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Enhancing Human Resources and Use of Appropriate Training for Maternal and Perinatal Survival in Sub-Saharan Africa (ETATMBA) [Project no. 266290]

Evaluation Report

Deliverable 2.3

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On behalf of the ETATMBA Group

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1 Executive summary

1.1.1 Background

There is a chronic shortage of medical doctors in many Sub-Saharan African countries and indeed many of these countries have very little to spend on healthcare. As a consequence levels of maternal and neonatal mortality still very high and many are struggling to meet the WHO Millennium development goals.

Many African countries like Malawi have a cadre of health workers called Non Physician Clinicians (NPCs) who are trained by the Ministry of Health and are often the most experienced health worker in hospitals and health centres across the country. Some of these NPCs specialize in emergency obstetric and neonatal care (EmONC) and are in the frontline providing care for mothers and babies. The value of NPCs cannot be understated, it will take many more years before countries like Malawi have enough doctors, and dedicated, hardworking and loyal NPCs are providing an essential and valuable service.

Enhancing Training and Appropriate Technologies for Mothers and Babies in Africa (ETATMBA) was an EC funded (FP7) project managed by The University of Warwick Medical School (WMS) and was being delivered in Tanzania and Malawi. Project partners include the Karolinska Institute (Sweden), The Ministry of Health (Malawi), the College of Medicine (Malawi) and Ifakara Health Institute (Tanzania).

The purpose of the project was to train non-physician clinicians (assistant medical officers (AMOs) in Tanzania) as advanced leaders providing them with skills and knowledge in advanced neonatal and obstetric care. Training it is hoped that they would cascade to their colleagues (other NPCs, midwives, nurses). We chose to trial effectiveness of this sort of education on NPCs because they tend not to emigrate and so it was possible to do longer term project work with more durable impact in these countries. The aim of the project was to try and address the high levels of maternal and neonatal mortality. This report is the result of the impact and process evaluation of the ETATMBA project in both Tanzania and Malawi.

1.1.2 Methods

In both Tanzania and Malawi we carried out an evaluation of impact and a process evaluation. In Tanzania we used a before and after design looking at health indicators in the health facilities where the trainees were to be based for the period leading up to the start of the training and approximately a year after the training. The choice of training areas and centres was determined by the national plan to upgrade remote rural health centres to provide emergency obstetric care. In Malawi we were delivering the intervention in the northern and central regions which contained 14 districts. We chose to randomize the design putting selected trainees in half of the districts. Outcomes were health indicators like in Tanzania. The primary outcome was perinatal mortality (specified as fresh stillbirth plus neonatal death before discharge from the health facility), with secondary outcomes of maternal mortality, obstetric complications and birth complications. In addition, in Tanzania we looked at infrastructure and availability of key items (e.g. electricity, running water, specific equipment and appropriate drugs). In both Tanzania and Malawi we carried out a qualitative process evaluation. Interviews explored perceptions of the training, trainees where we required to provide real evidence that they were implementing their new skills and knowledge into practice. We also interviewed cascadees (colleagues who may have received training from one of our trainees) district medical officers and a number of the trainers involved with the trainees.

1.1.3 Results

In both Tanzania and Malawi the training was successfully implemented. In Malawi 54 trainees started and by the end we had 46. In Tanzania, we had dyads of trainees that is an AMO and a nurse or a nurse

midwife (the plan was to train the nurse in anaesthesia). There were 54 trained and 36 evaluated. Of the 36 at the start (18 of each group) one passed away and two moved into other areas so we ended with 33 trainees. An ongoing initiative in Tanzania suggested that after being trained the trainee dyads would return to updated facilities (e.g. an operating theatre) that allowed them to use the new skills and knowledge. Training in Tanzania was an intensive period away working with the tutors and doctors whilst in Malawi it was more modular with clinical mentors visiting trainees in their own facilities: so-called "on-the-job" training. Both training courses included leadership training.

Whilst we were very successful at carrying out an evaluation in both countries problems with data do make us cautious about interpreting the results we have. In Malawi for the primary outcome of neonatal and perinatal mortality we did not demonstrate any difference. In Tanzania we found that it is not routine practice to record neonatal mortality at the facilities making it impossible to calculate perinatal mortality. However, in terms of maternal mortality there is a decline in maternal mortality in Tanzania and may be a trend in Malawi but this needs further statistical modelling to account for confounders. In Malawi the lack of any change in intervention districts compared to control may also reflect the fact that to achieve the BSc, NPCs' training continued to 2014 and a longer time may be needed to see the effect.

In Malawi there is some indication that in intervention districts there are more obstetric complications but this is apparent at baseline. The qualitative data strongly supports that in Malawi the trainees applied new skills such as vacuum extraction and breech delivery, but baseline differences in the quantitative data between groups make it difficult for this to be clear. In Tanzania there is evidence that patients are aware of the new skills with people turning up at facilities that trainees are working in.

Similarly, birth complications in Malawi appear to rise but differences at baseline make this difficult to interpret and again this may be a recording issue in the intervention group following training. For example, reported cases of asphyxia at birth have risen in both intervention and control districts. It is possible that training has influenced this; in ETATMBA we did extensive teaching on neonatal resuscitation but an important confounder has been a countrywide initiative called 'Helping Babies Breathe' that could have impacted on asphyxia rates in control districts.

In both countries it is clear that resources and infrastructure have a huge impact on the ability of health workers, at times, to carry out their work. Basic no expensive drugs are often unavailable equipment is poorly maintained and running (clean) water and electricity are not guaranteed. Roads and vehicles for patient transfer or emergencies again are at times note available or so poorly maintained they are a major barrier to access to emergency obstetric care.

Trainees across the study note that they would welcome ongoing support and mentorship as our project closes. Trainers are maintaining some contact but face-to-face is difficult. In Tanzania the pattern of shortages of medical doctors is different to Malawi (where the shortage is urban as well as rural). In Tanzania you can find doctors in major centres but as you get into remote areas there are considerably less of them. The trainees note that often they are the only health professional available in these areas yet they are poorly supported with very poor housing and little or no recognition. There were similar feelings of isolation in Malawi with trainees feeling they lack a clear career path. The training and the setting up of a BSc for NPCs has given them some hope. There is evidence from our qualitative study that due to the leadership training trainees in both countries are engaging with local communities and officials and working with the teams and management in the facilities to try and bring about clinical service improvements.

1.1.4 Conclusions

This study has demonstrated that up-skilling non-physician clinicians with skills and knowledge in obstetrics, neonatal care and leadership is possible in sub-Saharan Africa. Not only is it possible it can

have a real impact on lives. The project highlights a number of the challenges of working in sub-Saharan Africa. This work provides strong evidence that this cadre are an important and integral part of the future of healthcare in sub-Saharan Africa and more should be done to encourage a future well-educated and supported generation who will have the health of nations in their hands and provide a sustainable solution for many countries in sub-Saharan Africa for the future.

2 Overview

The overall aim of Enhancing Human Resources and Use of Appropriate Training for Maternal and Perinatal Survival in Sub-Saharan Africa (ETATMBA) project was to develop, implement and evaluate a programme of locally based clinical service improvement including clinical guidelines and pathways, structured education, leadership training and workforce development. This linked to specialist support. This clinical service improvement involved implementing best existing practice and providing the context for understanding the additional health gain from the use of appropriate available technologies designed to reduce morbidity-specific maternal case-fatality rates and fresh stillbirth rates (intra-partum fetal mortality) across different African communities (Malawi and Tanzania).

This report, the culmination of 42 months (3.5 years) years of work, is the evaluation of the impact of the project. The project has not been without its challenges. A considerable amount of work was put into developing clinical guidelines (reported elsewhere) in both Malawi and Tanzania. These guidelines were operationalised and applied as job aides by the clinicians in their workplace and used in training others and in clinical service improvement. Structured education, leadership training and workforce development have taken place in both countries and we have evaluated the impact of these.

The innovative teaching programme, which introduced a technology that was new to Malawi and Tanzania where resources are poor showed that the NPCs as a cadre are capable of adapting and making significant service improvement, given support, respect, skills updating and leadership training. Below we outline the evaluations that have taken place.

In Malawi a cluster randomised controlled trial design was adopted for the evaluation. This was to allow comparisons between districts where training had taken place and districts where it had not. In Tanzania a before and after design was adopted looking at facilities where trainees were based. In both cases health facility data including maternal and neonatal (perinatal) mortality are recorded and form our primary outcomes. In both countries we have carried out a qualitative process evaluation exploring how the training has impacted on practice and the challenges faced by the trainees in implementing the skill learned.

The rest of the report (below) is structured around four main headings:

1. Background information;
2. Evaluation in Malawi;
3. Evaluation in Tanzania;
4. Synthesis of the results from both countries.

Acknowledgements, References and appendices follow at the end.

3 Background

A widespread crisis in the health workforce is affecting the realisation of the health-related millennium development goals. [1 2] There is also an imbalance in the range of health worker skills with many countries having too few specialist doctors such as surgeons, obstetricians and anaesthetists, relative to the health needs of their population.

An important indicator of the global personnel shortage in the health sector is the proportion of women assisted by skilled birth attendants. [3] In most industrialised countries, skilled birth attendance is provided at almost all births whilst fewer than 50% of births in the majority of countries in South Asia and sub-Saharan Africa receive such support. [4] Estimates show that skilled birth attendance rates are only improving at less than 0.5% per year: by 2015 it is likely that it will still be fewer than 50% of births where there is the support of a skilled birth attendant. [5]

Maternal mortality in most of sub-Saharan Africa remains obstinately high [6] in Tanzania, for example, the maternal mortality rate in 2008 was 449/100,000 compared to the UK 8/100,000. [7] and in Malawi, for example, the maternal mortality ratio is 675/100,000. [6 8 9] Whereas there has been a steady decline in maternal mortality in Europe over the past 60 years, in Africa even long periods of stability and increases in health spending have had little apparent effect in some countries. [10] The UN has set a target for maternal case fatality rate of less than 1%. Skilled health personnel attend less than 50% of women in low-income countries, yet life-threatening complications that require emergency care will arise for around 15%. [10] Perinatal mortality is 12 times higher than maternal mortality and accounts for seven million deaths: about three million babies are stillborn and four million die in the neonatal period. Much of this loss is preventable. [6 10 11] The major causes of the almost four million neonatal deaths in low-income countries in or around the first week of life are infection, pre-term birth and asphyxia. [11]

There is a need for alternative strategies as Models of healthcare like those that have developed in Europe, based on highly trained medical specialists, using complex technology, are unlikely to be practical or sustainable in sub-Saharan Africa. There is much evidence to support a different model of service provision in Africa, whereby the relatively scarce resource of medical obstetric specialists are focused to train and support a service mainly provided by healthcare staff other than doctors, e.g. non-physician clinicians (NPCs), assistant medical officers, clinical officers, midwives and outreach community health-workers. In this model, the medically trained specialist obstetricians, mainly operating in large centres and capital cities, can focus their attention on management of difficult clinical cases and on providing support, leadership and training for NPCs. In sub-Saharan Africa, due to training and retention difficulties, there are only 5 doctors per 100,000 people. [12] Many women in rural and urban communities in Africa give birth without any trained assistance for their pregnancy and childbirth. Programmes of training for health-workers to provide safe outreach community healthcare are being developed but these need to be systematic, transferable, and able to be scaled up to meet the needs of these woman across Africa. A health delivery model of non-physician clinicians (NPCs) and with support and supervision of the physician specialist obstetricians would be an affordable and sustainable system for these communities. To address the global health workforce crisis many countries are now considering task shifting strategies. Task shifting from physicians to non-physicians appears to be both safe and effective in countries that have organised and supported the extension of their maternal care in this way. [12-18] In Malawi NPCs have been established health providers since 1976 performing surgical procedures, giving anaesthetics and providing medical care. [19 20]

Much work has been done to assess the efficiency of training NPCs (assistant medical officers, clinical officers and specialist midwives) in the skills of clinical decision-making and surgical intervention. [12 14] Training skilled attendants to prevent, detect and manage major obstetric complications, including undertaking emergency caesarean surgery in complicated deliveries is arguably the single most important factor in preventing maternal deaths and protecting the human rights of women. [12-14 17] To be effective NPCs need appropriate equipment, drugs and technology essential for managing obstetric complications in rural or deprived communities.

Task shifting from physicians to non-physicians appears to be both safe and effective in countries that have organised and supported the extension of their maternal care in this way. [12-17]. However, recent work has shown that whilst they are a valuable resource they often feel undervalued and under supported and this can and will have an impact on their retention. [21 22] The WHO has made strong recommendations to optimise the NPCs role in maternal and new-born health. [23] Major surveys consistently show that extra training and support can achieve task shifting and improve maternal and fetal mortality and morbidity in the areas where these schemes have been piloted. [13 14 17] Most of the maternal population in sub-Saharan Africa lives outside the major cities and for these women there remain major challenges to effective maternal care. Solutions must include outreach of effective care to this population. In addition to lack of available trained manpower, factors that have been identified as contributing to the higher maternal and perinatal mortality include poor availability of relatively cheap drugs and simple technologies for managing post-partum haemorrhage (PPH). For example, shortages of immediately available blood, lack of access to senior advice on 24/7 basis, access to facilities and staff for emergency Caesareans, and delays and inadequacies in the safe transport to hospital when complications arise. There can also be a problem in recognising complications early enough for effective action (for example; breech, transverse lie, placenta previa, pre-eclampsia and anaemia). Early detection of these could be improved with training and simple technologies. It is estimated that 75% of maternal deaths and more than 60% of perinatal deaths are caused by eight major conditions. For the mother the five major killers are post-partum haemorrhage, sepsis, hypertensive disorders of pregnancy, obstructed labour, and unsafe abortion and the three major causes of perinatal child death are low birth-weight, birth asphyxia, and infection. [14 24]

4 Evaluation in Malawi

4.1 Background

In Malawi, training and deployment of NPCs can be traced to as early as 1875 when Dr Robert Laws started on the job training of Medical Orderlies and Medical Assistants. The Government introduced formal training of Clinical Officers in 1976. They are a major human resource for health in Malawi as far as clinical services are concerned. They perform surgical procedures, give anaesthetics and provide medical care. NPCs have been established health providers in Malawi for a long time, yet lack a clear career pathway [21 22]. It was hoped that by providing NPCs with advanced leadership and skills training (the intervention) we will have an impact on hard hospital outcomes (e.g. reduced maternal and neonatal morbidity and mortality) and help to strengthen the position of mid-level providers which has the potential to expand cost-effective, quality services to under-serviced areas and thereby improve equitable access to care.

Specific objectives

To explore changes in hospital outcomes like maternal and perinatal mortality comparing intervention districts with controls.

- The primary outcome is perinatal mortality (defined as fresh stillbirths and neonatal deaths before discharge from the health care facility)

Secondary outcomes include:

- Maternal death rates (case specific);
- Recorded data (e.g. still births, Post-Partum Haemorrhage, C Section, (pre-)eclampsia, Sepsis);

Alongside this we carried out a process evaluation of the implementation of the intervention to inform future implementation of interventions like these. The process evaluation includes outcomes which will explore how or why the intervention was either effective or indeed not effective. Including:

- Challenges faced;
- Acceptability;
- Sustainability.

Process evaluations particularly help researchers understand the causal pathways by which complex interventions might work and sometimes to interpret equivocal results. The shift towards greater evidence-based-practice means there is a greater need to know why an intervention works and, if it does not, why not. Process evaluation can facilitate this understanding and should be incorporated into the evaluation of health promoting interventions/programmes. [25] A protocol for this evaluation was published in 2012. [26]

4.2 Methodology

4.2.1 Design

The study was a cluster randomised controlled trial with an embedded process evaluation.

4.2.2 Study Place

The study was conducted in Districts within the central and northern regions of Malawi. There are a total of 14 districts in these regions which will be randomised to either intervention or control (Dedza, Dowa, Kasungu, Lilongwe, Mchinji, Nkhotakota, Ntcheu, Ntchisi, Salima, Chitipa, Karonga, Mzimba, Nkhata Bay, Rumphi). A pragmatic decision was made that as Lilongwe is such a large district and had

two major tertiary care hospitals, it would be divided into two with one half randomised to intervention and the other to control making a total of 15 districts. Stratified randomisation of the districts, to ensure the two groups are comparable was carried out by a statistician at the University of Warwick, UK. This used data from the Malawi government for 2010. There were 8 intervention districts and 7 controls.

