4 quantitative data analysis.

This study was conducted as an operational research; health facility managers and health system administrators were involved from the onset. The study highlighted challenges with routinely collected data, and in-service training programmes. Within a year of completion of the study, following dissemination of the results to Ministry of Health, obstetricians and midwifery associations in Kenya, a competency based approach to in-service EmONC training has been adopted. A 5 rather than 14 day EmONC training programme has been approved for implementation nationally. Standards and guidelines for implementing trainings have also been developed based on the findings

of this study. It was easy for the Kenya health systems managers to adopt the finds of this study because of their active participation throughout the study.

B. Limitations

In addition to limitations presented in the methodology section, limitations at level 2 and 4 are highlighted below.

Evaluation at Level 2

The assessors of level 2 skills testing were also trainers on the course; this has a potential for bias but two facilitators evaluated each participant and agreed on a final score. Participants who arrived late for the training were excluded from the pre-training assessments but included in the post-training assessments if they did not drop out of the training.

Although there were advantages to having homogenous groups for qualitative interviews (paired/triad or group discussions) (participants feeling safer and more comfortable with colleagues in the same job cadre), this has a potential to limit the extent of the discussion. A mixed group can also limit disclosure but may have allowed the research to study the team dynamics when assessing behaviour change.

Evaluation at level 4

The evidence on outcome measures could have been stronger if control sites were used; also increasing the sample size may have affected the results. If DCOFR was used to calculate the sample size, a larger sample size will have been arrived at. SBR was used because this data is more accurately recorded at referral hospitals compared to obstetric complications. This is because some obstetric complications are not uniformly defined across hospitals and the maternity registers may not be user friendly. In this study only uniformly defined obstetric complications were used and multiple sources of data where used to ensure that the data set was as complete as possible.

The study sites were all comprehensive EmOC facilities, the level of knowledge and skills of staff in these hospitals is likely to be much higher than at lower level health care facility. Therefore this study may have had different results if all health care facilities within a referral network were included in the intervention.

Data analysis was as for a before/after study rather than a SWD study. This was due to the extent of missing data required to perform a SWD analysis and the extent of intracluster variation. Having matched controlled sites will have strengthened the cause/effect conclusions from this study.

7.5. Implications for policy, practice and future research

7.5.1. Policy implications

Non-physician clinicians can be trained to provide EmOC; this is an important approach to address the shortage of SBAs in resource-limited settings that have high maternal mortality ratios. Short competency-based EmONC interventions based on evidence-based training methods can be effective in improving the quality of EmOC.

Long and ineffective EmONC training interventions may not represent the best use of resources, at a time when most countries lagging behind in achievement of the MDGs need to implement strategies likely to accelerate their MDG progress.

Policies to support implementation and evaluation of short competency-based EmONC training programmes within the countries health are needed to contribute to MDG progress. This will improve the quality and capacity of both SBAs and mid-level health care providers who provide maternity care.

Proper selection of maternity care providers for training, retention of staff post training, appropriate, adequate supervision of trained staff, timely provision of training equipment and EmOC medications will improve the effectiveness of EmONC training interventions.

Health system administrators should adopt a structured procedure to implement evidence-based EmONC training interventions. This should include adequate planning with stakeholders, proper selection of trainees, staff retention post training, provision of equipment post training and supportive supervision. Policies supporting the evidence generated from this research are likely to result in improved availability and performance of EmOC in low-resource settings.

7.5.2. Research implications

An interesting indicator that demonstrates increased capacity to manage obstetric complications reported by two studies was the proportion of obstetric emergencies referred out of facilities supported by EmOC training intervention (Makuwani et al. 2010, Basnet et al. 2004). Data regarding

this indicator will be routinely available and, based on the quality of records, it can be disaggregated further to identify the types and pattern of referrals. Further investigation through audits of case notes can assess the extent of resuscitation, and admission-to-decision-to-refer interval. These can be compared to a period before the intervention or compared with matched control health care facilities. This will have improved the evaluation of the communication referral and triage module and resuscitation modules at Kirkpatrick's level 3 in this research.

Study design

Although it will appear that more experimental designs – for example, cluster randomized controlled trials using direct observation of practice after training – will provide the least biased results, these may be expensive, froth with the ethical dilemma of excluding some sites from the intervention. Also, such experimental study designs may be difficult to conduct to scale; however, the stepped wedge CTR provides a good option for this type of research.

While a stepped wedge trial design is suitable for this type of operational research, analysis depends on a complete dataset at all time periods. During this study, health care facilities were not visited at 9 months for quantitative data collection but this was collected from the various sources during the 12-month visit. There were more missing data at 9 and 12 months compared to 3 and 6 months.

The use of health care facility data is critical to keeping costs low; however, the quality of the hospital records is equally crucial to obtaining a complete data set for analysis. It may be necessary to institute data improvement interventions prior to baseline data collection in all in all sites prior to the intervention. Also, the design of maternity registers can be improved so they have appropriate columns to document obstetric complications; they can be made user-friendly by including simple case definitions. Complementary to this may be the use of full-time data collectors on site to prospectively document all obstetric/newborn events occurring at the study sites. Both recommendations will improve the quality of routinely available data and data required for research and are consistent with the principles of operational research (Zachariah et al. 2009, Zachariah et al. 2012). These data improvement interventions will contribute to having complete data sets for analysis based on the SWD in future studies.

Another approach will be to audit case notes of women who received EmOC by trained teams before and after the intervention or using matched controlled sites or in a stepped wedged cluster randomized controlled trial. Specific indicators reflecting the knowledge and skills introduced during the intervention can be extracted from the case notes. Again, this depends on the accuracy of the

notes. For example, to determine the impact of the training on C/S a comparative retrospective audit of case notes can be performed to determine any significant change in indications for C/S, pre-operative care, operative techniques, blood transfusion rates, post-operative care and post-operative recovery time. Another example is management of severe pre-eclampsia/eclampsia management: treatment regimen, intravenous fluid use-type and volume, and treatment monitoring; outcome for the woman and her newborn can be compared before and after the intervention period or between intervention or control site (Ameh, Ekechi & Tukur 2012).

Walker et al. (2012) introduced an interesting method of assessing team effectiveness post training; teams trained by the PRONTO EmONC programme were made to develop plans for improvement of EmOC at their facilities post training, and these were objectively assessed by researchers 3 months after the intervention. This can be quite complementary to assess on-site skills/drills with detailed debriefing sessions at each site; the challenge will be sustaining this approach without an external driving influence (Walker et al. 2012).

A new format of evaluating training that removes focus on the individual, focuses on the team, is objective and introduces the concept of 'fire drills' can also be developed. This is likely to reinforce teamwork, communication and embed the concept of 'fire drills' within obstetric teams. It should be used before and immediately after training and periodically at health care facilities. This way, newer members of the team (who have missed the full EmONC training) can be trained and supported by other team members to change behaviours and practice. This will be designed like assessed multi-component scenarios/fire drills, with a strong feedback component.