4.2.3 Study Population

Within the eight intervention districts approximately 50 NPCs were provided with advanced leadership and skills training (the intervention). In each district which is randomised to the intervention one or two hospitals, depending on the size of the district, (e.g. District and Rural Hospitals) participated with between 3 and 8 NPCs in each district (again number depends on size of district, minimum would be 3 in one district, overall total cannot exceed 50). The research assistants invited all the 'trained' NPCs to be involved in the evaluation. Their involvement in the evaluation is related to the process evaluation and will include interviews. District medical and nursing officers in the intervention districts were invited to be interviewed about the districts involvement in the intervention and at follow-ups how the intervention has worked/fitted in to the hospital routine. As part of the intervention the trained NPCs are expected to cascade the training they have received to others within their districts (e.g. other NPCs or midwives). The research assistants identified a number of these people from the NPC's records and they were approached and interviewed about the training they received and how they have been able or indeed unable to implement what they have been taught. All participants were provided with information about the study and asked to provide written informed consent.

4.2.4 Study Period

Between November 2010 and June 2014.

4.2.5 Sample Size

The primary sample for the RCT are the fifteen districts, the Malawi Ministry of Health hospitals and health centres within them and 50 participating NPCs from the 8 intervention Districts.

4.2.6 Power calculation

The projects primary outcome measure is the proportion of live-born infants who died in the hospital or health facility in the early neonatal period, i.e. from birth to the day of discharge from facility. Other outcome measures of interest considered are the comparisons of proportions of fresh stillbirths We computed a sample size for proportion in an unmatched study with 80% power, a one sided alpha of 0.05, and an ICC 0.0025. The current neonatal mortality rate in Malawi: is 30 per 1000 live births (source UNICEF) and assuming a minimum number of clusters of 14 in our sampled districts, the study was powered to detect a 20% difference between the two birth cohorts (intervention and control) in the proportion of live-born neonates delivered by NPCs or staff trained by them) surviving to hospital discharge.

With the allocation of 7 districts per arm with an estimated 700 births per NPC (or staff trained by them), 1028 births per study arm per district would provide sufficient power for a total of 2056 neonates per district. That is, a decline from 30 per 1000 live births to 24 per 1000 live births, rate ratio 0.20.

4.2.7 Inclusion criteria

Only NPCs providing emergency obstetric and neonatal care (EmONC) from the 7 randomised intervention Districts in Central and Northern Region who have received the intervention training will be invited and those who will give their informed consent will be included in the project or:

The District medical or nursing offices (in intervention districts) or

NPCs, midwives or nursing staff who have been trained by one of the intervention NPCs

4.2.8 Data Collection

4.2.8.1 Quantitative Data Collection

Primary data was extracted from the maternity log (Malawi Ministry of Health Maternity Register, Ver. 2 (July 2008)) at the district hospital and rural hospitals in each district by the two research assistants monitored by the local and UK team. Other facilities within the district (e.g. health Centres) also complete the same maternity log book from which summary data is returned to the district hospital on a monthly basis. This data will also be gathered by the researchers and the combined data will make up a complete picture of the districts. We planned to collect data three points in time retrospectively (i.e. the year leading up to date). However, only two data collection times were used. Baseline at about 18 months into the project and at the end in January/February 2014 (data collected in total was for 2011, 2012, and 2013).

Within the intervention districts at the time of visits the research assistants will approach the consenting NPCs (primarily to interview them, described below) but also to gather information about project related activities (e.g. who they have trained, when they did this, how many training session done, etc.).

For process evaluation purposes training registers, adherence to training procedures (during the project period), knowledge scores and training feedback were also collected and collated from the intervention team. No identifiable data was recorded.

4.2.8.2 Qualitative Data Collection

Semi structured interviews were carried out at three time points. The first set of interviews was undertaken four to five months after the delivery of module 1 with a convenience sample of trainees. A researcher (WC) visited each intervention district for 1-2 days and interviewed ETATMBA trainees available during her visit. During the interviews the trainees were asked their perceptions of the training and support and, with no prompting about training content, they were asked what new knowledge they gained. The second set of interviews was undertaken by a researcher (WC) during 1-2 day visits to all the intervention districts four to five months after delivery of the second module on clinical leadership. Available trainees were asked, without prompts about training content and about implementation of what they had learnt from the training in their work place. We then prompted them to talk about challenges and successes in using and sharing these skills in their facilities. During these data collection visits available district medical and nursing officers were interviewed, exploring how they perceived the training and how it had fitted into their hospital. The researcher also asked the trainees to identify cascadees such as nurses, nurse midwifes, or NPCs to whom they had delivered some training. The researcher then sought interviews with available cascadees about the delivery and content of training they had received. Three researchers (WC, DE and FG) carried out a third set of interviews with trainees, in an amendment to the protocol, while they were attending the week long residential delivery of modules five and six in May 2013. We asked the trainees to provide specific examples of how they had used the training in their clinical work, describing actual cases. In the first part of the interview no prompts about course content were used. In the latter part of the interview trainees were asked to provide the examples from their clinical work, of the application of each of the following key aspects of the training: delivery skills Breech, forceps, vacuum, C-section , neonatal resuscitation, management of postpartum haemorrhage, the use of partograms. At this time, we also interviewed the two obstetricians who had worked alongside the NCPs.

Data was drawn from Malawi Ministry of Health (MOH) documents for describing the context of the trial. Data from the MOH data on the pool of NPCs from which recruits were selected in the intervention

districts is used to describe the reach of the intervention. Dose delivered is assessed using attendance and assignment submission logs.

Figure 1 illustrates the intervention and research timelines.

All interviews were audio recorded and transcribed verbatim. A study specific Nvivo (version 10) project stored the transcripts and facilitated analysis. Coding was undertaken by WC and DE with FG providing independent quality checks on 20% of transcripts early in the coding process. We adopted a thematic approach for analysis. Coding was based on the interview schedule and initial reading of the transcripts. Additional codes were added as themes emerged from the data. The coding team discussed and agreed on themes and their definitions. Coding discrepancies were discussed and coding definitions refined. For analysis we used a modification of the process evaluation framework as our framework (see table 1).

Data relating to context were extracted from the MOH documents and selected summary statistics are presented to provide an illustration of the district. The officers from the MOH, who carried out the recruitment of the trainees, provided the overall numbers of NPCs they selected from this figure is summarised.

4.2.9 Intervention

4.2.9.1 The Training package

The intervention is the training of NPCs in specific skills. Module 1 consisted of in depth theoretical review and demonstration of prevention and management of the five major killers of mothers and the three most common causes of neonatal death e.g. resuscitation of the new born, treatment of maternal and neonatal sepsis etc. with facilitated referral in delivery. Module 2 dealt with leadership and module 3 included on the job training in surgical skills for the management of emergency obstetric complications and the prevention of pre-term labour. The control Districts/Hospitals continued with their usual EmONC services.

Briefly, the training package was a 30 month programme of knowledge and skills training including mentoring of practice. In addition, two obstetricians at specialist registrar level with 5 years of clinical experience worked alongside the NPC, each for two weeks in each district providing peer support and sharing of skills and knowledge. Figure 1 contains a summary of the content of the training modules and further detail is on the ETATMBA website. [27] This is empowering education, and differs from basic didactic education. We were not just lecturing them we hoped to ‘empower’ them to think and to maximise the use of their limited material resources to provide the best care possible for their patients and facilities. Included in the training there were key components of clinical service improvement and values based practice, which can be expected to yield returns out with the study period.

Figure 1. An overview of the Malawi ETATMBA training modules when they were delivered and the time points at which interviews were carried out

Timeline	Modules & Research Activity	
Nov-Dec 2011	**Module 1: Clinical Officers as Advanced Leaders** This concentrated on the five major causes of maternal mortality in Malawi, hypertension/eclampsia, postpartum haemorrhage, post delivery sepsis, sepsis after unsafe abortion, obstructed labour.	Simulation and skill drills on emergency obstetrics included, external cephalic version, vaginal breech, postpartum haemorrhage, B Lynch suture, shoulder dystocia, eclamptic fit, vaccum extraction, obstructed labour (partograph)
April – May 2012	**1st interviews: N = 19 Trainees**	
May – June 2012	**Module 2: Clinical service improvement and leadership in emergency obstetric and neonatal care** Introduction to leadership Behaviours and leadership skills Leading and managing change Introduction to service improvement and problem identification Service improvement and values stream mapping Introduction to values based practice	Key concepts in values based practice Introduction to Clinical Leadership Compentency Framework (CLCF) (trainees expected to use new leadership skills on return to district) Quality improvement in obstetrics Audit workshop (assignments given and audits conducted on return to districts (completion Nov 2012) Neonatal care videos (eight training videos covering a variety of topics)
Oct – Nov 2012	**2nd Interviews: N = 12 Trainees, N = 10 Cascadees, N = 7 DMO/DNO**	
Nov – Dec 2012	**Module 3: Born too soon** Neonatal survival in Malawi Prevention of pre-term labor Gestational age Preterm neonatal resuscitation	Special care of preterm babies Kangaroo mother care Evidence-based medicine Second and third trimester scanning technique Setting up the machine (ultrasound scanner)
Dec 2012 – Feb 2013	**Module 4 "Professional project" involving a literature review, audit and re-audit.**	
May – June 2013	**Module 5: Understanding research evidence and critical appraisal** Training NPCs Introduction to evidence-based medicine Evidence-based medicine overview Bias Interaction How to read an academic paper How to critically appraise an article Critical Appraisal Skills Programme	Helsinki Ethical Principles for Medical Research National Health Services Research Committee of Malawi: Guidelines National Health Services Research Committee of Malawi: Application form Revised guidelines and operational procedures Qualitative research appraisal Qualitative research data analysis Statistics
	Module 6: Essentials of clinical training in obstetric and neonatal care in a low-resource setting Introduction to clinical education Clinical teacher briefing Learning styles and strategies	How to teach practical skills Teaching practical skills On-the-job teaching Small group mentoring Interprofessional education
	3rd interviews: N =39 trainees, N = 2 Registrars	

4.2.10 Data Analysis

4.2.10.1 Primary outcomes

The full data set will consists of 3 full years of data (12-months prior to the start of the project and 24 months of the project). Taken form summary maternity registers in all facilities, in the fourteen districts) that deliver maternity care.

Quantitative data were entered onto a study database (MS Excel) and for data management and transferred to the STATA study database for analysis.

Descriptive statistics will be produced and appropriate statistical tests applied if needed.

Data will be presented in tables as appropriate.

4.2.10.2 Qualitative Data Analysis

Interviews were digitally recorded, subject to permission of each participant, and where appropriate, will be transcribed verbatim. The recordings will be stored in a secure digital environment and only members of the research team will have access to them. Participants will not be identified and a code number will identify transcripts. Subsequent written material will use pseudonyms, for participants, and at the end of the study, recordings will be erased. Data will be analysed using the Framework method. This approach is described by Ritchie and Spencer [28] and Pope et al., [29] and is broadly as follows:

- Data familiarisation: reading of complete interview transcripts, listening to original audio-recordings and use of field notes;
- Identifying a thematic framework: key issues, concepts and themes are identified and an index of codes developed;
- Indexing: whereby the index generated through identification of the thematic framework is applied to all data;
- Charting: a summary of each passage of text is transferred into a chart to allow more overall and abstract consideration of index codes across the data set and by each individual;
- Mapping and interpretation: understanding the meaning of key themes, dimensions and broad overall picture of the data and identifying and understanding the typical associations between themes and dimensions;
- The charting process provides an opportunity to code data from numerous vantage points, by demographic factors, such as gender or age, by personality characteristics, such as looking specifically at people who are highly anxious compared to those who are not, or by medical aspects, such as those with diabetes compared to those without.
- The charting process provides an opportunity to code data from numerous vantage points, by demographic factors, such as gender or age, by personality characteristics, such as looking specifically at people who are highly anxious compared to those who are not, or by medical aspects, such as those with a particular condition compared to those without.

The computer package NVivo 10 was used to facilitate this process. Researcher bias was minimised through regular crosschecking of data and findings by the members of Research Team. Quotes will be used as exemplars of key points in the writing up of these data.

4.2.11 Ethical considerations

All participants will obey the charter of fundamental rights of the European Union (2000/C364701, 7 Dec 2000).

Hospitals were provided with full information about the trial and consent was sought from the district medical officer for permission for access to the data required (e.g. maternity logs, summary maternity logs). Researchers were respectful of the needs of the hospitals and made appropriate arrangements to visit and collect data.

No patient identifiable data was collected during this study. However, hospital data will be seen and summaries recorded on trial CRF for inputting into study database. None of the data collected identifies individuals. Paper copies of data are stored in a secure environment (locked office in locked filing cabinet) and entered onto a secure study database in a secure digital environment.

4.2.11.1 Ethical approval

The study was reviewed and approved by the Biomedical Research Ethics Committee (BREC) at the University of Warwick, UK (143/09/2011) and The College of Medicine research ethics committee (COMREC), Malawi (P.07/11/1102). It has the approval and support of the Ministry of Health, Malawi.

4.3 Results

The following results section is in two parts and contains the results from the evaluation of the ETATMBA project in Malawi. The first part relates to the quantitative findings whilst the second part relates to the qualitative.

Fifty-four trainees were recruited represented 67% (54/81) of the COs working in emergency obstetric and new-born care (EmONC) in the intervention districts. 46/54 trainees remained in the programme, at the end, 25 from the central region of Malawi covering nine hospitals (district and central hospitals) and 21 from the northern region of Malawi representing six hospitals (district and central hospitals), one of the smaller districts in the northern region now only has one ETATMBA trainee within it working in the district hospital. Nearly all the trainees are male with only two females. More detail on the intervention and trainees can be found in the qualitative results later.

We note here that the data collected from the districts that are the basis of these results was found to be variable, with some sites poorly recorded and poorly stored as a result we are being very cautious in over interpreting these results. Lilongwe is a very large district and we planned to divide this into two, half intervention half control. However, when data were gathered the data was not at the facility level (i.e. it was not broken down into its individual health centres and hospitals) this has meant we could not split it. So here we have presented Lilongwe as an intervention district. However, during data cleaning it was noted that the Lilongwe data were an outlier. This was a design fault as we were unaware that Kmusu Central in effect handles few deliveries compared to Bwaila, which was our intervention facility and which serves the entire city. As such we have included it in all descriptive but we have also provided totals which exclude it.

Our primary outcome was to look for reduction in perinatal mortality (defined in this study as fresh stillbirth and neonatal death before discharge from the facility). In Table 1 below we present the total births, the perinatal mortality number and mortality rate per 1000 births from all of the districts for the three years of the project (2011 – 2013). The table highlights a number of things. Firstly, the huge variation across districts in perinatal mortality rate, in 2013 rates range from 25+ to 14 per 1000 births. There are no significant differences although it appears the control group districts saw the greatest reduction rates appear to have levelled out at around 20 per 1000 births. Overall the trend does appear to be downward.

Table 1. Perinatal mortality for each district for the project period

Districts		Total Births (n)			Perinatal Mortality (n)			Perinatal Mortality per 1000 births		
		2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	3186	4708	6812	30	89	170	9.4	18.9	25.0
Karonga	I	7018	6088	7553	132	147	129	18.8	24.1	17.1
Kasungu	I	14190	14480	17761	324	346	358	22.8	23.9	20.2
Lilongwe	I	43004	29402	45752	736	651	694	17.1	22.1	15.2
Mzimba	I	10095	16510	20348	180	336	393	17.8	20.4	19.3
Nkhotakota	I	5135	4784	9449	90	107	234	17.5	22.4	24.8
Ntcheu	I	5519	6879	12668	112	132	267	20.3	19.2	21.1
Rumphi	I	4827	5632	3191	107	110	59	22.2	19.5	18.5
Dedza	C	21627	22685	23501	326	338	430	15.1	14.9	18.3
Dowa	C	20417	12647	12986	387	254	231	19.0	20.1	17.8
Mchinji	C	19373	20486	17512	1142	849	444	58.9	41.4	25.4
Nkharta Bay	C	6193	3883	6079	200	94	100	32.3	24.2	16.5
Ntchisi	C	5855	3986	6920	75	64	139	12.8	16.1	20.1
Salima	C	MD	7479	12294	MD	134	175	MD	17.9	14.2
Total		166439	159649	202826	3841	3651	3823	23.1	22.9	18.8
Intervention		92974	88483	123534	1711	1918	2304	18.4	21.7	18.7
Control		73465	71166	79292	2130	1733	1519	29.0	24.4	19.2
Intervention*		49970	59081	77782	975	1267	1610	19.5	21.4	20.7

I = Intervention, C = Control. *Intervention totals excluding Lilongwe. MD = Missing data

Perinatal mortality is made up of neonatal mortality and fresh stillbirth, in Table 2 below we present the number and rate (per 1000 births) across all districts for the three years of the project. You will see that overall neonatal death remains around 9 to 11 per 1000 births and has not changed much during the project period. We note again a huge variation across districts with figures which suggest caution.