Specific new research

To strengthen the evidence from this research, on the use of evidence-based short, multidisciplinary, competency-based EmONC training programmes:

- A comparative study of the long LSS/EmONC training package with the short EmONC training package described in this research should be undertaken. Half of matched health care facilities can receive the standard training (long LSS/EmONC training) and the other half the short EmONC training package. There should be a specific component of enhancing the quality of routinely available data; the effectiveness of the training can be investigated by direct observation of procedures, comparing the extent of non-evidence-based practice and also conducting audit of case notes (use of partograph, treatment of eclampsia, management of PPH, episiotomy repair, and outcome for AVD, MRP and MVA by

professional cadre of staff who performed them). For management of PPH and caesarean section, a good indicator can be the mean blood transfusion in the unit, amongst others; a good indicator for episiotomy repair can be the extent of complications from the procedure before and after, and the satisfaction of women who received care before and after the study (pain relief offered or not, communication, comfort, overall satisfaction with procedure).

- Economic evaluation comparing long and short EmONC training, to determine cost-effectiveness and value for money.
- There is anecdotal evidence that ministries of health in Africa may not be open to short in-service EmONC training programmes, because it is perceived that the duration of training is too short for less skilled health care workers. A stepped wedge randomized control trial to investigate the additional benefit of the short LSS EmONC on the availability of EmOC and health outcomes should be undertaken.
- A similar study design can be used to see if there is additional benefit in introducing audit and feedback systems (maternal and perinatal death reviews) for the availability of EmOC and maternal/newborn health outcomes.
- Also the relative importance of the various components of this intervention (training, equipment supply, supportive supervision) on change in practice, behaviour and health care outcomes should be carried out. Multivariate analysis can be used to understand this better.
- What is the effect of EmONC training on referral patterns and maternal health outcomes? Qualitative results in the current study show HCWs recommended that training HCWs from lower-referral health care facilities could increase the effectiveness of the intervention. This was achieved as a spin-off during this study in Mbagathi hospital and Nyeri PGH (trained master trainers initiated training of staff from units they receive referrals from). The indicators that can be used includes number and types of referrals from lower level to higher level, types of complications received at CEmOCs and maternal health outcomes. Research design, training referral clusters together and tracking flow of patients are important elements to consider
- What is the knowledge and skills retention by maternity care providers after training in short EmONC training in middle- and low-income countries? This will help determine the minimum interval for retraining, and identify factors that contribute to knowledge and skills retention.

7.6. Summary

This was the first evaluation of EmONC training in a low-resource setting at all four levels of training evaluation described by Kirkpatrick. The implementation of the study was consistent with a stepped wedge research design; however, a simple before and after analysis was performed.

A combination of events resulted in change and, if the results are to be replicated or even improved, it is important that these events are not only implemented but in the right sequence – planning for training, buy-in from stakeholders at national and hospital level, agreement on any adaptation and evaluation framework, agreement on implementation plan, proper participant selection and timely supply of equipment required to practice skills covered during the training. Based on this research, critical numbers of skilled health care workers need to be trained to ensure change in practice and health care outcomes.

The evidence may have been stronger if the analysis had been carried out based on the study design; however, this was not possible due to the extent of missing data at some data collection points. Kirkpatrick's level 4 indicators could have been explored further to improve the strength of the evidence; this is, however, subject to the quality of data available.

The next and final chapter will conclude this dissertation based on the background and results.

Chapter 8: CONCLUSION

The final chapter of this thesis will reflect on the introduction and discussion chapters. It will tie together, integrate and synthesize various issues from the previous chapter as well as provide answers to the research questions. Further discussion on the theoretical and policy implication of this research will be discussed.

8.1. Introduction

This study was set out to identify the various emergency obstetric and newborn care training interventions implemented in middle- and low-income countries, identify/review evidence of

effectiveness of the various components of such interventions, and describe the extent of evaluation of these interventions based on a framework for evaluating training programmes described by Kirkpatrick in 1952. The general theoretical literature on EmONC training shows that very few programmes have been specifically designed for low-resource settings and fewer have been implemented at all Kirkpatrick's four levels of training evaluation. This study further evaluated an EmONC training package specifically designed for low-resource settings, which was implemented in Kenya. The study specifically sought to answer the following questions:

a. What is the reaction of trained maternity care providers to the EmONC intervention? This was to evaluate their level of acceptance of the training intervention. (**Kirkpatrick level 1)**
b. Does the EmONC training intervention improve the knowledge and skills of maternity care workers trained? (**Kirkpatrick level 2)**
c. Does the EmONC training intervention result in 'up-skilling' of non-physician clinicians of maternity care providers? This was to evaluate the uptake and performance of critical EmOC signal functions or skills by non-physician clinicians after the training. **(Kirkpatrick level 3)**
d. Does the EmONC training intervention improve availability of skilled birth attendance and emergency obstetric care? This was to evaluate any change in availability of skilled attendance at birth and practice after implementation of the intervention. (**Kirkpatrick level 3 and 4)**
e. Does the EmONC training intervention improve maternal and newborn health care outcomes? This is to evaluate the effect of the intervention on DOCFR, SBR, FSBR and the proportion of babies admitted to newborn care units for birth asphyxia. (**Kirkpatrick level 4)**
f. What are the challenges and enablers to performing emergency obstetric care after implementation of EmONC training intervention? This was to identify barriers and facilitators of change in practice following implementation of the intervention. **(Kirkpatrick level 3)**

8.2. Empirical findings

The main empirical findings of this study are chapter-specific and were summarized within the respective empirical chapters: **Chapter 4**: level 1 and 2 results, **Chapter 5**: level 3 (change in behaviour) qualitative findings and **Chapter 6**: level 4 (change in health outcomes) quantitative results. This section will synthesize the empirical findings to answer the study's five research questions.

8.2.1. What is the reaction of trained maternity care providers to the EmONC intervention? This was to evaluate their acceptability of the training intervention. (Kirkpatrick level 1)

Results from evaluation at Kirkpatrick's level 1 show that trained maternity care providers accepted the EmONC training intervention. Maternity care providers showed a strong positive reaction to practical and lecture-based sessions. Overall, the preventing obstructed labour breakout session was the most acceptable breakout or practical session. Midwives and non-specialist medical doctors reacted more highly to the preventing obstructed labour module than specialist medical doctors. Clinical officers and specialist medical doctors found the venous cut-down breakout sessions most useful compared to midwives. Overall, trained maternity care providers found the training useful and a good use of their time. The positive reaction to the training was attributed to the content and teaching methods but trainees recommended a longer duration of practical sessions. They also recommended regular refresher training as well as training of all maternity care providers at every level of care in Kenya.

8.2.2. Does the EmONC training intervention improve the knowledge and skills of maternity care workers trained? (Kirkpatrick level 2)

Overall, there was significant improvement in knowledge and skills after the training compared to before. Although trainees found the prevention of obstructed labour module most useful, there was no statistically significant improvement in this module. The largest effect size was in the obstetric haemorrhage module.