Maternal mortality was a secondary outcome in this study. In Table 3 below you see again the huge variation in results. There is a possible trend towards an improvement in many of the intervention districts, with six of the eight with lower numbers but also importantly rate. Whilst in the control districts maternal mortality appears to worsen with five out of six having an increase in rate. In the totals it is harder to see any improving trend as in the intervention districts overall the rate has risen from 302.2 to 317.3 per 100,000 births in 2013 with a huge increase in 2012 to 658.9 per 100,000 births. We draw attention to a number of outlier figures, not least Lilongwe district, which are within our results that make a number of the districts look very poor. For example the 2012 – 2013 results in Ntchisi where 84 and 83 deaths are reported in the district when there were only around 4000 and 7000 births respectively, compared to 2 in 2011. Rumphi in 2011 recorded 121 deaths from only 4827 births, data that is hard to believe. When we remove Lilongwe from the totals we see a downward trend from 480.3 in 2011 to 264 (2012) and 255.8 in 2013. This variability in the reported results that appear to be outliers means that more complex multivariate analysis with modelling will need to be undertaken before any firm conclusions can be drawn and further checking of source data in Malawi will need to be undertaken before publication.

Table 2. Neonatal deaths and stillbirths across all districts over the three years

		Neonatal death (ND)						Stillbirth fresh (SBF)						Stillbirth macerated (SBM)					
		n			ND rate per 1000 births			n			SBF rate per 1000 births			n			SBM rate per 1000 births		
	I/C	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	12	38	95	3.8	8.1	13.9	18	51	75	5.6	10.8	11.0	7	39	47	2.2	8.3	6.9
Karonga	I	71	88	82	10.1	14.5	10.9	61	59	47	8.7	9.7	6.2	65	31	86	9.3	5.1	11.4
Kasungu	I	132	162	125	9.3	11.2	7.0	192	184	233	13.5	12.7	13.1	112	148	238	7.9	10.2	13.4
Lilongwe	I	328	362	281	7.6	12.3	6.1	408	289	413	9.5	9.8	9.0	378	296	380	8.8	10.1	8.3
Mzimba	I	82	190	215	8.1	11.5	10.6	98	146	178	9.7	8.8	8.7	66	169	214	6.5	10.2	10.5
Nkhotakota	I	41	58	134	8.0	12.1	14.2	49	49	100	9.5	10.2	10.6	37	53	72	7.2	11.1	7.6
Ntcheu	I	62	66	170	11.2	9.6	13.4	50	66	97	9.1	9.6	7.7	25	52	76	4.5	7.6	6.0
Rumphi	I	59	59	27	12.2	10.5	8.5	48	51	32	9.9	9.1	10.0	34	62	28	7.0	11.0	8.8
Dedza	C	128	148	185	5.9	6.5	7.9	198	190	245	9.2	8.4	10.4	164	149	155	7.6	6.6	6.6
Dowa	C	146	109	110	7.2	8.6	8.5	241	145	121	11.8	11.5	9.3	148	115	116	7.2	9.1	8.9
Mchinji	C	261	253	228	13.5	12.3	13.0	881	596	216	45.5	29.1	12.3	154	161	135	7.9	7.9	7.7
Nkharta Bay	C	133	49	65	21.5	12.6	10.7	67	45	35	10.8	11.6	5.8	58	94	146	9.4	24.2	24.0
Ntchisi	C	35	18	49	6.0	4.5	7.1	40	46	90	6.8	11.5	13.0	45	57	62	7.7	14.3	9.0
Salima	C	MD	50	70	MD	6.7	5.7	MD	84	105	MD	11.2	8.5	MD	51	91	MD	6.8	7.4
Total		1490	1650	1836	9.0	10.3	9.1	2351	2001	1987	14.1	12.5	9.8	1293	1477	1846	7.8	9.3	9.1
Intervention		787	1023	1129	8.5	11.6	9.1	924	895	1175	9.9	10.1	9.5	724	850	1141	7.8	9.6	9.2
Control		703	627	707	9.6	8.8	8.9	1427	1106	812	19.4	15.5	10.2	569	627	705	7.7	8.8	8.9
Intervention*		459	661	848	9.2	11.2	10.9	516	606	762	10.3	10.3	9.8	346	554	627	6.9	9.4	8.1

I = Intervention, C = Control. *Intervention totals excluding Lilongwe. MD = Missing data

Table 3. Total births, maternal death numbers and rate per 100,000 births for all districts between 2011 and 2013

Districts		Total Births (n)			Maternal Deaths (n)			Maternal Mortality rate per 100.000 births		
		2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	3186	4708	6812	6	9	4	188.3	191.2	58.7
Karonga	I	7018	6088	7553	16	3	8	228.0	49.3	105.9
Kasungu	I	14190	14480	17761	40	24	33	281.9	165.7	185.8
Lilongwe	I	43004	29402	45752	41	427	193	95.3	1452.3	421.8
Mzimba	I	10095	16510	20348	14	85	112	138.7	514.8	550.4
Nkhotakota	I	5135	4784	9449	35	4	17	681.6	83.6	179.9
Ntcheu	I	5519	6879	12668	8	6	5	145.0	87.2	39.5
Rumphi	I	4827	5632	3191	121	25	20	2506.7	443.9	626.8
Dedza	C	21627	22685	23501	11	8	15	50.9	35.3	63.8
Dowa	C	20417	12647	12986	11	12	8	53.9	94.9	61.6
Mchinji	C	19373	20486	17512	23	6	16	118.7	29.3	91.4
Nkharta Bay	C	6193	3883	6079	7	4	11	113.0	103.0	181.0
Ntchisi	C	5855	3986	6920	2	84	83	34.2	2107.4	1199.4
Salima	C	MD	7479	12294	MD	2	12	MD	26.7	97.6
Total		166439	159649	202826	335	699	537	201.3	437.8	264.8
Intervention		92974	88483	123534	281	583	392	302.2	658.9	317.3
Control		73465	71166	79292	54	116	145	73.5	163.0	182.9
Intervention*		49970	59081	77782	240	156	199	480.3	264.0	255.8

I = Intervention, C = Control. *Intervention totals excluding Lilongwe. MD = Missing data

The next two tables (Table 4 and Table 5) are summaries of the obstetric complications data we collected. This is presented again for each of the districts over the three years of the project. The number of events and the rate of these events per 1000 births are given. In Table 4 sepsis rates remain low across the project period whilst complicated labour (e.g. prolonged labour) and (pre-) eclampsia are rising across all districts. The biggest rises seem to be in intervention districts which may suggest that our trainees are handling more of the complicated cases but this is also apparent at baseline in 2011. Interestingly, as noted above there is not a rise in maternal mortality. We see a similar trend in the handling of ruptured uterus or haemorrhage.

The following three tables (Table 6, Table 7 and Table 8) are summaries of the birth complication data collected. We see in intervention districts that the rate is higher than control districts at baseline and this confounder makes it difficult to ascribe any change over time as a result of the intervention. We see a similar trend in breech delivery and caesarean sections with a greater number of procedures being done in intervention districts suggesting trainees may be making use of the updated skills provided (Table 6). There may be a trend towards a decrease in premature and low birth weight births, which are very high in Malawi in both intervention and control districts (Table 7) and this is encouraging. Rates of asphyxia have increased in both intervention and control districts. This at first sight seems puzzling. One possible

explanation is that these are being recorded more often following the 'Helping Babies Breathe' initiative and indeed the ETATMBA neonatal resuscitation training. Sepsis rates at birth are low and when accounting for the outlier district (Lilongwe) we see a reduction over the three years in both intervention and control districts (Table 8). Prolonged labour seems to have increased across all districts from 2011 to 2013 and this might be due to recurrent fuel crises and lack of transport delaying referral to hospital during these periods. It might also reflect more women from outlying parts of the district getting to hospital, albeit late in the labour.

The apparent increase in the recording of the complications could be due to the raised awareness among trainees and better detection and recording for example of pre-eclampsia after the training.

Table 4. Obstetric complications, by district and year, number and rate per 1000 births

		Prolonged/Labour						(Pre-)Eclampsia						Sepsis (maternal)					
		n			Per 1000 births			n			Per 1000 births			n			Per 1000 births		
	I/C	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	32	80	222	10.0	17.0	32.6	1	9	33	0.3	1.9	4.8	0	4	5	0.0	0.8	0.7
Karonga	I	176	151	190	25.1	24.8	25.2	70	37	58	10.0	6.1	7.7	21	45	42	3.0	7.4	5.6
Kasungu	I	175	273	717	12.3	18.9	40.4	32	67	92	2.3	4.6	5.2	41	44	44	2.9	3.0	2.5
Lilongwe	I	1724	1189	2064	40.1	40.4	45.1	325	540	400	7.6	18.4	8.7	21	28	38	0.5	1.0	0.8
Mzimba	I	119	775	993	11.8	46.9	48.8	68	179	216	6.7	10.8	10.6	32	32	21	3.2	1.9	1.0
Nkhotakota	I	180	225	514	35.1	47.0	54.4	14	24	48	2.7	5.0	5.1	9	32	26	1.8	6.7	2.8
Ntcheu	I	140	170	458	25.4	24.7	36.2	16	26	63	2.9	3.8	5.0	1	3	6	0.2	0.4	0.5
Rumphi	I	131	173	122	27.1	30.7	38.2	40	71	19	8.3	12.6	6.0	13	19	7	2.7	3.4	2.2
Dedza	C	653	797	948	30.2	35.1	40.3	89	98	151	4.1	4.3	6.4	5	17	14	0.2	0.7	0.6
Dowa	C	776	655	599	38.0	51.8	46.1	142	100	94	7.0	7.9	7.2	14	6	4	0.7	0.5	0.3
Mchinji	C	683	677	661	35.3	33.0	37.7	129	169	119	6.7	8.2	6.8	17	34	17	0.9	1.7	1.0
Nkhata Bay	C	429	196	377	69.3	50.5	62.0	25	12	25	4.0	3.1	4.1	16	6	11	2.6	1.5	1.8
Ntchisi	C	86	127	286	14.7	31.9	41.3	21	35	23	3.6	8.8	3.3	39	24	5	6.7	6.0	0.7
Salima	C	MD	194	277	MD	25.9	22.5	MD	34	73	MD	4.5	5.9	MD	3	20	MD	0.4	1.6
Total		5304	5682	8428	31.9	35.6	41.6	972	1401	1414	5.8	8.8	7.0	229	297	260	1.4	1.9	1.3
Intervention		2677	3036	5280	28.8	34.3	42.7	566	953	929	6.1	10.8	7.5	138	207	189	1.5	2.3	1.5
Control		2627	2646	3148	35.8	37.2	39.7	406	448	485	5.5	6.3	6.1	91	90	71	1.2	1.3	0.9

I = Intervention, C = Control. MD = Missing data

Table 5. Obstetric complications, by district and year, number and rate per 1000 births, continued

		Ruptured uterus						Haemorrhage					
		n			Per 1000 births			n			Per 1000 births		
	I/C	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	0	2	12	0.0	0.4	1.8	21	49	111	6.6	10.4	16.3
Karonga	I	9	3	10	1.3	0.5	1.3	220	184	195	31.3	30.2	25.8
Kasungu	I	21	19	41	1.5	1.3	2.3	203	190	420	14.3	13.1	23.6
Lilongwe	I	56	46	69	1.3	1.6	1.5	844	1841	857	19.6	62.6	18.7
Mzimba	I	10	30	44	1.0	1.8	2.2	120	399	392	11.9	24.2	19.3
Nkhotakota	I	20	7	27	3.9	1.5	2.9	77	107	205	15.0	22.4	21.7
Ntcheu	I	6	3	13	1.1	0.4	1.0	81	76	136	14.7	11.0	10.7
Rumphi	I	11	18	3	2.3	3.2	0.9	84	125	50	17.4	22.2	15.7
Dedza	C	12	17	21	0.6	0.7	0.9	293	407	393	13.5	17.9	16.7
Dowa	C	31	25	13	1.5	2.0	1.0	294	200	209	14.4	15.8	16.1
Mchinji	C	40	33	13	2.1	1.6	0.7	324	421	456	16.7	20.6	26.0
Nkhata Bay	C	9	5	3	1.5	1.3	0.5	122	127	125	19.7	32.7	20.6
Ntchisi	C	5	4	3	0.9	1.0	0.4	92	88	125	15.7	22.1	18.1
Salima	C	MD	13	21	MD	1.7	1.7	MD	167	221	MD	22.3	18.0
Total		230	225	293	1.4	1.4	1.4	2775	4381	3895	16.7	27.4	19.2
Intervention		133	128	219	1.4	1.4	1.8	1650	2971	2366	17.7	33.6	19.2
Control		97	97	74	1.3	1.4	0.9	1125	1410	1529	15.3	19.8	19.3

I = Intervention, C = Control. MD = Missing data

Table 6. Birth complications (number and rate per 1000 births)

		Vacuum extraction						Breech delivery						Caesarean section					
		n			Per 1000 births			n			Per 1000 births			n			Per 1000 births		
	I/C	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	17	72	73	5.3	15.3	10.7	36	75	115	11.3	15.9	16.9	1	141	445	0.3	29.9	65.3
Karonga	I	22	83	76	3.1	13.6	10.1	164	101	128	23.4	16.6	16.9	323	242	283	46.0	39.8	37.5
Kasungu	I	338	212	304	23.8	14.6	17.1	355	261	304	25.0	18.0	17.1	691	729	1059	48.7	50.3	59.6
Lilongwe	I	1383	790	1215	32.2	26.9	26.6	1072	606	814	24.9	20.6	17.8	2529	2344	4019	58.8	79.7	87.8
Mzimba	I	106	156	289	10.5	9.4	14.2	161	314	372	15.9	19.0	18.3	773	1895	2331	76.6	114.8	114.6
Nkhotakota	I	61	69	153	11.9	14.4	16.2	87	90	146	16.9	18.8	15.5	359	340	866	69.9	71.1	91.6
Ntcheu	I	30	85	126	5.4	12.4	9.9	107	133	225	19.4	19.3	17.8	177	334	553	32.1	48.6	43.7
Rumphi	I	62	92	15	12.8	16.3	4.7	87	97	61	18.0	17.2	19.1	232	480	91	48.1	85.2	28.5
Dedza	C	201	193	291	9.3	8.5	12.4	483	413	479	22.3	18.2	20.4	982	774	933	45.4	34.1	39.7
Dowa	C	138	122	119	6.8	9.6	9.2	448	284	298	21.9	22.5	22.9	1335	1090	768	65.4	86.2	59.1
Mchinji	C	199	278	555	10.3	13.6	31.7	1043	869	376	53.8	42.4	21.5	832	900	762	42.9	43.9	43.5
Nkhata Bay	C	136	131	141	22.0	33.7	23.2	93	77	102	15.0	19.8	16.8	446	432	502	72.0	111.3	82.6
Ntchisi	C	17	36	50	2.9	9.0	7.2	99	114	169	16.9	28.6	24.4	328	443	487	56.0	111.1	70.4
Salima	C	MD	293	80	MD	39.2	6.5	MD	155	200	MD	20.7	16.3	MD	307	725	MD	41.0	59.0
Total		2710	2612	3487	16.3	16.4	17.2	4235	3589	3789	25.4	22.5	18.7	9008	10451	13824	54.1	65.5	68.2
Intervention		2019	1559	2251	21.7	17.6	18.2	2069	1677	2165	22.3	19.0	17.5	5085	6505	9647	54.7	73.5	78.1
Control		691	1053	1236	9.4	14.8	15.6	2166	1912	1624	29.5	26.9	20.5	3923	3946	4177	53.4	55.4	52.7

I = Intervention, C = Control. MD = Missing data

Table 7. Birth complications (number and rate per 1000 births) continued

		Premature						Birth weight less than 2500g					
		n			Per 1000 births			n			Per 1000 births		
	I/C	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	46	87	182	14.4	18.5	26.7	33	192	232	10.4	40.8	34.1
Karonga	I	204	164	175	29.1	26.9	23.2	178	198	255	25.4	32.5	33.8
Kasungu	I	378	378	390	26.6	26.1	22.0	346	277	543	24.4	19.1	30.6
Lilongwe	I	1499	833	1210	34.9	28.3	26.4	1616	1221	2060	37.6	41.5	45.0
Mzimba	I	299	603	665	29.6	36.5	32.7	281	664	738	27.8	40.2	36.3
Nkhotakota	I	138	138	212	26.9	28.8	22.4	130	140	455	25.3	29.3	48.2
Ntcheu	I	169	210	422	30.6	30.5	33.3	133	232	431	24.1	33.7	34.0
Rumphi	I	119	152	72	24.7	27.0	22.6	111	157	63	23.0	27.9	19.7
Dedza	C	661	550	553	30.6	24.2	23.5	990	845	864	45.8	37.2	36.8
Dowa	C	584	384	343	28.6	30.4	26.4	761	589	592	37.3	46.6	45.6
Mchinji	C	570	623	577	29.4	30.4	32.9	1412	1059	522	72.9	51.7	29.8
Nkhata Bay	C	167	134	146	27.0	34.5	24.0	280	159	417	45.2	40.9	68.6
Ntchisi	C	113	90	181	19.3	22.6	26.2	280	286	266	47.8	71.8	38.4
Salima	C	MD	210	259	MD	28.1	21.1	MD	228	410	MD	30.5	33.3
Total		4947	4556	5387	29.7	28.5	26.6	6551	6247	7848	39.4	39.1	38.7
Intervention		2852	2565	3328	30.7	29.0	26.9	2828	3081	4777	30.4	34.8	38.7
Control		2095	1991	2059	28.5	28.0	26.0	3723	3166	3071	50.7	44.5	38.7