8.2.3. Does the EmONC training intervention result in 'up-skilling' of non-physician clinicians of maternity care providers? This was to evaluate the performance of critical EmOC signal functions or skills by non-physician clinicians after the training. (Kirkpatrick level 3)

Qualitative data from trainees and quantitative data from study sites showed that more critical EmOC signal functions were performed by trainees (such as midwives, clinical officers and non-specialist medical doctors) that were usually performed by specialist medical doctors at 12 months post intervention compared to baseline.

Significantly more vaginal breech (53.8%) and assisted vaginal deliveries were conducted 12 months after the intervention compared to baseline. Midwives could also perform MVA as part of post-abortion care. The increase in vaginal breech deliveries at 6 months post intervention was about 6 times more than observed at 12 months post-delivery.

8.2.4. Does the EmONC training intervention improve availability of skilled birth attendance and emergency obstetric care? This was to evaluate any change in availability of skilled attendance at birth and change in practice after implementation of the intervention. (Kirkpatrick levels 3 and 4)

There was an increase in the availability of skilled attendance at birth, an increase in the number of obstetric emergencies recognized and treated, no change in caesarean section rate, an increase in the number of critical EmOC procedures performed by trained maternity care providers, and improved monitoring of labour with use of the partograph and eclampsia monitoring chart.

Although there was only a 3.8% (baseline: 16,764, 12 months post intervention: 17,404) increase in the number of women that received skilled birth attendance at birth in all study sites, there was a significant (66.8%) increase in obstetric complications managed 12 months (1,911) after the intervention compared to baseline (1,146).

There was only a 4.6% increase in the availability of EmOC at 12 months post intervention compared to baseline. Assisted vaginal delivery was the least available EmOC signal function in all sites, when this was available; exclusively specialist medical doctors performed it pre-intervention. At 12 months post intervention there was a statistically significant increase in the proportion of AVD performed by non-physician clinicians. There was a non-significant 6% reduction in caesarean section rate at 12 months after the intervention compared to baseline.

Based on qualitative data (Kirkpatrick level 3), there was improved practice across all sites; specific examples were improved monitoring of labour with use of the partograph and eclampsia monitoring chart, improved organisation of care and reduced admission–treatment interval.

8.2.5. Does the EmONC training intervention improve maternal and newborn health care outcomes? This was to evaluate the effect of the intervention on DOCFR, SBR, FSBR and the proportion of babies admitted to newborn care unit for birth asphyxia. (Kirkpatrick level 4)

There was a reduction of all maternal and newborn health indicators monitored in this study. The reduction was greater when one hospital that had very poor staff retention at 3 and 12 months post training was excluded from the analysis.

When baseline indicators were compared to 12 months post training for all study sites, there was **35% reduction in DOCFR, 34% reduction in stillbirth rate, 10% reduction in FSBR and 48% reduction in the proportion of newborns admitted to NBU for birth asphyxia.**

The reduction at 6 months was less than at 12 months post intervention for DOCFR **(32% vs. 35%),** stillbirth rate **(19% vs. 34%),** fresh stillbirth rate **(0 vs. 10%)** and proportion of births admitted for birth asphyxia **(21% vs. 48%).**

Excluding PGH Nakuru (only 38% staff retention), there was **47% reduction in DOCFR**, **66% reduction SBR**, **14% reduction of FSBR and 53% reduction in the proportion of newborns admitted to NBU for birth asphyxia.**

8.2.6. What are the challenges and enablers to performing emergency obstetric care after implementation of EmONC training intervention? This was to identify barriers and facilitators of change in practice following implementation of the intervention. (Kirkpatrick level 3)

Late arrival of patients and lack of consent for life-saving EmOC procedures were reported as limitations to practice post intervention. Maternity care workers reported that their perceived effectiveness of the **interactive, mixed teaching methods and multidisciplinary** nature of the training package, availability of EmOC equipment post training, and supportive supervisors were factors which facilitated change in practice post training. Barriers to non-availability of EmOC were poor staff deployment and retention policy post training, lack of equipment to perform EmONC, lack of support from obstetricians and nurse/midwifery administrators, lack of training for all maternity care providers (including medical interns, medical officers and staff from lower level health care facilities) and lack of clarity on the scope of practice for nurses/midwives.

8.3. Theoretical Implication

A comprehensive evaluation of the effectiveness of an evidence-based in-service training package in the context of operational research in a resource-limited setting was undertaken. The training package evaluated addresses the main direct causes of maternal and newborn deaths and uses evidence-based teaching and learning methods. The training was implemented along with EmOC equipment support and on-site supportive supervision (Msemo et al. 2013). Short training packages like this may only be effective for maternity care providers with sufficient pre-service training. A cross-sectional study to evaluate the baseline retention of previous neonatal training of health care

workers (skilled and unskilled) in Sierra Leone by Conroy et al. (2014) showed very poor retention of skills (Conroy et al. 2014).

Although the Kenya National Health Service provision survey 2010 reported that 95% of hospitals had up-to-date registers, this was not consistent with observations during this study. The 2010 Kenya national health service survey defined 'up-to-date register' as one which has at least 1 entry in the past 30 days, at minimum that indicates delivery outcome". This definition is grossly insufficient for the requirements of this study where details of obstetric and newborn complications and the outcomes were used. Maternity registers alone could not provide all the information required in this study; various sources of information were used within the same health care facility (registers from postnatal ward, gynaecology ward and operation theatre, hospital information management records and ward nursing reports). The quality of data available through the maternity registers improved with time in the health care facilities during the study; this is consistent with the concept of operational research. There may have been under-recording of complications prior to the intervention (potentially lowering the baseline CFR and SBRs); therefore, the increase in the number of obstetric complications recognized may be less than observed. The 10% reduction in FSBR observed in this study is not consistent with trend in stillbirths and asphyxia NBU admissions and may be due to poor case definition and under recording.

Only 0.2% of vaginal deliveries at baseline were by vacuum extraction which was available in only 50% of the study sites; this was a lot higher than reported in the 2010 Kenya health care facility survey (assisted vaginal delivery was available in 13% of hospitals). The survey involved sub-district, district and specialist hospitals while the hospitals in the current study were level 5 hospitals. Level 5 hospitals have more specialists (obstetricians) who can perform assisted vaginal delivery. Sub-district and district general hospitals usually only have medical officers (average of two years post graduation and have no specialist training) or/and clinical officers with additional training in reproductive health (can perform C/S). The results from this study of significant 'up-skilling' of non-physician clinicians, means that, potentially, similar training intervention packages can be used to improve the availability of AVD in Kenya and similar settings(National Coordinating Agency for Population and Development (NCAPD) [Kenya], Ministry of Medical Services (MOMS) [Kenya], Ministry of Public Health and Sanitation (MOPHS) [Kenya], Kenya National Bureau of Statistics (KNBS) [Kenya], ICF Macro 2011).