I = Intervention, C = Control. MD = Missing data

Table 8. Birth complications (number and rate per 1000 births) continued

		Asphyxia						Neonatal sepsis					
		n			Per 1000 births			n			Per 1000 births		
	I/C	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Chitipa	I	30	97	244	9.4	20.6	35.8	1	46	63	0.3	9.8	9.2
Karonga	I	110	137	158	15.7	22.5	20.9	129	161	164	18.4	26.4	21.7
Kasungu	I	292	592	583	20.6	40.9	32.8	80	86	333	5.6	5.9	18.7
Lilongwe	I	1256	1039	1644	29.2	35.3	35.9	108	92	85	2.5	3.1	1.9
Mzimba	I	222	538	817	22.0	32.6	40.2	68	148	132	6.7	9.0	6.5
Nkhotakota	I	90	134	350	17.5	28.0	37.0	15	135	125	2.9	28.2	13.2
Ntcheu	I	84	148	363	15.2	21.5	28.7	6	22	26	1.1	3.2	2.1
Rumphi	I	106	91	68	22.0	16.2	21.3	25	21	12	5.2	3.7	3.8
Dedza	C	343	537	830	15.9	23.7	35.3	26	65	47	1.2	2.9	2.0
Dowa	C	489	355	402	24.0	28.1	31.0	140	35	39	6.9	2.8	3.0
Mchinji	C	319	524	611	16.5	25.6	34.9	198	149	116	10.2	7.3	6.6
Nkhata Bay	C	209	199	306	33.7	51.2	50.3	154	15	196	24.9	3.9	32.2
Ntchisi	C	65	129	284	11.1	32.4	41.0	69	12	7	11.8	3.0	1.0
Salima	C	MD	224	307	MD	30.0	25.0	MD	18	110	MD	2.4	8.9
Total		3615	4744	6967	21.7	29.7	34.3	1019	1005	1455	6.1	6.3	7.2
Intervention		2190	2776	4227	23.6	31.4	34.2	432	711	940	4.6	8.0	7.6
Control		1425	1968	2740	19.4	27.7	34.6	587	294	515	8.0	4.1	6.5

I = Intervention, C = Control. MD = Missing data

We have been very cautious in analysing this data due to a number of anomalies. Multivariate analysis with modelling will be needed to ascribe statistical significance to any of these apparent changes after further attempts to clean up the database.

Table 9 presents results from data collected from the Ministry of Health Database and this represents a portion of the national data for Malawi. We only present a small number of key variables for the year 2012 and 2013. The data included is filtered so we only have data on districts involved in ETATMBA. This shows some interesting similarities and differences with our own data. Chitipa has a much higher perinatal mortality rate in the national data compared to ours whilst maternal mortality is the other way round. Inaccuracy in the collection of the statistics in 2011 probably underlies this anomaly. Whilst in some cases numbers are exactly the same in other cases they are considerably different, demonstrating the importance of not placing too much reliance on the data collected routinely in health facilities in Malawi.

Table 9. Data from National database for key variables for ETATMBA districts for 2012 and 2013

		Total birth events	Maternal mortality	Stillbirth (fresh)	Neonatal death	Maternal mortality per 100,000	Perinatal mortality n	Perinatal mortality per 1000 births
Chitipa (I)	2012	3350	5	31	40	149.3	71	21.2
	2013	6812	4	47	75	58.7	122	17.9
Dedza (C)	2012	1016	0	9	15	0.0	24	23.6
	2013	18314	11	117	173	60.1	290	15.8
Dowa (C)	2012	6565	3	52	71	45.7	123	18.7
	2013	20500	14	168	176	68.3	344	16.8
Karonga (I)	2012	4011	7	24	50	174.5	74	18.4
	2013	8219	10	48	92	121.7	140	17.0
Kasungu (I)	2012	9239	17	111	109	184.0	220	23.8
	2013	17814	49	125	234	275.1	359	20.2
Lilongwe (I)	2012	29402	427	296	289	1452.3	585	19.9
	2013	47371	166	355	363	350.4	718	15.2
Mchinji (C)	2012	5894	0	51	54	0.0	105	17.8
	2013	17531	11	135	216	62.7	351	20.0
Mzimba (I)	2012	16510	85	146	190	514.8	336	20.4
	2013	20348	112	178	215	550.4	393	19.3
Nkhata Bay (C)	2012	3883	4	45	49	103.0	94	24.2
	2013	6079	11	35	65	181.0	100	16.5
Nkhotakota (I)	2012	4784	4	53	49	83.6	102	21.3
	2013	9449	17	72	100	179.9	172	18.2
Ntcheu (I)	2012	6722	4	55	47	59.5	102	15.2
	2013	12668	5	97	170	39.5	267	21.1
Ntchisi (C)	2012	2948	79	39	25	2679.8	64	21.7
	2013	7643	83	68	93	1086.0	161	21.1
Rumphi (I)	2012	2972	18	38	29	605.7	67	22.5
	2013	5333	113	44	63	2118.9	107	20.1
Salima (C)	2012	6120	39	35	28	637.3	63	10.3
	2013	11205	11	81	98	98.2	179	16.0
2012 ID total		75987	544	720	818	715.912	1538	20.24
2012 CD total		27429	148	265	227	539.575	492	17.94
2012 TOTAL		103416	692	985	1045	669.142	2030	19.63
2013 ID total		156909	377	1173	1544	240.267	2717	17.32
2013 CD total		52377	240	397	589	458.216	986	18.83
2013 TOTAL		209286	617	1570	2133	294.812	3703	17.69

I = intervention, C = Control, ID = intervention districts, CD control districts

4.4 Process evaluation results

We present the results here mapped against our process evaluation categories. Where we provide illustrative quotations from interviews we identify the role and ID number of the interviewee and where interviewees were interviewed more than once, we indicate whether it was interview 1, 2 or 3.

4.4.1 Context

The NPCs receiving the intervention worked in hospitals in the following eight districts of Malawi: Lilongwe, Nkhotakota, Ntcheu, Chitipa, Karonga, Mzimba/Mzusu, Kasungu and Rumphi. For the randomised controlled trial, the control districts were; Lilongwe north, Dedza, Dowa, Mchinji, Ntchisi, Salima and Nkhata Bay. All districts have a district hospital; two also have a large central hospital (Lilongwe and Mzimba) and most have rural hospitals. Table , adapted from a 2011 Malawi Ministry of health report, [8] provides a summary of the population, maternal deaths, stillbirths and neonatal deaths for each of the study districts. The districts are a mix of urban and rural with populations ranging from 172 000 to 1 905 000 (median 397 000). There is variance across the districts in terms of the number of deliveries each year with institutional deliveries ranging from 5298 to 53426 (median 12965). Maternal deaths range from three to 48 (median 14), Stillbirths range from 116 to 988 (median 233) and early neonatal deaths (within 24hrs of birth) ranging from four to 293 (median 100) with the perinatal mortality rate (per 1000 deliveries) ranging from 9.77 to 59.06 (median 24.70) (see **Error! Reference source not found.**). [8]

Table 10. Data sources and analyses approaches mapped against our adapted process evaluation framework

Framework	Description of framework item	Data source	Analysis approach
Context	Description of geographical location and summary of perinatal and maternal mortality in the intervention districts	Malawi Ministry of Health data	Descriptive summary
Reach	Description of the trainees and the pool of NPCs from which they were recruited	Malawi Ministry of Health data	The distribution of trainees across the districts
Dose Delivered	Delivery of training sessions and training support	Course documentation Interviews with obstetricians who provided support	Interrogation of data for variation from intended delivery of training e.g. non-attendance
Dose Received	Participation in training by NPCs and their perceptions of what they learn	Course attendance registers. First set of in interviews with opportunistic sample of 19 NPCs	Attendance counts. Thematic analysis of NPC responses to question 'what did you learn that was new to you?'
Early Implementation	Implementation of initial learning in the NCP's own clinical working context particularly leadership skills	Interviews undertaken with an opportunistic sample of 12 NPCs from the seven intervention districts 6 months after module two	Interrogation of interviews for spontaneously given examples of change in their working style.
	Evidence of cascading of learning by NPCs	Interviews with an opportunistic sample of 10 cascadees	Thematic analysis of what was taught by the NPCs to cascadees
	Evidence of cascading of learning from the perspective of District Medical Officers	Interviews with an opportunistic sample of 5 District Medical Officers (DMO)	Interrogation of interviews for examples of cascading of training
Later implementation	Implementation of training up to attending modules 5 and 6	Interviews with 39 NPCs when attending modules 5 and modules 6	Thematic analysis of actual use of skills used by NPCs

Note: The opportunistic samples are based on the presence and availability (e.g. not interfering with normal workload) of individuals at the time of the researcher's (WC) visit to the facilities.

Table 11. An overview of the ETATMBA intervention districts showing population, maternal deaths, stillbirths and neonatal deaths 2010

	District Population (1000)	Number of institutional [a] deliveries	Maternal deaths (all facilities) Direct [b]	Maternal death rate (per 1000 deliveries)	Stillbirth All facilities	Early Neonatal deaths [c]	Perinatal mortality rate (per 1000 deliveries) [d]
Northern Region Districts							
Chitipa	179	7177	14	1.95	133	43	24.62
Karonga	270	7422	14	1.89	257	77	44.92
Mzimba	862	27697	20	0.72	430	140	20.56
Nkhata Bay	216	5298	14	2.64	198	115	59.06
Rumphi	172	8014	5	0.62	116	68	23.00
Central Region Districts							
Dedza	624	17751	3	0.17	327	113	24.77
Dowa	558	14394	20	1.39	287	92	26.29
Kasungu	627	16824	26	1.55	395	99	29.34
Mchinji	456	16800	34	2.02	261	100	21.49
Nkhotakota	304	8444	14	1.66	156	102	30.55
Ntcheu	472	16065	18	1.12	153	4	9.77
Ntchisi	225	6934	9	1.30	127	24	21.87
Salima	338	11536	13	1.13	208	107	27.29
Lilongwe	1905	53426	48	0.90	988	293	23.97

[a]Institutional deliveries- deliveries which take place in a health facility (not home births)

[b]Direct complications and direct causes of maternal death include: APH, PPH, obstructed/prolonged labour, ectopic pregnancy, severe abortion complications, retained placenta, ruptured uterus, postpartum sepsis, severe pre-eclampsia/eclampsia. Excludes "other" direct complications or causes of death including non-severe abortion complications Weighted for total number of health centres

[c] Early neonatal death was defined as a death occurring within 24 hours after delivery

[d] Perinatal mortality rate = (stillbirths + v. early neonatal deaths)/(number of deliveries)

Table adapted from Republic of Malawi Ministry of Health report; Malawi 2010 EmONC Needs Assessment Final Report [8]

4.4.2 Reach

Fifty-four trainees were recruited representing 67% (54/81) of the NPCs working in emergency obstetric and new-born care (EmONC) in the intervention districts. Of those recruited, 46 remained in the training programme at the time of the third interview, 25 from the central region of Malawi drawn from nine hospitals (district and central hospitals) and 21 from the northern region drawn from six hospitals (district and central hospitals). One of the smaller districts in the northern region had one ETATMBA trainee working in its district hospital. Nearly all the trainees are male with only two females which reflects the gender balance of NPCs in Malawi.

4.4.3 Dose delivered

Six modules (five taught and one professional project) had been delivered by the time we completed data collection for this process evaluation (See above, Figure 1). The two obstetricians from the UK spent six months each in Malawi; the first from January 2012 to June 2012 and the second from July

2012 to January 2013. They rotated to all intervention hospitals where they worked with each trainee reinforcing the training received during modules. They supported the use of operative skills new to the trainees including undertaking transverse caesarean sections rather than the more commonly used midline incision, and the use of B-Lynch sutures for postpartum haemorrhage. They also supported the use of practical skills learnt through the course including the use of partograms, vacuum extraction, neonatal resuscitation and antibiotic use in C-section.

> *There is a lot of wastage of antibiotics, …non-emergency elective C-section (caesarean section), uncomplicated, they used to put these women on large doses of antibiotics. ……..…three times a day, for ten days. Why do you need this? … save some money by reducing antibiotics.* [Obstetrician 1]

> *The number of C-sections was going up … when you look at some of their (the trainee's) audits… most would opt to do caesarean section because it was taken as an easier way out… the number done second stage was quite high and these were the ones associated with complication rates…teaching them vacuum extractions we would improve this … we used the Kiwi (vacuum extraction equipment).* [Obstetrician 2]

Interviews with the trainees indicate that the obstetrician visits were valued, with many noting that the encouragement and support they received has helped to improve them as clinical officers.

> *The attachment that we had of the obstetrician … we actually were able to change from the routine way of doing things to real evidence based…* [T23:3]

4.4.4 Dose received

All trainees attending Module one (54/54). Five trainees withdrew before module two so 49/54 attended. An additional three withdraw between modules two and three so 46/54 attended module three. There was no more attrition for the remaining modules with all remaining trainees attending with 46/54 attending module five and six and completing the professional project. Reasons for withdrawal included the inability to find time for course work and switching to other courses.

In all interviews with trainees we found them able to recall unprompted, some components of the training modules. For understanding dose received, we report on data from the first set of interviews with 19 trainees as we report on later interview data in subsequent sections. In these interviews trainees described receiving new learning on neonatal resuscitation (11/19 trainees); post-partum haemorrhage (6/19), B-lynch suture (5/19) and audit (5/19); management of breech delivery (2/19); cascading of their new knowledge to others (2/19); caesarean section (1/19); infection control (1/19); management of (pre-) eclampsia (1/19). For example:

> *When we are resuscitating a new born we gave up very easily because people were saying a new born who cannot breath after ten minutes then that one will be useless. But we have found that given time and given good extra time, you find that it could be done. I have learnt that time*

and improved knowledge on how to resuscitate a new born can make a difference to the life of the baby. [T33:1]

4.4.5 Early implementation

The second set of interviews gives us insight into the early implementation of the new knowledge and skills the trainees had received. Here we focus on how the trainees work with and transmit new learning to others in their work place. Of the 12 trainees interviewed ten talked about how the leadership training had helped them work better with those around them

> *This course has really helped me to change the way I am interacting with my colleagues …, because the approach to a colleagues is very important. Sometimes you can talk to colleagues while angry or even with a sense of contempt, but with this training we have learnt how we can talk with colleagues. It has changed me because I know how I can talk to my bosses at work.. If we have an issues as clinicians and nurses which we need to present to the DHO (District Health Officer), now we are taught that we must have facts and we must approach him humbly. We can start with the positives and end with the negatives, so that has really changed me, this is now how I work, both with my colleagues and the DHO.* [T46: 2]

District Health Officers reported that the trainees were taking leading roles in improving health care practice:

> *I have seen a couple of them doing neonatal and maternal deaths audits and sharing those experiences with other health care workers. Also advocating for change in practice, change in attitude. They have taken a leading role to ensure that prenatal care scales up in this district.* [DO 2]

The ten interviews with cascadees indicate that trainees were sharing their knowledge and skills with those around them. The step-by-step approach of helping a new-born to breathe was reported most commonly as having been taught.

> *I also learnt as a new thing, clearly defined steps of how to do resuscitation of the baby*. [CA 10]

Several cascadees reported improved understanding of the use of procedures:

> *I see myself improving in these areas…, like vacuum extraction, the timing itself. Previously we were just rushing in doing vacuum extraction in women where it was not supposed to be done, just to run away from procedures like caesarean section. After that training we have*

learnt something on how we can do it in proper time and the benefits of doing caesarean section when it is supposed to be done. [CA 5]

One cascadee reported they received instruction on how to use equipment that until then had remained unused:

That equipment, the Kiwi (vacuum extraction equipment), we were just leaving things because we didn't know how to use it. These guys (the trainees) they helped us to use these things, which had been just staying in the labour ward but we didn't know how to use them. [CA 12]

Several cascadees reported learning new techniques of managing post-partum haemorrhage including the use of the drugs misoprostol and oxytocin and the condom tamponade:

New techniques like the condom tamponade, it was quite new to me, at school we did not learn anything about condom tamponade. [CA 3]

Several cascadees reported learning about the use of magnesium sulphate to manage pre-eclampsia.

We didn't know that when somebody is suffering pre-eclampsia they gave her magnesium sulphate. Since this is a health centre we didn't have magnesium sulphate but after the training now we have it in the labour ward. When the patient just arrives, it should be, see the condition of a patient and if it is needed we give magnesium sulphate, then we refer the patient. That is how we are working. [CA 14]

Take the example of eclamptic case, everybody was afraid to use magnesium sulphate but now everybody is capable of using magnesium sulphate. [CA 6]

Cascadees also talked about the trainees sharing knowledge about infection control including effective hand washing.

In their interviews the obstetricians mentioned encouraging or experiencing trainees cascading their learning.

In things like PPH (postpartum haemorrhage), I was trying to tell them memory is not good enough. When you want to remember something you put it on the wall so you don't have to memorise. It is easy for you to see and say ok, PPH we need……...medicine. For them they found this difficult, so what I did was, in two hospitals I actually had to get them to write their posters and put it on the wall, so that you just look at it and you just remember. [Obstetrician 1]

I remember they used get a nurse or an external speaker to come and teach them on a particular topic at the CPD (continuing professional development) session. After their training they decided they could use this particular session to cascade the training. [Obstetrician 2]

During their interviews, district officers described seeing evidence of trainees cascading what they had learnt to their colleagues:

> *He goes out orienting people on the use of vacuum extraction … he goes around in the health centres so the clinicians get skills from him.* [DO 6]

4.4.6 Later implementation

Here we report from the interviews with 39 trainees in the third set of interviews. These provide evidence of how they used the various skills and knowledge from their training in clinical practice. Here we report data from the section of the interview where we prompted for data on each of the key aspects of the training. First we report on the use of practical skills, then the use of audit skills. Finally we report on the use of leadership skills, particularly when used in conjunction with practical skills learnt on the course. The subsections under each of the three headings are in frequency order with those discussed the most at the top.

4.4.6.1 Practical skills

Caesarean Section Twenty-eight of the 39 interviewees mentioned the training about caesarean section. Of these 26 mentioned using the transverse incision as a new skill.

> *The training was different from what has been happening at our institution… we discussed as a group at our institution, then when one of our tutors came. They facilitated changing to the transverse type incision at our institution. It has been adopted that in every patient, it has to be done with that (transverse) incision*. [T12:3]

Neonatal Resuscitation Twenty-seven trainees mentioned neonatal resuscitation as a skill they encountered in the training with 25 giving examples of how they had used the skills in practice. Seventeen indicated that they had cascaded the skill to their colleagues in their facilities. Neonatal resuscitation was not a skill new to them but they described how the training taught them how to take a systematic approach, which was previously lacking. Several trainees mentioned upgrading their knowledge about resuscitation and on the length of time to continue resuscitating a baby.

> W*e used to have a lot of neonatal deaths because of poor skill of resuscitation before ETATMBA, because easily giving up. The literature we read in school used to say resuscitate a baby for about 20 minutes. If it's longer than that you can drop it because what might come out might not be a useful baby. But in this module we learnt that we can resuscitate our neonates as long as we have positive heartbeat. We've actually seen that the babies that we then used to say no, you can dispose, wait for it to die, have survived, actually very healthy babies. So, that's just an example that I have actually enjoyed*. [T30:3]

Postpartum Haemorrhage Twenty–three trainees talked about skills in the management of a postpartum haemorrhage. Out of these 19 trainees reported using the skills in practice. Aorta compression had been

used by six trainees, the B-lynch suture by five, the condom tamponade by five and three had used misoprostol.

> *I applied the B-lynch suture, with my colleague another ETATMBA trainee....we applied it and the patient actually, stopped bleeding. We managed to give fluids and transfuse, and she improved. The patient actually went home, was discharged from the facility. Before the training I never used it. I had heard of the B-lynch suture but was so afraid to use it. I was given a chance to actually use it on a stimulation in the practical part of the class. It was made so simple … it gave me courage, and I did it and it actually saved a life. So that gave me courage*. [T45:3]

Co-ordinating effort for the management of PPH was mentioned by two people.

> *You have to call for assistance and you need to take a sample for the laboratory for grouping and cross-match. We are encouraging people to use big hole cannulas, preferably where is possible you need to insert two on both arms to make sure that the circulation is not depleted. There is also encouragement of monitoring of vital signs, it is very crucial in people with PPH, even the use of antibiotics since most of time there are various procedures during the management of PPH, so you can also give prophylactic antibiotic to prevent this woman from sepsis after PPH* [T24 3]

Partograms Fourteen trainees mention the training had helped them realise the advantages of monitoring labour with the use of partograms:

> *At this point in time, we are really following the partogram and we are really taking action on each and every deviation from the normal. If cervical dilation is not there… action is being taken. Not only ETATMBA students but even the nurses. Whenever they see something is deviating from the normal, they consult…this patient came in with this problem and the partograph is moving to the other side, so please assist. So we are working together now.* [T32:3]

Vacuum Extraction Thirteen people mentioned vacuum extraction as a skill they first encountered in the ETATMBA training. Most of the trainees mentioned this was not a new skill but they had lacked expertise to perform the skill well. They reported the training improved their skill and confidence. Three reported cascading the skill to their colleagues. Several trainees said their clinical judgment had improved as to whether to conduct vacuum extraction or not. Others indicated the training had changed practice. For example, where a caesarean section would have been normal practice, vacuum extraction is now considered first.

> *We have been taught the skill of vacuum extraction. And at one time, I think last year we were given, what we call a Kiwi vacuum extraction…and that one we are able to use. So, patients who could have gone for caesarean section with prolonged labour, we are able to assist them with vacuum extraction.* [T1:3]

Breech Twelve trainees discussed learning about breech delivery skills but only two were able to cite examples of how they had used the skills. Several trainees indicated they had managed to cascade the skill to others.

> *We managed to cascade the training on breech deliveries. Before we were taught, when there was a breech, they used to call somebody ….whoever was more senior clinician in the institution to go and deliver the breech. Now after the training, at least most of the nurses at the hospital are able to do this.* [T35:3]

Trainees indicated that learning the skills for breech delivery helped reduce the number of caesarean sections.

> *Breech delivery, to me it was one of the most difficult scenarios encounter. When there was a breech delivery, most of the time I was just saying let's just do C-section, running away from how I could deliver it. But after going through this course we have learnt how to tackle that particular breech because they are several types, each type has got its own way of delivery. So, now we are able to deliver, the breech deliveries.* [T28:2]

Forceps delivery: Two trainees mentioned forceps and both indicated they had never used them.

4.4.6.2 Audit

Of the 39 trainees participating in the third set of interviews, all had undertaken two audits and 35 mentioned audit as an important skill. Table (below) presents examples of audits and their outcome.

4.4.6.3 Leadership

Leadership was, without doubt, the part of the training that trainees talked about most and with the most enthusiasm. Many trainees became quite excited during the interview when talking about how they had used these skills to bring about change in the clinical care delivered. For many it was a revelation that by taking a different approach so much could be achieved. We have already reported evidence of the use of leadership skills from the second set of interviews as part of early implementation. Throughout the remaining data analysis we have reported there is also evidence of the trainees using leadership skills to change practice. Here we provide examples that provide additional insight into how the trainees were using their new learning. Trainees had developed a collaborative approach to working with their colleagues, particularly the nurses, which was not there before.

> *We share, I just don't go there and say, do you know how to resuscitate? (I say) come and let me teach you, we go together sister, let's start, bring that, bring that, we say this one we put here, maybe the mask, this is how we position the baby, am starting to bank watch for this, then she goes oh ok, what about this? We work as a team.* [T41:3]

They had learnt to be strategic in seeking, finding or using resources.

Nurses were going through the training for newborn resuscitation. So, it was easy for me to work with the nurses, who had already gone through this training. I was able to organise a good area for resuscitation and lobby for more resource from the DHO. [T15:3]

Some said no, they are not working because maybe they were worn out things, like that… I discussed this with the nurse in charge of the ward…and our colleagues in theatre. We looked around and we found things here and there and actually we have now replaced them. [T14:3]

We complain that we don't have blood in the laboratory, but there are some procedures that are done where the patient has been asked to mobilise blood yet we don't need to use this blood in the end. Some patients were being given blood that did not require blood. After this training, if a patient donates blood for a procedure, if we see that this patient do not require this blood, we keep it and channel it to a patient that may be in dire need of blood. [T23:3]

There was also evidence in the interviews with the obstetricians of the impact of the leadership training.

I wanted the relationship between them and other clinicians to improve so they would work as a team not as individuals…it was good to see change whilst we were there. The midwives would come to say "we never used to do these things with clinical officers before, but you know they don't now wait to be called they come and check with us what is going on and we would tell them and we would discuss management". [Obstetrician]

(I saw them) taking on some leadership roles because they were respected. They were actually doing their audits and some had results with them so they presented to the district health management team… (about) things that they wanted to change. [Obstetrician 2]

Table 12. Examples of audits and the outcome of the audit reported by ETATMBA trainees at interview

Audit topic*	
Use of partograms	Trainee found that nurses/midwives were not completing the partogram routinely. After presenting audit findings at team meeting and providing training there was change in practice: *So, what we see today is, any patient going to labour ward the nurse fill out the labour graph, and record and monitor. They now see that the monitoring aspect has a bearing on the outcome.* [9:3]
Management of pre-eclampsia and eclampsia	*I went to the DNO with my findings… most of the health centres don't have magnesium sulphate…they are afraid to give magnesium sulphate and they cannot order the drug…For this year I have not seen any death from eclampsia… we are able to manage them there because they are stabilised (at the health centre) before they arrive (at the hospital).* [T40:3]
Post abortion care	Trainee noted that current system was chaotic and that there was a lack of instruments. *(During the audit) in the pharmacy I found equipment, (lying un used)…I distributed it around the health centres… I conducted some training like to teach them how to do a vacuum extraction, how to take care of a vacuum extractor… for the instruments to stay longer. So, it has really given me a clue, of trying to check some things, doing this now and again as a way of improving services* [T2:3] Another trainee's audit revealed patients were being sent for evacuations in theatre unnecessarily and so incurring unnecessary cost when manual vacuum aspirations (MVA's) were more appropriate. *…patients who were meant for MVA's were sent for evacuations in theatre. So, looking at the cost it was, actually the cost was high… just because maybe there wasn't enough equipment for MVA's, so I discussed that with the management and they bought some sets and we proceeded doing MVA's.* [T32:3]
Neonatal sepsis	An audit of neonatal services found high sepsis rates in neonates. Reporting findings back to the group had a positive impact on practice. *The sepsis (rate) has reduced by this time after the auditing.* [T12:3]
Neonatal resuscitation	Audit found clinical staff were not following the step-by-step procedure for neonatal resuscitation and not documenting the procedure. After sharing the results of the audit and training of colleagues there was improvement in the following of the step-by-step procedure. *…previously probably we were not putting things in order and then with the ETATMBA students they have drilled us to follow each step… we are resuscitating step by step…*[NMW cascadee]
Postpartum haemorrhage	An audit revealed colleagues were not checking vital signs when patients were and the hospital did not have misoprostol for controlling the bleeding. After presenting to the management and colleagues the management agreed to stock misoprostol and he saw a change in practice in terms of checking for vital signs. Another audit resulted in change in practice as follows: *Every patient from now, whether from the health centre or not, if they can't get access for two IV (intravenous) lines they are able now to put even one at least, which is ok. Instead of leaving the patient alone with the driver (of car bringing the patient to hospital), at least they are able from the health centres to send somebody to accompany the patient in case of any problems.* [T9:3]

*audit topics in descending order of frequency reported

4.5 Discussion (Malawi)

The main aims of this study were to evaluate the impact on health outcomes (e.g. maternal and perinatal morbidity and mortality) of the ETATMBA training. In the Malawi evaluation we used a randomized design with an embedded qualitative process evaluation. We are pleased to report success in these aims. Notwithstanding the facts that there have been a large number of challenges we have successfully trained 46 NPCs with advanced skills and knowledge in obstetric, neonatal care and clinical leadership. Furthermore, the Malawi trainees graduated with a BSc degree in International Obstetrics awarded by the University of Warwick in October 2014. We have also carried out a comprehensive evaluation.

In terms of our primary outcome of an impact on perinatal mortality, the picture suggests there is no effect from the intervention compared to control districts. Neonatal death rates have remained at a similar rate across all districts (intervention and control) over the three years of the project. Our original assumption was that training would reduce perinatal deaths through early effective resuscitation and care of the neonate. Two major initiatives from US aid organisations at the time of our study were rolled out across Malawi: Helping Babies Breathe and Kangaroo Mother Care. The control districts could not ethically be deprived of these initiatives and this may have contributed as a major confounder. Another important consideration is that in analysing the data from 2011-2013 within the constraints of the time period for the project there may not have been enough time for the full effect of the training to be seen as this continued for the BSc through to May 2014. Continuing to study data for 2014 and 2015 may show the effect.

For maternal mortality in Malawi the numbers show a trend that might suggest maternal mortality is decreasing. There is evidence of a real impact of our training in this area from the process evaluation and in many of the interviews there are clear examples of reductions in maternal mortality as a result of the training. Complex statistical analysis with modelling will be done to see whether there is an effect on maternal mortality.

The process evaluation shows us that the trainees have not only been using their new skills and knowledge they have been sharing that knowledge with others around them. The number of interventions for obstetric complications was greater in intervention districts when compared to controls. There are many factors that can contribute to this, many outside the scope of this study, but our process evaluation does show us that trainees are more confident to intervene and work with the local team to provide a better outcome for mothers. Because much of this difference was seen also at baseline we await further statistical analysis to be confident that these changes are real.

Similarly, during birth, the numbers of procedures like vacuum extraction and caesarean sections appear to be being used more often in intervention districts when compared to control. However this also appears at baseline. We know from the process evaluation that these were skills that the trainees were up-skilled in and many report how they have used their new found skills and knowledge to change their clinical practice. This and the fact that they all, following the leadership training, became more confident with managing themselves and working collaboratively with those around them for the benefit of the patients. Intervention districts (not including Lilongwe) have a higher premature birth rate and this may be falling (by almost 30 per 1000 births) over the project period but it is still high compared to the control districts where there was only just over a one point fall (66.5 & 26.0 per 1000 births, respectively).

Asphyxia rates have increased considerably across the whole sample. When considering what may be contributing to this increase one has to consider the reporting system in the health facility. All patients are entered into the maternity log and as labour and birth happen notes are added to this log. For both obstetric and birth complications the person entering data can only enter one complication for each (thus they have to make a judgment of the 'main' complication). Neonatal resuscitation has been an important consideration by many Agencies in Africa and the 'Helping Babies Breath' initiative has been widespread in Malawi. This and our own ETATMBA neonatal resuscitation training may have contributed to the increased recording of asphyxia in all districts as the main birth complication as more staff now are confident to intervene. Although not recorded, we can assume that this may reflect widespread increases in resuscitation of these neonates.

In reporting our findings from this evaluation we are cautious about over-interpreting results from a study that has a number of limitations. At the outset of this project we visited many of the districts and in our early development work we found that health facilities completed a monthly summary sheet drawn up from the maternity log book. These summaries are sent to a central point in the district where they are stored and entered onto the national data base; this is a requirement of the Ministry of health. Thus we felt that we would have access to a full set of data for the three years of the project. However, the reality was that over half of the districts were very poor at completing and storing these records. The dataset we have here we know has holes within it with data missing from facilities within the districts to data from a whole district missing. Our findings lead us to question how accurate the national data is, as this is based on the same records. Here we have presented some comparisons and it is clear there are differences. Indeed it is possible that missing data mean that we or the Ministry of Health are not capturing the true picture in Malawi. No one, it seems, challenges districts to accurately record data and systems for storage and recovery of data are poor.

This said we can only present the data we have and our process evaluation gives support to our findings. Lilongwe we had identified as a problem at the outset. It is a huge district that has a population that lives areas that range from very urban to the very remote rural. We planned to split this in two but availability of data has made this problematic. We had trainees in the main hospital but this is the place that has over 17,000 births per year and many women arriving who have travelled many miles and have many complications. Impact in this chaotic situation can prove difficult. Thus we have presented results with and without Lilongwe.