Trainees appreciated the use of routinely collected data to review service provision and individual health care provider competence through supportive supervisors.

8.4. Policy implications

National health authorities in Kenya and other sub-Saharan countries need to guide implementation partners on the design, implementation, monitoring and evaluation of EmONC in-service training programmes based on evidence from the literature and this research in Kenya.

The importance of a skilled health care worker, working in an enabling environment has for long been recognized; it is also well established that 'skilled health care workers' are in short supply in regions of the world with the greatest burden of maternal deaths. This is further compounded by the lack of sufficient skills and knowledge by these health care workers who routinely provide maternity care. EmONC in-service training programmes have been implemented for years in sub-Saharan Africa based on the model introduced by the American College of Nurse-Midwives in the mid-1980s; this model has had mixed evaluation reports and may not be cost-effective(Penny, Murray 2000, Osei et al. 2005). There may be issues with the content, duration and methodology of training as well as implementation of other complementary interventions to ensure that skilled health providers function optimally. The typical model involves professional cadre-specific training of small numbers of health care workers representing several health care facilities over two to four weeks and is very common in many middle and low-income countries (Penny, Murray 2000, Van Lonkhuijzen et al. 2010).

This study contributes to the growing evidence that short evidence-based, multidisciplinary EmONC in-service training programmes using adult learning techniques are acceptable to maternity care providers in LMIC and are effective. Although this study did not set out to compare the longer LSS/EmONC training programme, evidence from qualitative data indicates that the methods used are more acceptable to health care workers; there was change in practice and behaviours following training. Of crucial importance to the approach is training all cadres of maternity care providers together; while this has an advantage of improving teamwork and communication, as demonstrated in this study, there is a risk that lower cadres of staff in other settings may find it difficult to cope with the pace of the training and the volume of new information. In this research, staff from the lowest cadre trained were clinical officers; staff in this category appear to have had sufficient pre-service midwifery training to build upon.

The commonest direct cause of maternal deaths in sub-Saharan Africa is obstetric haemorrhage and the EmONC intervention improved the knowledge in this module significantly, with the largest effect

size. Potentially, a short EmONC training intervention like the one used in this study can be used to effectively improve knowledge of maternity care providers in other settings in SSA.

It can be argued that, if in-service training programmes require more than five days to run, they no longer serve the purpose of a quick update/refresher training but are in a way more like primary training. There is evidence from the literature that pre-service training may be deficient and this may have facilitated the proliferation of long in-service EmONC training packages. In the light of serve shortages in SBAs, taking health care workers away from their duty for long periods of time may be counterproductive.

To strengthen the evidence from this research, a comparative study of the long LSS/EmONC training package with the short EmONC training package described in this research should be undertaken.

The strict selection criteria used in this study ensured that critical numbers of ONLY maternity care providers were trained. The effectiveness of this intervention at Kirkpatrick's level four was shown to be different when less than 50% of maternity care providers were trained. Therefore an ***important policy recommendation is proper selection of trainees, ensuring that only health care providers who routinely provide maternity services are trained, and they should be retained long enough to improve maternal health outcomes***.

All maternity care providers including medical interns and non-specialist medical doctors should be trained in EmONC. Trainees who participated in this study recommended that medical interns and medical officers who work along midwives in the frontline of emergency obstetric care should be trained to improve the impact of the intervention. Two studies in Rwanda and South Africa support this finding (Homaifar et al. 2013, Frank, Lombaard & Pattinson 2009).

Results from this research also indicate that the training methodology and content of the short competency-based EmONC training programme is beneficial to pre-service midwifery and medical training. It is recommended that the impact of introducing this new content and teaching method to pre-service education should be further evaluated. This may strengthen recommendations for curriculum review by midwifery and medical tutors/clinical instructors/lecturers in this study.

8.5. Summary

Maternal mortality ratios are still high in many low-income countries, and skilled attendance at birth and emergency obstetric care are complementary strategies to reducing maternal mortality. There

are shortages in skilled health care workers in countries with the greatest burden of maternal mortality and there is evidence that these maternity care providers may not have the required knowledge and skills to manage obstetric and newborn care emergencies. Non-SBAs have been used to provide maternity care in some of these settings. This lack of competent SBAs is further compounded by the underutilization of simple but proven health technologies such as vacuum extractors, Karman's syringes for manual vacuum aspiration and the partograph for monitoring labour. In-service EmONC training intervention packages have been implemented in the last 30 years in sub-Saharan Africa but there is limited evidence on how effective they are or what the best components of such packages are. Also, few maternity care providers receive regular in-service training.

Evidence from comprehensive evaluation of EmONC training interventions within existing health systems (operational research) will be useful in scaling up EmOC and SBA strategies. There has been no evaluation of an EmONC training programme implemented in low-resource settings at all four levels of training evaluation techniques as described by Kirkpatrick.

A before/after study was conducted in Kenya at 10 comprehensive EmOC hospitals to evaluate the effectiveness of a short, competency-based, multidisciplinary evidence-based training intervention.

Maternity care providers in Kenya, who showed significant improvement in knowledge and skills after the training, accepted the intervention evaluated in this study. They also reported improved confidence and communication and showed change in practice and behaviour, and there was significant 'up-skilling' of maternity care providers who could perform manual vacuum aspiration, breech vaginal delivery and assisted vaginal delivery. Also the training resulted in improved recognition and management of obstetric and newborn complications.

Recommendations at the end of this study are:

- To replicate the effectiveness of this intervention in other low-resource countries there should be engagement with stakeholders to ensure proper selection of trainees, ensuring that only health care providers who routinely provide maternity services are trained and that they should be retained long enough to improve maternal health outcomes. This may need to be backed by relevant policies by ministries of health.
- To increase the effectiveness of this training intervention, all maternity care providers including medical interns and non-specialist medical doctors should be trained in EmONC.

Training can be systematically carried out to include all health care workers in all health care facilities within referral networks.

- To develop multidisciplinary skills testing used to assess teamwork, communication and management of obstetric and newborn complications.

Further research on using more robust research designs, indicators and tools to investigate the impact of the training on management of obstetric complications should be explored – research on economic evaluation of the training intervention, comparing the two-to-three-week LSS EmONC training to the short EmONC evaluated in this study, and research to assess the knowledge and skills retention of trained maternity care providers after short EmONC training.