To conclude the Malawi evaluation the ETATMBA training was successfully implemented and appears to have been well liked by the trainees and trainers. We do, however, interpret these results with an air of caution and present what we have found. There are trends in the data which suggest an improving picture. There is also evidence from the process evaluation/qualitative study that the training has changed practice supported with data from managers and cascadees. Malawi in the future has a number of challenges not least the chronic staff shortages in healthcare. Training NPCs who have shown a dedication and willingness to make a commitment to their local communities and health facilities is possible and it seems that up-skilling them with evidence based practice and leadership can make a difference to practice and possibly help to save lives. The college of Medicine (the University of Malawi) have taken a number of steps to ensure a legacy from ETATMBA with offering BSc courses in a variety of disciplines to NPCs. This should only be the start future work needs to look at up-skilling of this cadre and ensuring that they have a clear career pathway and support for this important work.

5 Evaluation in Tanzania

5.1 Aims of the study

5.1.1 Broad aims

The main aims of this study were to evaluate the impact on health outcomes (e.g. maternal and perinatal morbidity and mortality) of the training in the facilities where the trainees are based and to explore perceptions of the training from a range of stakeholders.

5.1.2 Specific aims

To explore changes in maternal and perinatal mortality (pragmatically defined in this study as fresh stillbirths and neonatal deaths before discharge from the health care facility) comparing data from before the training was implemented and an endpoint not less than a year after the trainees completed their training.

5.2 Methods

5.2.1.1 Design

The study was mixed methods with a retrospective before and after comparison of the quantitative data and a qualitative evaluation (interviews) exploring the perceptions of the programme from a number of stakeholders including the trainees, their district medical officers, colleagues whom they have cascaded ETAMBA skills to and trainers.

5.2.1.2 Outcomes

The primary outcome for the study was early neonatal mortality (only includes deaths that occur before discharge) in the district.

Secondary outcomes include:

- Perinatal mortality (defined as fresh stillbirths and neonatal deaths before discharge from the health care facility)
- Maternal death rates (case specific);
- Recorded data (e.g. still births, Post-partum Haemorrhage, C-Section, Eclampsia, Sepsis,);
- Availability of resources (e.g. infrastructure and drugs);

5.2.2 Research team

The primary data collection team consisted of two local research assistants based at the Ifakara health institute, Dar Es Salaam, Tanzania. Both of the research assistants are experienced researchers. The principal investigator at the Ifakara health institute provides local support with management/oversight provided by David Ellard at Warwick.

5.2.3 Participants

During late 2010 and 2011 approximately 25 dyads (50 trainees) of Assistant medical officers (AMOs) nurse midwives/nurses (anaesthesia) were recruited from districts across Tanzania and invited to join the ETATMBA training programme. Whilst there has been some attrition (e.g. withdrawn from the training), the remaining trainees represent the sample from which we will invite participation in interviews. All were invited to participate. In addition, we identified a number district medical officers and cascadees to be involved in interviews (Cascadee – a nurse, midwife, AMO whom our ETATMBA

AMO have shared their ETATMBA skills and knowledge with) from facilities where trainees. We also invited a number of the local faculty, who delivered the training, to give interviews.

5.2.4 Procedure

5.2.4.1 Interviews

A letter of invitation including an information sheet and a copy of a consent form was sent via email to all trainees from the Ifakara health institute. Similarly, the researchers identified the facilities where trainees were based and emailed letters and information to the district medical officer. The letter two purposes the first to inform them about our research in general and secondly to invite them to participate. A copy of the consent form was included for information.

Tanzania is a very large country and road access is at times problematic. The research team arranged a 'grand tour' of all of the included districts and health facilities. This was undertaken in January/February 2014. This limited the opportunities to carry out interviews with everyone. In all districts the researchers invited all of the available trainees, cascadees and DMOs for interview.

Interviews were carried out at or near the health facilities at mutually agreeable times during the researcher's visit.

The researchers in Ifakara conducted most of the interviews in Kiswahili (the National language) to ensure no loss of meaning in expressions. English is actually the third language in Tanzania but it is commonly spoken and all of the trainees have good levels of English but it was found that they were more comfortable using Kiswahili. There are no formal inclusion exclusion criteria for this evaluation as we are targeting specific populations. Those outside these groups will not be invited.

5.2.4.2 Quantitative data

The research assistants identified the facilities in which trainees are working and extracted the study variables from the Ifakara database and create an ETATMBA database. Baseline data was data for the facility for the year 2011. The follow-up data will be the same variables for the year 2013. The follow-up data was gathered during the 'grand tour'.

5.2.5 Data analysis

5.2.5.1 Quantitative Analysis

Descriptive and summary statistics were produced for the two years, change scores will be produced, and appropriate paired statistics carried out. Significance will be set at 5%. Data are presented in tables and graphs as appropriate.

5.2.5.2 Qualitative Data Analysis

Interviews were digitally recorded, subject to permission of each participant, and where appropriate, transcribed verbatim. The recordings are stored in a secure digital environment and only members of the research team have access to them. Participants will not be identified and a code number will identify transcripts. Subsequent written material will use pseudonyms, for participants, and at the end of the study, recordings will be erased. Data were analysed using the Framework method. This approach is described by Ritchie and Spencer [28] and Pope et al. [29], is broadly as follows:

- Data familiarisation: reading of complete interview transcripts, listening to original audio-recordings and use of field notes;
- Identifying a thematic framework: key issues, concepts and themes are identified and an index of codes developed;

- Indexing: whereby the index generated through identification of the thematic framework is applied to all data;
- Charting: a summary of each passage of text is transferred into a chart to allow more overall and abstract consideration of index codes across the data set and by each individual;
- Mapping and interpretation: understanding the meaning of key themes, dimensions and broad overall picture of the data and identifying and understanding the typical associations between themes and dimensions;
- The charting process provides an opportunity to code data from numerous vantage points, by demographic factors, such as gender or age, by personality characteristics, such as looking specifically at people who are highly anxious compared to those who are not, or by medical aspects, such as those with diabetes compared to those without.
- The charting process provides an opportunity to code data from numerous vantage points, by demographic factors, such as gender or age, by personality characteristics, such as looking specifically at people who are highly anxious compared to those who are not, or by medical aspects, such as those with a particular condition compared to those without.

The computer package NVivo 10 was used to facilitate this process. Researcher bias was minimised through regular crosschecking of data and findings by the members of Research Team. Quotes are used as exemplars of key points in the writing up of these data.

5.2.6 Ethical approval

The study was reviewed and approved by the Biomedical Research Ethics Committee (BREC) at the University of Warwick, UK (REGO-2013-572) and The National Institute for Medical Research, Institutional review board, Dar es Salaam, Tanzania (no.35).

5.3 Results

The following results section is in two parts and contains the results from the evaluation of the ETATMBA project in Tanzania. The first part relates to the quantitative findings whilst the second part relates to the qualitative findings.

A total of 54 were trained in Tanzania. Thirty-six received the ETATMBA training including the full leadership component; the 18 trainees in Kigoma received partial leadership training. These were treated as a pilot group and were excluded from the research analysis. The 36 were made up of 18 assistant medical officers (AMOs) and 18 nurse midwives (NMW). During the project period one AMO and one NMW left the programme to pursue other interests and one NMW passed away. Thus attrition at the end of the programme was around 8%.

The trainees were based in health centres and district hospitals across Tanzania some in urban areas but many in remote or very remote areas. The plan in Tanzania was to recruit trainees from health facilities that were to be upgraded with equipment and resources so the trainees could implement their new skills and knowledge. However, the reality was that of the 33 trainees who completed the programme only 19 returned to the place from where they were selected, seven of these returned to facilities that had not been upgraded or where upgrading is still in process. Fourteen trainees did not return to the facility where they were recruited as the facilities had not been upgraded most of these (10/14) were returned to district hospitals in the area they had come from. Often these decisions were made by local District Medical Officers responding to need and not to the strategic planning of the central Ministry. Table 13 below gives an overview of where the trainees were based and the type of facility they work in. This also notes the availability of an operating Theatre in the facility as this is one of the key things that was

to be upgraded (note: upgrading of facilities was not part of the ETATMBA project it was ongoing work with the Government and other funding agencies).

Table 13. Health facilities where the Tanzanian ETATMBA trainees were based in 2013

	District	Name of facility	Operating Theatre	COMOC or BEMOC	No. Trainees
1	Bukombe	Bukombe District Hospital	Yes	CEMOC	1 AMO
2	Bukombe	Uyovu Health Centre	No	BEMOC	1 AMO, 1CO
3	Geita	Nzela Health Centre	Yes	CEMOC	1 NMW, 1 Nurse
4	Geita	Katoro Health Centre	No	BEMOC	1 NMW
5	Inyonga	Mamba Health Centre	Yes	CEMOC	1 NMW
6	Karambo	Matai Health Centre	No	BEMOC	1 AMO, 1NMW
7	Liwale	Liwale District Hospital	No	CEMOC	2 AMO
8	Meatu	Mwandoya Health Centre	No	BEMOC	1 AMO, 1 NMW
9	Mpanda	Mpanda District Hospital	Yes	BEMOC	1 AMO, 1 Nurse
10	Nachingwea	Nachingwea District Hospital	Yes	CEMOC	2 AMO
11	Nkasi	Kirando Health Centre	Yes	CEMOC	2 AMO
12	Nyanghwale	Nyanghwale Health Centre	No	BEMOC	1 AMO, 1 NMW
13	Nyanghwale	Kharumwa District Hospital[a]	Yes	CEMOC	1 AMO, 1 NMW
14	Ruangwa	Ruangwa District Hospital	Yes	CEMOC	1 AMO, 1 NMW
15	Sumbawanga	Laela Health Centre	No	BEMOC	1 AMO, 1 NMW
16	Chato	Chato District Hospital	Yes	CEMOC	1 AMO, 1 NMW
17	Lindi	Nyangao Mission Hospital[b]	unknown	CEMOC	2 NMW

[a] Upgraded to a district hospital between 2011 &2013. [b] This hospital not visited so not included in in analysis. AMO – Assistant medical officer, NMW – Nurse midwife, Nurse – nurse/anaesthetics. CEMOC – Comprehensive Emergency Obstetric Care, BEMOC - Basic Emergency Obstetric Care

Table 14 below summarises the key maternal, neonatal and birth complication figures across Tanzania for 2011 and 2013 from the included health facilities. It is important to note here that we were unable to collect our primary outcome of neonatal mortality and thus perinatal mortality (defined as fresh stillbirths and neonatal deaths before discharge from the health care facility). Whilst stillbirths are recorded as a matter of course neonatal death is not recorded at the facilities visited.

No significant differences were found for any of the key maternal, neonatal and birth complication variables across the lifetime of the project. The number of deliveries seemed to reduce slightly overall (-604) but the number of deliveries in health centres did rise (from 7326 to 7961). There is only a slight increase in overall fresh still births (+16, an increase of 1 case per 1000 births) whilst macerated appear to worsen in health centres (from 8.3 to 13.9 cases per 1000 deliveries). Maternal death shows a downward, improving, trend over the two years (down from 282 to 232 cases per 100,000 deliveries),

but this is not significant using simple statistics. There is a reduction in the number of caesarean sections overall down from 80.2 to 77.2 (cases per 1000 deliveries) with the largest reduction indicated in health centres where rates are down from 10.6 to 6.2 (cases per 1000 deliveries). The three birth complication variables collected all show a slight increase overall but each show differing trends in where the complications are reported. The rates of post-partum haemorrhage change little over time whilst obstructed labour rates increased in district hospitals (6.4 to 9.5 cases per 1000 deliveries) but in health centres there was a decrease (6.7 to 2.9 cases per 1000 deliveries). Sepsis follows a similar trend with an increase in hospitals (1.7 to 3.1 cases per 1000 deliveries) and a decrease in health centres (1.6 to 0.5 cases per 1000 deliveries). This could imply earlier recognition and transfer of at-risk mothers from health centres to hospitals as a result of training.

Table 14. Comparison of key maternal, neonatal and birth complication figures from baseline (2011) to follow-up (2013)

	2011			2013			
	DH (n=7)	HC (n=9)	Total [a]	DH (n=7)	HC (n=9)	Total [b]	*Difference [b-a]
Total Deliveries	17893	7326	25219	16654	7961	24615	-604
Fresh stillbirths (FSB)	287	65	352	300	68	368	16.0
FSB per 1000 births	16.0	8.9	14.0	18.0	8.5	15.0	1.0
Macerated Stillbirths (MSB)	312	61	373	305	111	416	43.0
MSB per 1000 deliveries	17.4	8.3	14.8	18.3	13.9	16.9	2.1
Maternal deaths (n)	68	3	71	55	2	57	-14.0
MD per 100,000 deliveries	380	41	282	330	25	232	-50
No. caesarean deliveries	1944	78	2022	1851	49	1900	-122
CS per 1000 deliveries	108.6	10.6	80.2	111.1	6.2	77.2	-3.0
Post-partum Haemorrhage	200	77	277	225	86	311	34.0
PPH per 1000 deliveries	11.2	10.5	11.0	13.5	10.8	12.6	1.7
Obstructed labour	114	49	163	159	23	182	19.0
Obst/Lab per 1000 deliveries	6.4	6.7	6.5	9.5	2.9	7.4	0.9
Sepsis	31	12	43	51	4	55	12.0
Sepsis per 1000 deliveries	1.7	1.6	1.7	3.1	0.5	2.2	0.5

DH – District hospitals, HC – Health centres. * Note: there are NO significant differences here so p-values not shown.

The following sections are the results related to infrastructure, drugs and supplies at the health facilities where we have ETATMBA in Tanzania. These results originate from the survey undertaken in early 2014 by ETATMBA researchers. As noted in Table above there were 17 facilities across the country that housed ETATMBA trainees during this survey one of these facilities (due to its distance and

remoteness) was not visited all results are based on 16 facilities nine health centres and seven district hospitals.

Facilities: overall capacity and infrastructure

Table 15 shows diversity in the availability of important rooms in our sample of health facilities. All it seems to have is a delivery room and a pharmacy. It seems that some (n=3) do not have an operating theatre.

Table 15. Availability of rooms for different activities within health facilities

Room	N (%)
An Emergency Room	0 (0)
Labour / Delivery Room	16 (100)
An Operating Theatre?	13 (81.25)
Obstetric / Maternity	10 (62.50)
Laboratory	15 (93.75)
Pharmacy	16 (100)
Autoclave Room	1 (6.25)

Table 16 gives an insight into the general infrastructure of the health facilities. Running water is it seems a very significant problem with only one of nine health centres and four of seven district hospitals found to have none. As are functioning toilets with around half not having availability. Most facilities have sufficient access to lighting to perform task at night but clearly some still struggle. Delivery beds were found to be available in 5/9 health centres and 6/7 district hospitals. Ambulance availability is poor at health centres with only one having availability whereas six of the seven district hospitals have an ambulance available. Referrals from within the maternity area are problematic as only 4 health centres have a working phone in this area none of the district hospitals do.

Table 16. Health facility Infrastructure Availability of Power & Availability of water

	Facilities with the items		
Infrastructure	Overall	HC (%) n=9	DH (%) n=7
Sufficient light source to perform tasks at night	12 (75%)	6 (67%)	6 (86%)
Means of ventilation	5 (31%)	1 (11%)	4 (57%)
Running water	5 (31%)	1 (11%)	4 (57%)
Functioning toilet	9 (56%)	6 (67%)	3 (43%)
Functional fan/air conditioning	5 (31%)	1 (11%)	4 (57%)
Curtains/means of providing patient privacy	14 (88%)	9 (100%)	5 (71%)
Waiting area for visitors and family	6 (38%)	4 (43%)	2 (33%)
Facility with electricity	14 (89%)	8 (86%)	6 (86%)
Motor Vehicle Ambulance Available and functional	6 (38%)	1 (22%)	5 (71%)
Available and functional landline telephone in the maternity area	4 (25%)	4 (43%)	0 (0%)
Delivery bed / table	11 (69%)	5 (56%)	6 (86%)

The availability of health related registers is variable varying from 100% for items like the delivery register and monthly/annual reports to 6% or less for the gynaecology register, patient records and discharge registers (Table 17).

Table 17. Availability of health related registers

Register	HC (%) n=9	DH (%) n=7	All
General admission register	5 (56%)	6 (86%)	11 (69%)
Delivery register	9 (100%)	7 (100%)	16 (100%)
Maternity ward register	4 (44%)	5 (71%)	9 (56%)
Female ward register	4 (44%)	5 (71%)	9 (56%)
Operating theatre register	4 (44%)	6 (86%)	10 (63%)
Gynaecology register	0	0	0 (0%)
Post-abortion register	4 (44%)	5 (71%)	9 (56%)
Individual patient records	0	1 (14%)	1 (6%)
Discharge register	0	1 (14%)	1 (6%)
Death register	6 (67%)	5 (71%)	11 (69%)
Mortuary register	2 (22%)	5 (71%)	7 (44%)
Monthly / annual facility summary reports	9 (100%)	7 (100%)	16 (100%)

Drugs and equipment

Items for normal delivery

Table 18 gives a snapshot view of the equipment, supplies and drugs available within the health facilities for carrying out normal birth deliveries. Generally, supplies and equipment availability was good but there are a number of exceptions. Only about 50% of facilities had needles and syringes available and similarly availability of suction and manual extraction equipment was low. The availability of drugs for normal delivery purposes was very variable with some drugs readily available (e.g. Lignocaine) whilst other have very low availability (e.g. injectable antibiotic and Diazepam).