Annexes

Annex 1: Training programme

DAY 1:

07:30–08:15 Faculty meeting

08:00	**Registration**		
08:30	**Welcome**		**Ministry of Health**
09:00	**Pre-Course Skills Assessment**	*Course Assessor*	***Research Team***
09:15	**Pre-Course Knowledge Test**	*Course Assessor*	***Research Team***
09:30	**Introductions and Purpose of the Course**	*Course Director*	***Facilitator***
09:55	**Lecture**	*ABCs and Maternal Resuscitation*	***Facilitator***

10:20–10:40 Tea/Coffee Break

10:45	**Demonstration**	*The ABC Approach* ***4 Facilitators***	

11:05 **Lecture** *Care of the Newborn* ***Facilitator***

11:25 **Breakout – Skills** *Resuscitation* ***Facilitator***

Room	**1**	**2**	**3**	**4**
Skill	**Airway**	**CPR – Basic Life Support**	**Care of the Newborn**	**Venous Cut down**
11:25	A	B	C	D
11:45	D	A	B	C
12:05	C	D	A	B
12:25	B	C	D	A

12:45–13:35 **Lunch + Meet your Mentor**

13:40–13:55 **Lecture** *Shock and the Unconscious Patient* ***Facilitator***

14:00 **Breakout – Scenarios** *Shock and the Unconscious Patient*

Room	**1**	**2**	**3**	**4**
Scenario	**Unconscious**	**Hypovolaemia**	**Septic**	**Cardiogenic**
14:20	A	B	*C*	D
14:40	D	A	B	C
15:00	C	D	A	B
15:20	B	C	D	A

15:40 **Tea Break**

16:00 **Group work** *Communication, Triage, Referral* ***Facilitator***

16:30 **Feedback from Group work**

16:50 **General Feedback from Participants + Closure**

17:00–17:30 **Faculty Meeting**

DAY 2:

07:45–08:45 **Faculty meeting**

08:45 **Registration**

09:00 **Lecture** *Pre-eclampsia and Eclampsia* ***Facilitator***

09:15 **Breakout – Scenarios and Workshops** *Pre-eclampsia and Eclampsia*

Room	**1**	**2**	**3**	**4**
Scenario	**Workshop – Recognition**	**Scenario Management BEOC**	**Scenario Management CEOC**	**Workshop – BP and Fluid Balance**
09:15	A	B	C	D
09:35	D	A	B	C
09:55	C	D	A	B
10:15	B	C	D	A

10:35 **Tea Break**

10:55 **Lecture** *Haemorrhage* ***Facilitator***

11:10 **DVD** *Active Management of Third Stage of Labour* ***Facilitator***

11:25 **Breakout – Workshops and** *Haemorrhage*

Scenarios

Room	**1**	**2**	**3**	**4**
Scenario /Workshop	**Workshop – Volume Replacement**	**Workshop – Atonic Uterus**	**Scenario – Placenta Abruption**	**Scenario – Placenta Praevia**
11:25	A	B	C	D
11:40	D	A	B	C
11:55	C	D	A	B
12:10	B	C	D	A

12:25–13:15 Lunch + Meet your Mentor

13:20 Lecture: *Sepsis* ***Facilitator***

13:35 Breakout – Scenarios *Sepsis*

Room	**1**	**2**	**3**	**4**
Scenario	**Sepsis in Pregnancy**	**Sepsis after Delivery**	**Newborn Sepsis**	**Severe Sepsis**
13:40	A	B	C	D
13:55	D	A	B	C
14:10	C	D	A	B
14:25	B	C	D	A

14:40 Lecture *Obstetric emergencies* ***Facilitator***

15:00 DVD *Breech*

15:35 Breakout – Skills *Obstetric emergencies*

Room	1	2	3	4
Skill	**Breech**	**Shoulder Dystocia**	**Cord Prolapse / Uterine Inversion**	**Twins**
15:35	A	B	C	D
15:50	D	A	B	C
16:05	C	D	A	B
16:20	B	C	D	A

16:35 General Feedback from Participants + Closure

16:40–16:55 Faculty Meeting

DAY 3:

07:45–08:45 Faculty meeting

08:45 Registration

09:00 Lecture *Preventing Obstructed Labour* ***Facilitator***

09:15 Breakout – Workshops and Scenarios *Obstructed Labour, Use of Partograph*

Room		1	2	3	4
09:20	**Obstructed Labour 1**	A	B	C	D
09:40	**Obstructed Labour 2**	D	A	B	C
10:00	**Obstructed Labour 3**	C	D	A	B

10:20	**Obstructed Labour 4**	B	C	D	A

10:40 Tea Break

11:00 Lecture *Assisted delivery* ***Facilitator***

11:15 DVD *Vacuum delivery* ***Facilitator***

11:35 Breakout – Skills *Assisted delivery*

Room	**1**	**2**	**3**	**4**
Skill	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**
11:35	A	B	C	D
11:55	D	A	B	C
12:15	C	D	A	B
12:35	B	C	D	A

12:55–13:50 Lunch Break + Meet your Mentors

13:55 Lecture *Surgical Skills* ***Facilitator***

14:15 DVD *C-Section* ***Facilitator***

14:35 Breakout – Workshops / Skills *MVA, Retained Placenta, Caesarean Section and Perineal Repair*

Room	**1**	**2**	**3**	**4**
Workshop	**Skill: MVA and**	**Skill: Retained**	**Workshop: Difficulties**	**Episiotomy Repair, 3rd- & 4th-Degree**

/ Skill	ERPOC	Placenta	during C-Section	Tear Repair
14:35	A	B	C	D
14:55	D	A	B	C
15:15	C	D	A	B
15:35	B	C	D	A

15:55	**Post-Course Skills Assessment**	*Course assessor*	***Research Team***
16:10	**Post-Course Knowledge Test**	*Course assessor*	***Research Team***
16:25	**M & E, Supportive Supervision of LSS EOC & NC Trainees**		***Research Team***
16:40	**Tea Break and Handing out of Certificates,**	***Rep. Ministry of Health***	
16:55	**Group Photographs**		
17:05	**Faculty Meeting**		

Annex 2: Supportive supervision tools

Logbooks used for supportive supervision

Name of Health worker		Cadre	Doctor		Midwife	
Health Facility			RCO		Others specify	
District & Province		Date of LSS EOC Training			month	year
Number of deliveries conducted during the month		Report for the Month of:				

Emergency Obstetric and Newborn skills performed

** 1 = Has not or could not perform skill, 2 = Performed skill under supervision, 3 = Independently performed skill.

S/No	SKILL		NUMBER OF TIMES	Confidence in performing**	Remarks
	Cardiac compression				
	Management of unconscious patient				
	Management of patient in shock				
	Newborn resuscitation				
	Venous cut down	Successful			
		Unsuccessful			
	Use of Partograph				
	Assisted vaginal breech deliveries				
	Twin deliveries				
	Management of Shoulder dystocia				
	Management of cord prolapse				
	Active management of 3rd Stage				
	Manual removal of Placenta				
	Management of Antepartum				

S/No	SKILL		NUMBER OF TIMES	Confidence in performing**	Remarks
	Haemorrhage (APH)				
	Management of Eclampsia				
	Management of pregnancy related sepsis				
	Caesarean section				
	Vacuum Extraction	Successful			
		Unsuccessful			
	Management of septic abortion				
	Manual Vacuum Aspiration				
	Management of neonatal Sepsis				
	Premature Care (KMC)				

	Performing episiotomy			
	Suturing of episiotomy			
	Suturing of perineal tears			
	Suturing of cervical tears			

Comments on problems or constraints in performing LSS-EOC&NC skills:

_____

_____

_____

_____

Do you feel that after training you are getting enough practice to remain proficient in these skills?