Table 18. Drugs and equipment: Availability of Items for normal delivery

Equipment	facilities with the equipment		
	Overall (%) N=16	HC (%) N=9	DH (%) N=7
Equipment and Supplies			
Blood pressure cuff/machine	13 (81%)	7 (78%)	6 (86%)
Stethoscope	15 (94%)	8 (89%)	7 (100%)
Fetal stethoscope	16 (100%)	9 (100%)	7 (100%)
Clinical thermometer	13 (81%)	6 (67%)	7 (100%)
Sterile gloves	16 (100%)	9 (100%)	7 (100%)
Non-sterile protective clothing/apron	15 (94%)	8 (89%)	7 (100%)
Scissors or razor blade for cutting cord	15 (94%)	9 (100%)	6 (86%)
Cord ties	10 (63%)	5 (56%)	5 (71%)
Needles and Syringes	8 (50%)	4 (44%)	4 (57%)
IV fluid set (giving set)	15 (94%)	9 (100%)	6 (86%)
Suture needles and suture materials	10 (63%)	5 (56%)	5 (71%)
+ suction apparatus	8 (50%)	3 (33%)	5 (71%)
+ Manual vacuum extractor	5 (31%)	2 (33%)	2 (29%)
Obstetric forceps	11 (69%)	8 (89%)	3 (43%)
Drugs			
Pitocin (Oxytocin)	13 (81%)	6 (67%)	7 (100%)
Ergometrine (injectable)	4 (25%)	3 (33%)	1 (14%)
Normal saline	14 (88%)	8 (89%)	6 (86%)
Ringers lactate	7 (44%)	2 (22%)	5 (71%)
Dextrose / glucose	9 (56%)	3 (33%)	6 (86%)
Lignocaine 2% or 1%	15 (94%)	8 (89%)	7 (100%)
· + injectable antibiotic	5 (31%)	3 (33%)	2 (29%)
· + Magnesium sulphate	14 (88%)	8 (89%)	6 (86%)
· + Diazepam	6 (38%)	3 (33%)	3 (43%)
· + Skin disinfectant	12 (75%)	7 (78%)	5 (71%)

Infection prevention services in labour delivery/operating theatres

Overall only 75% or less of the facilities surveyed had the basics for infection prevention. None seemed to have soap for hand washing although antiseptics and beach were available and may be alternatives (Table 19 below).

Table 19. Availability of Infection prevention services in labour delivery/operating theatres

Equipment	facilities with the items		
	Overall N=16	HC N=9	DH N=7
Decontamination container with prepared solution	11 (69%)	5 (56%)	6 (86%)
Covered contaminated trash bin	11 (69%)	6 (67%)	5 (71%)
Sharps container	12 (75%)	6 (67%)	6 (86%)
Soap	0	0	0
Antiseptics	10 (63%)	5 (56%)	5 (71%)
Chlorine/ Bleach	6 (38%)	2 (22%)	4 (57%)
Sterile gloves	12 (75%)	6 (67%)	6 (86%)
Other items			
Regular trash bin	12 (75%)	6 (67%)	6 (86%)
Non sterile gloves	12 (75%)	6 (67%)	6 (86%)
Non-sterile protective clothing	12 (75%)	6 (67%)	6 (86%)

Comprehensive services (anaesthesia) Items for provision of anaesthesia

Most of the district hospitals surveyed seem to have availability of equipment and supplies for anaesthesia although Halothane is only available in 3/7 and less than 40% overall. Health centres seem to lack access to oxygen with only 2/9 having supplies when surveyed (Table 20, below).

Table 20. Availability of **c**omprehensive services (anaesthesia) Items for provision of anaesthesia

Equipment	facilities with the equipment		
	Overall N=16	HC N=9	DH N=7
Suction machine	6 (38%)	4 (44%)	2 (29%)
Filled oxygen cylinder with cylinder carrier and key to open valve	8 (50%)	2 (22%)	6 (86%)
Intubating forceps (Magill)	6 (38%)	4 (44%)	2 (29%)
Adult laryngoscope	11 (69%)	6 (67%)	5 (71%)
Adult ventilator bag and mask	11 (69%)	6 (67%)	5 (71%)
IV fluid set (giving set)	10 (63%)	5 (56%)	5 (71%)
Spinal needles (18-gauge to 25-gauge)	3 (19%)	1 (11%)	2 (29%)
Endotracheal tubes with cuffs (8 – 10mm)	9 (56%)	4 (44%)	5 (71%)
Halothane	6 (38%)	3 (33%)	3 (43%)
Ketamine	11 (6%)	5 (56%)	6 (86%)
Aesthetic face masks	9 (56%)	5 (56%)	4 (57%)

Items for management of birth complications and caesarean section

Overall, unsurprisingly, district hospitals have better availability of equipment, drugs and supplies for managing birth complications and for performing caesarean sections (Table 21 see below).

Table 21. Availability of items for management of birth complications and caesarean section

Equipment	Facilities with the items		
	Overall N=16	HC N=9	DH N=7
Items for management of pre-eclampsia/ eclampsia			
Magnesium Sulphate	7 (44%)	4 (44%)	3 (43%)
Valium (Diazepam-injectable)	10 (63%)	4 (44%)	6 (86%)
Niphedipine	1 (6%)	0 (0%)	1 (14%)
Blood pressure cuff/machine	13 (81%)	7 (78%)	6 (86%)
Stethoscope	15 (94%)	8 (89%)	7 (100%)
Adult ventilator bag and mask	13 (81%)	7 (78%)	6 (86%)
Needles and Syringes	4 (25%)	1 (11%)	3 (43%)
Urinary catheters (Foleys)	8 (50%)	3 (33%)	5 (71%)
Uristix	4 (25%)	1 (11%)	3 (43%)
Items for management of haemorrhage (parenteral uterotonics)			
Needles and Syringes	8 (50%)	4 (44%)	4 (57%)
IV fluid set (giving set)	9 (56%)	3 (33%)	6 (86%)
Items for Caesarean Section (not including anaesthesia)			
Operating table			
Light- adjustable, shadow less	11 (69%)	6 (56%)	5 (86%)
Antiseptics	10 (63%)	5 (56%)	5 (71%)
Sterile gloves	12 (75%)	6 (67%)	6 (86%)
Cord ties	10 (63%)	5 (56%)	5 (71%)
Needles and Syringes	6 (38%)	4 (44%)	2 (29%)
Benzyl Penicillin	4 (25%)	3 (33%)	1 (14%)
Metronidazole (IV)	2 (13%)	1 (11%)	1 (14%)
Gentamycin (IV)	1 (6%)	1 (11%)	0 (0%)
Caesarean section pack			
· + needle holder	13 (81%)	7 (78%)	6 (86%)
· + scalpel handle with blade	10 (63%)	5 (56%)	5 (71%)
· + retractor	12 (75%)	6 (67%)	6 (86%)
· + surgical scissors	12 (75%)	6 (67%)	6 (86%)
· + suction apparatus / 8	6 (38%)	4 (44%)	2 (29%)
· + oxygen	8 (50%)	2 (22%)	6 (86%)
· + sutures	11 (69%)	5 (56%)	6 (86%)
· + ketamine	11 (69%)	5 (56%)	6 (86%)
· + lidocaine / 5	12 (75%)	6 (67%)	6 (86%)

The following section of the results concentrates on the qualitative process evaluation results from ETATMBA in Tanzania.

5.4 Qualitative process evaluation results

Below we present the process evaluation results from the Tanzanian arm of the project. These are broken down into the following sections/themes:

- About ETATMBA Training – selection of trainees and exploring delivery of the training
- Relationships between NPCs and Medical Doctors
- Implementation into practice
- Support for implementation
- Challenges during implementation
- Impact of training
- Sustainability
- Recommendations

Quotations are used as exemplars of themes. Each quotation has an identifier. The 'ETATMBA trainer' is identified thus, as are the three Obstetricians. Trainees are identifies as T, then there profession e.g. NPC (non-physician clinician), NA (Anaesthetic Nurse), NMW (Nurse Midwife) and finally a number (1-27). Cascadees (those who have received training from our trainees) are identified by CA and a number (1-12). District medical officers and doctors in charge are identified as managers (MA) and a number (1-5)

5.4.1 About ETATMBA Training

Training in Tanzania took place at training centres away from normal places of work and included attachment to hospital facilities where skills were practiced. This also provided access to other experienced health professionals and mentors from whom the trainees could learn. Training included classroom and practical sessions.

> *'Lectures happened in morning hours and rest of the day hours were used for practical sessions. Apart from these, the trainees were expected to take duties after work hours that is, during weekends or during night calls/shifts. So two of them covered a ward together with an experienced Clinician so that they could understand more what happens after the office hours. The lectures were mostly 40 minutes lecture and then discussions but there were times of seminars in which there were group discussions, presentations from the group. We started by doing baseline assessment of all the participants to know their knowledge before we embarked on the individual lectures of the areas which we thought they were weak. We concentrated in new knowledge because we didn't use a lot of time with things that they already know, we wanted them to gain new knowledge.'* (ETATMBA trainer)

The ETATMBA trainees were selected from diverse locations across Tanzania to attend the training and it included dyads of a senior (AMO) and 1 junior (NMW) from a health facility. Selection was carried out by the ETATMBA project Obstetricians in Tanzania.

> '*…ETATMBA objectives are AMOs and NMWs from health centres that have been doing surgery or they were planning to build theatres, these were the criterions. And if there were none in the district let us say Lindi or we plan to build one. So we decided to take from district hospitals because actually in district hospitals even the regions AMOs do run maternity wards.'*(Obstetrician 3)
>
> *'This was a modular training so we called participants from various selected districts; the training was convened in one training unit centre. These participants were mainly AMOs and*

NMWs, AMOs were clinical people and NMWs were called in to be trained as nurse anaesthetists.' (Obstetrician 1)

The training was conducted in 3 months while 1 month was utilized for an internship program. The facilitators were staff at Ifakara hospital, with total of 6 specialists-gynaecologists, 1 medical officer and senior Assistant medical Officer, the nurse anaesthetist nurse midwives been assisted by other 3 senior nurse anaesthetists.

Various methods were used including lectures, presentations and demonstrations (theory) discussions which were followed by practical sessions where trainees had to work in a host hospitals taking knowledge into practice.

'*It was a mixed type of training and it was not purely didactic form of training -giving lectures. We engaged them in problem based situations; actual scenarios we were doing ward rounds with them and they saw how we managed the cases that was clinical mentorship. We were going with them in theatres not in all cases but for some cases, so they had access with their trainers as far as imparting of skills is concerned*.' (Obstetrician 2)

The topics that were covered during the training mainly focused on imparting clinical knowledge and skills including identifying complications during pregnancy, management of complications such as obstetric emergencies, PPH, (pre-)eclampsia, hypertension during pregnancy. Skills taught include filling of partograms and sterilization of equipment. Leadership and management was also taught. Many of trainees informed us that they never had formal training on these topics before and that they found them very useful.

The trainers explained that trainees were evaluated through examinations and they were provided with certificates for successful completion of studies.

'They were evaluated in daily basis at the end of the course they had written and practical structured exams; it went very well and they were given certificates. They were also keeping log books during the whole time of their course and procedures that had to acquire the skills and the log books… in terms of skills that they had to observe and practice then they were expected to do that independently following the standard pattern of the training.' (Obstetrician 1)

Trainers reported a very positive attitude towards their trainees. They said that most of trainees are health workers who have a long work experience, yet the training was still important as they were updated with new knowledge and skills which adds value to what they knew prior to the training.

'Their level of understanding was very high; these are the people who have been practicing for many years and they had a lot of experience. The problem that we saw is that they did not have continuous education although they understood some things but the new knowledge for them was too much. We didn't have a lot of difficulties because when we looked at the pre and post-tests the different was about 20-40%. So, their level of understanding was quite high. When you touched on clinicals, clinical officers were very good, when you touch issues of midwifery, the nurses were very good. But doctors didn't know much about midwifery issues and midwives didn't know much about the doctors' issues, so this was the difference.' (Obstetrician 1)

'Some of these guys have been trained 20 years ago they do not know new approaches of treatment so if they are taught that this is how such kind of problem can be managed they will be more interested because for them this is new knowledge, they were more attentive, they took some notes, they asked questions. For us this was very positive.' (Obstetrician 1)

Trainee's perception of the training were generally very good with a majority saying they liked the training and the 'amazing' facilitation.

'*...we were well received and our teachers cherished and loved us'*. (T.NA 4)

Most of them said accommodation and learning environment was very conducive

'…*we had good accommodation, we had necessary learning materials, we could easily access internet freely and we could get reference books '*. (T.NPC 18)

It was later realized that there was a different experience between participants who attended the training at different duration (i.e. batch of 2011 and 2012)

The participatory approach which actively involved trainees in discussions and practical's was highly appreciated. Facilitators were termed as being very cooperative and patient.

'Being with them for 4 months and plus of course when I visited them in their health facilities we got along quite well, we almost became friends. I find the role quite interesting and there was no way I could be negative with whatever questions they have been asking, they even asked irrelevant questions such as infertility, paediatric problems and somehow you really have to answer even if they are not relevant.'(Obstetrician 1)

Some trainees noted the presence of adequate teaching, learning materials and a conducive learning environment and a great learning motivation.

Asked about the dislikes of the training trainees noted their concerns about logistics matters rather than issues pertaining the training modality and content. Lack of transparency for allowances that were provided during the training emerged as a main concern, respondent said they were there are things that were promised in the beginning of a course but was never provided

'…*we were promised that we shall be provided with laptops but that never happened. Only trainers were using laptops.'* (T.NPC 5)

One trainee mentioned that some trainers frequently postponed some sessions, which was very annoying.

Among other things, majority complained that allowances for the training was inadequate and not timely provided, money for stationeries was provided but was said to be insufficient food was not good, was not served timely.

'…*in the beginning money for stationaries, uniform and living allowance was a problem*. *The food vendor was problematic, the venue that was used Internship***,** a one month period for

internship was said to be shorter because days for travel and getting used to a place were also included.

'*… we did internship at X hospital was very short, it was only 2 weeks including travel days'*. (T.NPC 16)

It was also reported that some trainees didn't go for internship at all; they said that was very disappointing.

'*...we expected to go for the internship work but it didn't happen*' (T.NMW 13)

During the internship one trainee mentioned that the host staffs had a place to rest during night shifts while there was no place for internship trainees to rest.

5.4.2 Relationship between NPCs and Medical doctors

Interestingly there were varied perspectives on relationship between AMOs and Medical Doctors. The majority of trainees, cascadees and managers (in both district hospitals and health centres we visited) said the relationship between NPCs and MDs has been positive both before and after the training.

'We don't have such a rival situation here before and after training; now the AMOs skills have been updated, doctors do still work with them and offer a help for obstetric cases'. (CA 2)

'*...they work together even after the training collaboration has been intensified'*. (CA 10)

'…even if there could be tension among the NPCs and MDs it can't affect anything. However, I never saw such a thing because as MDs we were performing what they went to learn at Ifakara.' (MA 2)

The trainers had different responses on this they revealed that tension among the 2 groups is historical and it has existed for a long time.

'*There have been a tension between MDs and AMOs for a long time, some of this has been historical while some of this has been due to different types of trainings which these people have had. But in my experience these differences can't be taken away in the sense that the MDs have longer training both in pre-school, university training, they have more education and also in the medical field so when they go and start practicing they look down upon the AMOs*.' (Obstetrician 1)

'*….relationship between them is a little bit complex because you see the AMOs, most of them have worked for a long time and they have a vast experience especially in surgery whereas the Medical Doctors are fresh from universities actually their experience is very different so, they feel very embarrassed when they are with AMOs… they are called medical doctors but they can't do a lot of things that an AMO can do*.' (Obstetrician 3)

However, trainers pointed out ETATMBA training has dissolved the tension and brought cohesion among the 2 groups; medical doctors now do feel that the AMOs can perform better after been updated with new skills.

'But after this training the AMOs, since they have been doing C-sections when we trained them MDs did not feel that these people are taking our jobs actually they think the AMOs are doing better. Instead of bringing competition it brought more cohesion in the sense that the doctors are more confident that the AMOs are doing operations properly.' (Obstetrician 1)

One cascadee noted that they had observed some MDs who were not happy to see the junior cadres (AMOs and nurses) attending the training, they felt that the MDs thought they should be included in the training.