Y ☐ N ☐

What (if any) skills would you like more training in?

_____

_____

_____

a. **Supervisory interview record**

Name of EmONC trainee	Supervisor	Skill Assessed against check list	Score	Any comments

b. **Supervisory action plan**

Problem	Root Cause(s)	Solution(s)	By Whom	By when	Status

Annex 3: Participant information sheet

Section A

Evaluation of emergency obstetric and newborn care training in Kenya

The above-named operational research has been conducted in 10 level 5 hospitals located in all 8 provinces of Kenya.

The purpose of the research is to evaluate the reaction of health care providers to the EmOC training, determine the effect on their knowledge and skills, explore the enablers and barriers to practising quality EmOC after training and identify the effect of the training on the availability and utilization of EmOC.

The research is funded by the Department for International Development, United Kingdom, through the Making it Happen programme.

You have been invited to participate in this research because your participation will greatly contribute to the purpose of this research, providing evidence to the Government of Kenya on the effectiveness of the new EmOC training package in Kenya. The results have the potential to influence policy around in-service training and the strategy to improve maternal health in Kenya.

Dr Charles Ameh will lead a team of 2 research assistants (Judith Maua and Elizabeth Washika) and EmONC trainers to collect data. Dr Charles Ameh and the research assistants will organize data collection at all sites.

Data use

Findings of analysed data will be disseminated via reports to the Kenyan Ministry of Health, hospital management, and the scientific committee (peer-reviewed journals and conferences). Data will be presented in such a way that individual hospitals, trainees and participants in the research are unidentifiable.

Section B

Your participation is voluntary and withdrawal at any stage, or non-participation, will not have any consequences and will not compromise your legal rights should anything go wrong.

You will be invited to participate during the training (knowledge and skills assessments), and in qualitative interviews carried out at the hospital 3, 6 and 12 months post training. Transportation costs will be reimbursed if you attend the follow-up interview sessions while off duty or on leave. Light refreshment will be provided for those attending the sessions during their lunch break.

Quantitative data collection during the training will be paper-based; qualitative data will be digitally recorded. All data will be securely stored and destroyed after data analysis is complete.

Confidentiality and anonymity

All data collected will be anonymized from the point of collection, and names of participating hospital units will be coded and stored separately in the researcher's personal password-protected laptop computer. All paper copies of data collection forms will be stored in locked cupboards in the researcher's secured office.

The identity of any participant in qualitative interviews will only be known to the research team. All quantitative and qualitative data collected during the training will be anonymous and cannot be traced back to the trainee who provided the information

Section C: Contact details

For further information and queries please contact:

Nairobi

1. Elizabeth Washika: 0733955477
2. Judith Maua: 0722666276

United Kingdom

1. Dr Charles Ameh. Email: charlesameh@yahoo.com, caameh@liverpool.ac.uk. Telephone: 078908167, 0721794593

YOU WILL BE GIVEN A COPY OF THIS DOCUMENT TOGETHER WITH A COPY OF YOUR CONSENT FORM

Annex 4: Consent form

CONFIDENTIAL

Title of Project: **Evaluation of emergency obstetric and newborn care training in Kenya**

Participant Identification Number for this Study:

Please initial box

1. I confirm I have read and understood the information sheet dated..... (Version.....) for the above study. I have had the opportunity to consider the information and ask questions, and have had these answered satisfactorily. ☐
2. I understand that participation in this study is voluntary and I am free to withdraw consent at any time, without giving a reason, without any penalties. ☐
3. I understand that data collected during the study may be looked at by individuals from LSTM and from regulatory authorities. I give permission for these individuals to have access to my records. ☐
4. I hereby declare that I have not been subjected to any form of coercion in giving this consent. ☐
5. I agree / do NOT agree to the data about me collected in this study being stored for further use in the future. (delete if not applicable) ☐
6. I agree to take part in this study.

Signing this declaration does not affect your right to decline to take part in any future study.

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Name of person taking consent	Date	Signature

When complete: 1 copy for participant; 1 copy (original) for research file.

Annex 5: Participants' Feedback/Course Evaluation form

Participants are encouraged to complete this form but this is not mandatory and of no consequence to them. Detailed instructions will be provided at the start of the training and any member of the faculty will be happy to discuss any queries you have about this form.

PLEASE NOTE YOUR NAME IS NOT REQUIRED ON THE FORM.

Thank you

Section 1:

What cadre of medical staff are you? Kindly tick the *most appropriate* below	
Nurse/Midwife	
Clinical Officer	
General Practitioner Medical Doctor	
Specialist Medical doctor	
Other – please specify	

Section 2:

Instruction: *Fill in as you go along the course; the last page pertains to your assessment of the whole course and this should be filled in after the last breakout session on day 3.*

Day 1

How useful were each of the following?

Lecture on ABCs and Maternal Resuscitation

1 2 3 4 5 6 7 8 9 10

Not extremely

Lecture on Care of the Newborn

1 2 3 4 5 6 7 8 9 10

Not extremely

Demonstration of the ABC Approach

1 2 3 4 5 6 7 8 9 10

Not extremely

Airway and Adult Resuscitation Skills Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Newborn Resuscitation Skills Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Venous Access Skills Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Shock and Unconscious Patient Lecture

1 2 3 4 5 6 7 8 9 10

Not extremely

Shock and Unconscious Patient Breakout Sessions

1 2 3 4 5 6 7 8 9 10

Not extremely

Communication, Triage and Referral Groupwork

1 2 3 4 5 6 7 8 9 10

Not extremely

Day 2

Lecture on Pre-eclampsia and Eclampsia

1 2 3 4 5 6 7 8 9 10

Not extremely

Pre-eclampsia and Eclampsia Workshops and Cases

Recognition of Pre-eclampsia and Eclampsia Scenario

1 2 3 4 5 6 7 8 9 10

Not extremely

Management of Eclampsia in BEOC and CEOC Facility Workshop

1 2 3 4 5 6 7 8 9 10

Not extremely

BP and Fluid Balance Workshop

1 2 3 4 5 6 7 8 9 10

Not extremely

Lecture on Haemorrhage

1 2 3 4 5 6 7 8 9 10

Not extremely

Haemorrhage Workshop Breakouts

Volume Replacement Workshop

1 2 3 4 5 6 7 8 9 10

Not extremely

Atonic Uterus Scenario

1 2 3 4 5 6 7 8 9 10

Not extremely

Placenta Abruption Scenario Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Placenta Previa Scenario Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Sepsis Lecture

1 2 3 4 5 6 7 8 9 10

Not extremely

Sepsis Breakout Sessions

1 2 3 4 5 6 7 8 9 10

Not extremely

Obstetric Emergencies Lecture

1 2 3 4 5 6 7 8 9 10

Not extremely

Obstetric Emergencies Skills Breakouts

Breech Skills Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Shoulder Dystocia Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Cord Prolapse Breakout

1 2 3 4 5 6 7 8 9 10

Not extremely

Multiple Pregnancy (Twins) Breakouts

1 2 3 4 5 6 7 8 9 10

Not extremely

Day 3

Lecture on Preventing Obstructed Labour

1 2 3 4 5 6 7 8 9 10

Not extremely

Preventing Obstructed Labour: Partograph Workshops

1 2 3 4 5 6 7 8 9 10

Not extremely

Lecture on Assisted Delivery

1 2 3 4 5 6 7 8 9 10

Not extremely

Assisted Delivery Skills Breakout Stations

1 2 3 4 5 6 7 8 9 10

Not extremely

Lecture on Surgical Skills

1 2 3 4 5 6 7 8 9 10

Not extremely

Surgical Skills and MVA Breakout Stations

MVA, ERCP and Post-abortion Care Workshop

1 2 3 4 5 6 7 8 9 10

Not Extremely

Retained Placenta Skills Workshop

1 2 3 4 5 6 7 8 9 10

Not extremely

Difficulties during C-Section Workshop

1 2 3 4 5 6 7 8 9 10

Not extremely

Episiotomy, 3rd- and 4th-Degree Perineal Repair Workshop/Skills Station

1 2 3 4 5 6 7 8 9 10

Not extremely

Section 3: Overall course assessment

Instruction: To be completed on the final day of the course

Please give a score for each of the following:

a) Was the course enjoyable?

1 2 3 4 5 6 7 8 9 10

Not extremely

b) Will you find the knowledge and skills acquired useful when you go back to your job?

1 2 3 4 5 6 7 8 9 10

Not extremely

c) Was it easy to join in the interactive sessions?

1	2	3	4	5	6	7	8	9	10
Not									extremely

d) Did you feel comfortable and at ease during the course?

1	2	3	4	5	6	7	8	9	10
Not									extremely

e) Was the course a good use of your time?

1	2	3	4	5	6	7	8	9	10
Not									extremely

f) How good was the venue?

1	2	3	4	5	6	7	8	9	10
Not									extremely

Do you have any other comments or suggestions?

Thank you.

You can contact Charles A Ameh by telephone (074562347) or email (caameh@liverpool.ac.uk) if you have any queries.

Annex 6: Level 4 baseline survey/follow-up data extraction tool

Any maternal/newborn care intervention/support received by the hospital from any organization or Government in the months of Month 1, Month 2 and Month 3? **Yes** ☐ **No** ☐

If **Yes**, name of organization or government department and type of intervention or support received?

_____

_____

_____

Table 1

Indicator	**Total for the Months of**		
	Month 1	Month 2	Month 3
No. of deliveries			
No. of live births			
No. of women referred out			
No. of women referred in			
No. of C-sections			
Caesarean section rate			
No. of (assisted) breech vaginal deliveries			
No. of MVA			
No. of D/C			
No. of deliveries by vacuum extraction			
No. of stillbirths			
No. of fresh stillbirths			

Indicator	Total for the Months of		
	Month 1	Month 2	Month 3
No. of newborns admitted to NBU with birth asphyxia			

Table 2: Case fatality rates

Obstetric complication	**Total for** Month 1, Month 2 and Month 3					
	Number of cases			**Number of deaths**		
	Month 1	Month 2	Month 3	Month 1	Month 2	Month 3
APH						
Retained placenta						
PPH (other)						
Prolonged or obstructed labour						
Complications from abortion – haemorrhage						
Complications from abortion – sepsis						
Eclampsia						
Ectopic pregnancy						
Ruptured uterus						
Non-specific complications						
Total						

Other maternal deaths

Date	**Cause of death**	**Number of deaths**

Neonatal	**Total for** Month 1, Month 2 and Month 3					
	Number of cases			**Number of deaths**		
	Month 1	Month 2	Month 3	Month 1	Month 2	Month 3
Fetal/newborn distress requiring resuscitation with bag and mask						

Dates of MNH/EOC- & NC-related CME activities in Month 1, Month 2 and Month 3

Date	**Topic**

Annex 7: Topic guide for key informants, paired/triad interviews and focus group discussions

Duration: 45–90 minutes

- *Each participant ward/unit (labour, antenatal, postnatal or newborn care unit) was noted; each participant was provided with a visually displayed number to enable facilitation of the discussion and recording.*
- *Obtain consent to proceed including audio recording.*

1. Has the training you received in LSS EOC & NC made any difference in professional practice?

Explore/prompt:

a. Teamwork
   i. Communication between doctors and midwives
b. Knowledge
c. Skills
d. Confidence

2. Has the training made any difference in patient care?

Explore/prompt:

a. Patient monitoring
b. Patient treatment
c. Patient outcomes

Explore/prompt specific aspects covered by the training:

	Direct training topic	Specific issues to explore
1.	Communication referral and triage	Teamwork
2.	Parenteral oxytocics	AMTSL, manual removal of placenta, management of atonic uterus
3.	Parenteral anticonvulsants	Use of mag. sulphate, dosages, fluid management, monitoring
4.	Parenteral antibiotics	Management of septic shock, pregnancy-related

	Direct training topic	Specific issues to explore
		sepsis
5.	Assisted vaginal delivery	Vacuum extraction
6.	MVA	Post-abortion care
7.	Manual removal of placenta	
8.	Blood transfusion	Blood transfusion, fluid management in shock, venous cutdown, condom catheter balloon
9.	Caesarean section	Peri-operative care, B-lynch suture, difficult C/S
10.	Monitoring of women in labour	Use of partograph, fetal heart monitoring

3. Has the training affected record-keeping, analysis and presentation etc.?

Explore/prompt:

a. How are records analysed, presented and used within the department?
b. Any notable difference in the quality of records kept?
c. Any key decisions taken as a result of record analysis?

4. What new equipment since the training have you observed being used in the maternity/labour ward?

Explore/prompt:

a. If new equipment is making any difference. Give specific examples if any

5. Are there any limitations to utilization of skills and knowledge acquired?

Explore/prompt:

a. Policy – hospital or government
b. Equipment
c. Confidence, skills etc.

6. How useful are the materials received during the training (manual, CD-ROMs etc.)

Explore/prompt:

a. How are they being used? Reasons for using them
b. Where are they found to be useful?

7. How can the quality and effectiveness of the training be improved?

Explore/prompt:

a. Duration of training? Intensity of the training...? What are recommended changes for the relevant aspects of the training?
b. Content of training? Is this adequate for emergency obstetric and newborn care? What else should be included?
c. Method of training? Training doctors with midwives? Use of mixed training methods? Low facilitator–participant ratio?
d. Participation in any similar training in the past? How long ago? How does this compare? Methods, effectiveness – how much you understood, your enthusiasm, confidence to put the new skills and knowledge into use etc.

Conclusion/debrief

Additional remarks/comments invited from participants

Thanks, refreshments and travel expense reimbursement.

Annex 8: Additional Level 2 knowledge assessment analysis

Table 57: Results of level 2 knowledge assessments by professional care and modules

Major cadre groups	Modules	Pre/Post	N	Mean Min=0, Max=5	Std. Deviation	Std. Error Mean
Specialist Medical Doctor	Communication, Triage and Referral	Pre-course	9	3.33	1.581	.527
		Post-course	10	3.90	1.287	.407
	Maternal and Newborn Resuscitation	Pre-course	9	3.00	1.581	.527
		Post-course	10	3.30	1.252	.396
	Shock and the Unconscious Patient	Pre-course	9	4.11	1.054	.351
		Post-course	10	4.30	.949	.300
	(Pre) Eclampsia	Pre-course	9	4.11	.928	.309
		Post-course	10	4.40	.699	.221
	Obstetric Haemorrhage	Pre-course	9	3.56	.882	.294
		Post-course	10	4.10	.738	.233
	Obstructed Labour	Pre-course	9	4.11	.928	.309

Major cadre groups	Modules	Pre/Post	N	Mean Min=0, Max=5	Std. Deviation	Std. Error Mean
		Post-course	10	3.70	1.160	.367
	Obstetric Emergencies	Pre-course	9	4.33	.500	.167
		Post-course	10	3.90	.738	.233
	Pregnancy Related Sepsis and Unsafe Abortion	Pre-course	9	4.00	1.118	.373
		Post-course	10	4.10	.876	.277
Non-specialist Medical Doctor	Communication, Triage and Referral	Pre-course	14	3.71	.726	.194
		Post-course	21	4.33	.913	.199
	Maternal and Newborn Resuscitation	Pre-course	14	3.21	.975	.261
		Post-course	21	3.48	.814	.178
	Shock and the Unconscious Patient	Pre-course	14	3.79	.893	.239
		Post-course	21	3.86	1.062	.232
	(Pre) Eclampsia	Pre-course	14	4.14	1.027	.275
		Post-course	21	4.19	1.078	.235

Major cadre groups	Modules	Pre/Post	N	Mean Min=0, Max=5	Std. Deviation	Std. Error Mean
	Obstetric Haemorrhage	Pre-course	14	3.71	.914	.244
		Post-course	21	3.90	.831	.181
	Obstructed Labour	Pre-course	14	3.36	.633	.169
		Post-course	20	3.35	.988	.221
	Obstetric Emergencies	Pre-course	14	3.64	1.216	.325
		Post-course	20	4.15	.745	.167
	Pregnancy Related Sepsis and Unsafe Abortion	Pre-course	14	3.36	1.499	.401
		Post-course	20	4.00	.858	.192
Nurse-Midwife	Communication, Triage and Referral	Pre-course	295	3.64	.937	.055
		Post-course	317	3.90	.954	.054
	Maternal and Newborn Resuscitation	Pre-course	295	2.60	1.135	.066
		Post-course	317	3.26	.972	.055
	Shock and the	Pre-course	295	2.99	1.013	.059

Major cadre groups	Modules	Pre/Post	N	Mean Min=0, Max=5	Std. Deviation	Std. Error Mean
	Unconscious Patient	Post-course	**315**	3.57	1.105	.062
	(Pre) Eclampsia	Pre-course	295	3.22	1.155	.067
		Post-course	314	3.73	.963	.054
	Obstetric Haemorrhage	Pre-course	293	2.44	1.405	.082
		Post-course	314	3.46	1.075	.061
	Obstructed Labour	Pre-course	292	3.17	1.031	.060
		Post-course	316	3.04	1.095	.062
	Obstetric Emergencies	Pre-course	285	2.89	1.149	.068
		Post-course	315	3.46	.948	.053
	Pregnancy Related Sepsis and Unsafe Abortion	Pre-course	**282**	3.27	1.134	.068
		Post-course	311	3.70	.886	.050
Mid-level cadre	Communication, Triage and Referral	Pre-course	4	3.75	.957	.479
		Post-course	7	3.57	.535	.202

Major cadre groups	Modules	Pre/Post	N	Mean Min=0, Max=5	Std. Deviation	Std. Error Mean
	Maternal and Newborn Resuscitation	Pre-course	4	3.25	1.500	.750
		Post-course	7	3.57	1.272	.481
	Shock and the Unconscious Patient	Pre-course	4	3.75	.500	.250
		Post-course	7	4.29	1.113	.421
	(Pre) Eclampsia	Pre-course	4	3.50	1.291	.645
		Post-course	7	4.00	.816	.309
	Obstetric Haemorrhage	Pre-course	4	2.50	1.915	.957
		Post-course	7	4.14	1.069	.404
	Obstructed Labour	Pre-course	4	3.50	1.291	.645
		Post-course	7	3.57	.976	.369
	Obstetric Emergencies	Pre-course	4	3.00	.816	.408
		Post-course	7	4.00	.816	.309
	Pregnancy Related Sepsis	Pre-course	4	3.50	1.000	.500

Major cadre groups	Modules	Pre/Post	N	Mean Min=0, Max=5	Std. Deviation	Std. Error Mean
	and Unsafe Abortion	Post-course	7	4.14	.378	.143
		Post-course	4	3.25	1.258	.629

Table 58: Results of independent T-test analysis of pre and post training knowledge assessment by modules and professional cadre

Grouped cadre	Modules	P value Sig. (2-tailed)
Specialist Medical Doctor	Communication, Triage and Referral	.401
	Maternal and Newborn Resuscitation	.651
	Shock and the Unconscious Patient	.686
	(Pre) Eclampsia	.451
	Obstetric Haemorrhage	.161
	Preventing obstructed Labour	.409
	Obstetric Emergencies	.157
	Pregnancy Related Sepsis and complications from abortion	.830
Medical Doctor	Communication, Triage and Referral	.041
	Maternal and Newborn Resuscitation	.395
	Shock and the Unconscious Patient	.837
	(Pre) Eclampsia	.897
	Obstetric Haemorrhage	.528
	Preventing obstructed Labour	.981
	Obstetric Emergencies	.141
	Pregnancy Related Sepsis and complications from abortion	.164
Nurse-Midwife	Communication, Triage and Referral	.001
	Maternal and Newborn Resuscitation	<0.001
	Shock and the Unconscious Patient	<0.001

Grouped cadre	Modules	P value Sig. (2-tailed)
	(Pre) Eclampsia	<0.001
	Obstetric Haemorrhage	<0.001
	Preventing obstructed Labour	.124
	Obstetric Emergencies	<0.001
	Pregnancy Related Sepsis and complications from abortion	<0.001
Clinical officer	Communication, Triage and Referral	.695
	Maternal and Newborn Resuscitation	.713
	Shock and the Unconscious Patient	.393
	(Pre) Eclampsia	.446
	Obstetric Haemorrhage	.096
	Preventing obstructed Labour	.919
	Obstetric Emergencies	.082
	Pregnancy Related Sepsis and complications from abortion	.152

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