'MDs were angry they thought why did the junior cadres went for the training, we were supposed to go because we are seniors'. (CA 1)

5.4.3 Implementation of training into practice

Most of trainees said they were now managing various cases on their own, only calling for support or help if unforeseen problems are encountered. They noted that they were now successfully performing a certain procedure including the management of PPH, (pre-)eclampsia, how to position a baby (for delivery) and resuscitation.

'Training has been of a great help to me, I now work in theatre with confidence than previously. I now understand how to differentiate anaesthesia medicines and recognizing a patient that should or should not be provided with such medications.' (T. NMW 13)

'*...in neonatal resuscitation we were taught differently from what we knew. We used to resuscitate a baby with breathing problem using adrenaline medicine In schools we were not taught to use any medicine for resuscitation, it was if you see that a baby can't breathe properly to put him/her on oxygen machine.*' (T.NA 27)

The trainees confirm that they already had skills that they used in practice but the training gave them an update and adjusted their practice.

'I think they have learnt a lot in terms of doing things correctly because you can be doing things routinely but not correctly because of your experience, you may think that you are doing correctly. I think they have updated their knowledge and skills, which is very positive.' (Obstetrician 2)

'*They were very happy because their knowledge was quite old, so they were really happy to get new knowledge. For example the management of eclampsia most of them didn't know that magnesium sulphate was a drug of choice*.'(Obstetrician 1)

'*Actually some of them are very brave, we have what we call breech delivery so, usually we'll do caesarean section but they said a child's buttocks are already out so they use the skills we taught them they said we did this and this and a baby came out*.' (Obstetrician 3)

Among other positive impact of the training, trainees and cascadees said referral is always opted if the matter becomes unmanageable at a level of a health facility while now referral can be suggested promptly. Recognizing the importance of keeping data, understanding that a mother should remain at a health facility at least 24 hours after deliver and management of new-borns cases including management of new born babies with problems.

It was reported that with other cascading strategies, morning clinical sessions have been used as cascading platform to present what was taught at the training.

Trainees said they have been able to convince their colleagues on importance of filling of partograms and lead them how to do that correctly, provision of anaesthesia, advice on importance of checking patient HB before surgery is performed.

The following accounts indicate how the trainees have been able to pass on skills and knowledge they acquired from the training.

> *'They taught us how to record partograph to understand that now this woman goes to an action line and be able to take action earlier before she gets other complications. It enables us to be keen in filling of partographs'*. (CA 1)

> *'She gave us training feedback during clinical meetings. She also showed us practically how to assist a mother who needs emergency care. It has also enabled us to ask things that we didn't ask before from the district hospital for example a medicine such as hydro-cortisone and for baby's resuscitation we didn't have sucker and ambubags, we never asked but now we ask.'* (CA 2)

We wanted to know if the trainees see any change on cascadees' performance after the passing on of skills and knowledge. All of them said they noted some improvement.

> *'They have changed for example when a patient enters a theatre room, they know what to do when I go there I find them prepared and consent form for a patient has been signed'* (T.NA 25)

This trainee said he/she see improvement on cascadees' performance despite few weaknesses for example in filling of a partograms,

> *'..although there are still some few challenges in filling of partographs especially among the medical attendants, these are people who stay in labour room they conduct a lot of deliveries, some of them are filling well, some are not but we keep on instructing them slowly.'* (T.NPC 17)

> *'…they came with new knowledge which we didn't have. For example in C-sections, we were used of making a patient stay with a bandage for 5 days then you change to see how the wound proceed then after 7 days you remove threads. The trainees were opening the wound after 24 hours and later the wound becomes completely healed. They were able to cascade that knowledge to other health workers here.'* (MA 1)

'*…they cascaded the knowledge to most health workers in maternity ward and they have really assisted junior doctors who are fresh from school but they are not experienced.'* (MA 1)

Few trainees mentioned that they became innovative after the training; they mentioned some steps they took as an effort of trying to cope with system constraints challenges; for example one had to use curtains as surgery gown for an emergency surgery

'…it has assisted me to be innovative for example we have few operating gowns at the hospital. One day I had to use drapers (curtains) as a surgery gown. There was a woman who was delayed to come to the hospital for delivery when they rushed her here she was profusely bleeding. When she arrived here we found there is no any operating gown. I was with my colleague we went together for ETATMBA training as an anaesthetist we had to put on drapers and performed surgery and both a mother and a baby survived.' (T.NPC 15)

5.4.4 Support for implementation

The majority of trainees said although they was no formal supportive supervision after the training they have been frequently receiving support from one of the ETATMBA trainer whom they identified as their mentor. All of them reported that at one point of time the trainer has been calling ask them whether they need any kind of clinical advice which he is always ready to support.

'After training my health facility in-charge was coming to see how I perform but my DMO never visited to see how I work.' (T.NPC 2)

Most of trainees applaud a help they receive from their trainer and mentor, they maintained that they are free to call him any time and he is always happy to assist.

'..he calls me and ask me if whether I came across any emergency case; if I have one I tell him. I can call him even at midnight and he is always happy to assist.' (T.NA 4)

We asked trainers example of questions that are frequently asked by trainees, the following quotes show questions that have been asked,

'Another concern is PPH here comes a woman 9 months pregnant before delivery severe bleeding starts h/she does caesarean section then she has no child and you have put a wound there so after the surgery it becomes very difficult to a mother, you see you operated her she expects she fails to have a live baby when you operate her and she finds she has a dead baby she finally gets confused. We teach them what to do in emergency to see if it is possible for her to deliver through vagina otherwise if you don't tell them that they will rush to caesarean section.' (Obstetrician 3)

'….the most common questions are when they are stuck to reach a final diagnosis, they have a patient in front of them, a patient has presented so many symptoms and they don't know what next. In that situation they usually call Prof xx, he gives them options of what to do, this when there is an emergency situation and they need urgent advice. Sometimes they call because they are curious to understand some issues that take more time, e.g. they may ask what if a woman comes and she has a dying baby in her uterus, the trainees may ask what should we do? So that is not an emergence because the patient is not in labour.' (Obstetrician 1)

However the trainees were disappointed that their trainers never visited them for supervision noting that it could help make trainers understand the real life challenges faced by the trainees at the ground.

Here the trainer acknowledges this as a gap and agrees that supervision and follow-up of trainees could be of a great importance.

> *'Actually there was no supportive supervision after the internship. I think the project envisaged the training and the internship after that there was no further contacts. Supportive supervision could be organized after 2 months to visit them and see what challenges they do face*.' (Obstetrician 2)

> '*…in fact we promised them that we shall do follow ups but we haven't been able to go there*.' (Obstetrician 2)

The great majority of trainees in districts said they have been receiving adequate support from the district level particularly DMOs except in one district where trainees were disappointed with a DMO who was not supporting implementation of the training. He was said to be against a surgeries conducted by AMOs in health centres.

> '*I have a good relationship with* my *DMO. When I came here I found only 1 CO after seeing increase of patients who comes for services I asked the DMO to bring another CO, he promptly responded now the workload is a bit reduced because I have adequate staff. I also get sufficient support from community leaders; the WEO and Member of a Parliament are people who connected electricity at the health centre, they soliciting funds to bring electricity here.'* (T.NPC 16)

At a health facility level majority of trainees said they have been receiving support from upper to lower levels i.e. health facility managers (health facility in charge, colleagues at their levels and junior staff)

At the community level the majority of trainees said their community leaders (Members of Parliament, WEOs, etc.) have been very supportive.

> *'…they assisted us getting solar power here it is the MP X, she went to the Ministry of Power and Minerals and ensure that we get solar power although we can't use for generator at night'*. (T.NPC 8)

A few trainees mentioned that there was less support being provided by community leaders while others consider them to be a stumbling block to improvement.

> *'I get sufficient support from my leaders at district health leaders but community leaders have been a big problem here. For example there is this car that was donated by UNFPA. We don't have always to put fuel so we tell patients' relatives to contribute fuel at 20,000/= community leaders do mislead the community by telling them not to contribute anything, they are supposed to get free service.'* (T.NPC 11)

5.4.5 Challenges during implementation

Most of the challenges that were mentioned by trainees are clinical challenges particularly system constraints including lack of medical supplies and equipment (vacuum, blood bags). The Medical Store Department (MSD), a Ministry of Health department with responsibility for maintaining supplies, are often blamed for failure to bring medicine to health facilities in a timely manner. In addition, lack of transport facilities (ambulances for referrals), lack of infrastructure (theatre room, room for neonate resuscitation), poor electricity and water supplies are all noted as challenges. In terms of electrification mains electricity can be sporadic and some centres have generators but again it is noted that these are poorly maintained, some not functioning due to fires whilst others lack the fuel needed to run them.

> *'…lack of equipment and supplies for example for theatre and provision of anaesthesia, there is no sufficient medicine for anaesthesia. For new-borns resuscitation there is lack of resuscitation machine and medicine such as adrenaline.'* (T.NA 3)

> *'…is lack of equipment and supplies due to inadequacy funding from the MoH. For example you do C-section and find you have only one type of thread, you don't have any option you just use what you have. At least I work here at the district hospital but my colleagues who work in health centres the situation is rampant, there is no supplies.'* (T.NPC 15)

> *'…we don't have some equipment, for example sterilizer; now equipment are not sterilized. Lack of electricity makes us fail to implement skills that are imparted to us, theatre activities have seized since the generator got burnt.'* (CA 3)

> *'…for example a mother comes here she has PPH, she needs a quick help of a drip, you don't have one you ask her relative to go and purchase. It is a challenge you look at a patient, the condition changes, she eventually dies. A mother comes with eclampsia sometimes we don't have magnesium sulphate, sometimes there is no syringe you ask a relative to go and purchase, if they are available you just take from the cupboard and give.'* (T.NPC 18)

> *'…for example you conduct C-section you should ensure the availability of blood for transfusion, you go to a laboratory there is no blood bags, you ask yourself, 'what do I do?* '(T.NPC 21)

> '*…lack of electricity because here we use generator, sometimes health facility in charge don't have money for purchase of fuel, so sometimes we involve patient's relatives to contribute money for that.'*(T.NPC 18)

> *'We don't have electricity we use solar; solar inventor has low voltage it is difficult to do sterilization, we should go to town for sterilization it is 130 kms, it is hard to work in such environment.* (T.NPC 21)

Similarly, interviewees note that there is often a lack of transport for referrals.

> '*…we have a health centre ambulance but due to shortage of vehicles at the district level it is often packed at the district office. In case of an emergency we contact the district office it needs to be prepared etc. it always causes delays*.'(T.NPC 17)

'….ambulance for example to take them to the referral hospital might be there but there won't be so for patients that may be too expensive for them; that may require about (Tanzanian Shilling) 50,000/= per trip, this is too much money for a villager.' (Obstetrician 2)

The seriousness and consequences of these challenges is outlined by one of the trainees.

'…I do refer several expectant mothers, we don't have an ambulance here, we use health facility X ambulance, and sometimes it is not there so it becomes a problem. One day the villagers brought an expectant mother here, it was around 9:00pm. I told them there is no way, she has to be taken to a district hospital for C-section. Her relatives left, they promised to come back but they didn't; they run away and left us with the patient. We called a nearby health centre to ask for an ambulance, there was none. Later around 11:00pm I called the police station office asking for a car, around12:00pm OCD sent a car to come and take the woman. The police asked me, 'who will pay?' I said, 'Her relatives will pay, just send her to the district hospital.' Unfortunately by then the uterus was ruptured, the woman died on the way to the hospital. To date the police ask payment of fuel for their car, the woman's relatives never came back here.' (T.NPC 21)

Staff are required to live near to the health facility but this too can be a challenge as the housing provided can be very poor quality. Health workers are not motivated to work in remote areas where there is housing problems either there are no houses for staff at all or the available houses are not habitable.

'…there are 5 old houses here; they are very old with various insects including bees and bats. Health workers are not ready to come and work here, I don't think you (the interviewer) would agree to enter there, you will say I will get an infection.'(T.NPC 10)

'…health facilities should improve the infrastructure to ensure conducive working environment because if we train them and they become dormant, they lose the skills.' (Obstetrician 1)

A number of managerial challenges were pronounced by trainees including lack of support from seniors/managers. This made it difficult for some trainees as they were unable to implement some of what they had into practice.

'…when the new DMO came I told him, he was completely negative, he said surgeries cannot be conducted at a health centre. He told me to write a letter explaining that, which I did. I even shown him invitation letter for attending the ETATMBA, he said it doesn't suffice. I attached my certificate of attendance. Yet he didn't seem to care, he didn't see any value of the training. Unfortunately now I don't practice anything on EmOC, I work as a physician, and it is very disappointing.' (T.NPC 2)

The majority of trainees said they are very disappointed because their expectations had not been met. They were informed that after the training they would be assigned to work in upgraded health centres

where they would be able to implement knowledge and skills they gained at the training. Unfortunately that did not happen, management doesn't seem to care while others have been transferred to health facilities where they haven't been able to practice what they learnt.

> *'..my expectation was after the training I was supposed to be transferred to Health Centre X. Nobody at the district office seems to care, I wrote a letter they said they plan to upgrade the health centre by building a theatre and a ward but that has not happened to date.'* (T.NPC 1)

Here this manager shows his districts commitment and willingness to enable EmOC services to be implemented.

> *'…the Council has been soliciting donor support, UNFPA has supported in renovation of a theatre, they also brought some equipment; they support for almost 80%. What remains now is lack of electricity, we are not connected to a national grid so we solely depend on solar. Solar is there but can't perform theatre procedures with solar power. UNFPA told us they will support us with generator. We have included budget for a generator in our Council plan, so we expect the health centre will soon start to provide emergence services-EmOC.* (MA 1)

It was noted by a number of trainees that they experienced resistance from more senior health workers in trying to implement new skills and knowledge.

> *'…experienced and senior health workers have been reluctant in accepting changes. For example one can go to a theatre room without taking patient blood group and has no catheter; you try to remind them they don't seem to care.'* (T.NPC 24)

Here an ETATMBA trainer agrees that there have been challenges that have impacted on the trainee's ability to implement into practice the skills and knowledge acquired.

> '*….the problem I think as I mention is lack of supportive supervision, some of them became dormant they had skills but their health centres are not upgraded to be able to provide obstetric care, perhaps their health facilities have no theatres, no equipment etc*.' (Obstetrician 2)

5.4.6 Impact of the training

A large majority of trainees, cascadees and managers said one of the most notable impacts of the training is a reduction of maternal deaths. Most of them said they don't have specific figures for this but they had seen a significant improvement.

> *'…maternal deaths have been reduced, I remember when we came back there were 29 deaths, this year we had only 12 deaths.'* (T.NPC 15)

> *'…previously when you looked at new-borns deaths, most of them were dying soon after birth. Maternal deaths also were rampant in previous years.*' (T.NPC 21)

'…if you go through our books maternal mortality rate has been reduced. We once had 101 maternal deaths it was then reduced to 4 deaths, last year we had only 4 deaths (if I'm not mistaken) maternal mortality so, I do appreciate the training (MA 1)

'…I can't talk about this directly because in health we always work as team; nurses and doctors if all of you you play part mortality do decrease. What I know as days goes on maternal deaths are reduced particularly this year. For example we have set a strategy that whoever will be responsible for any mother's death we shall hold him/her accountable.' (MA 4)

A number of interviewees noted that the ETATMBA training had reinforced other training and in particular in neonatal resuscitation. Also new skills had changed practice in managing difficult birth complications like eclampsia.

'The training has brought a big impact. We can now assist new born with difficult to breath, Now we can assist such children as we integrate with Help Baby to Breath program (HBB) we offer the best service for new-borns. (CA 10)

'…for example for obstetric emergencies like eclampsia previously we were using ketamine which is very risky to patients but now we use spinal and it has significantly reduced maternal and child mortality'. (MA 5)

The number of clients/women who attend a health facility for delivery has increased. It was also said that some clients have been bypassing nearby district hospitals to a health centre as they noted improved services that is provided after the training.

'…number of mothers who come to the hospital for deliveries have increased, previously we had 40 deliveries now we have almost 100 deliveries.' (T.NPC 21)

'…you will evaluate your service by identifying clients who come for your service especially those who come from far places like X and X. There are those who live closer to a district hospital they come here. (T.NPC 16)

As a result of the increase in health facility births home deliveries have been reduced.

'Yes, most mothers now do come here for delivery. Home deliveries have also decreased, after starting theatre procedures including C-sections, mothers have stopped going to the TBAs, and they now come here for deliveries.' (CA 5)

Trainees mention that they are now more confident in dealing with difficult cases and as a result are not referring out as much. They are now happy as they can assist some mothers who had to travel many kilometres to a district hospital, some of them were dying before reaching a hospital.

'…we have been able to assist mothers who had to travel 1130 kms to go to a district hospital, some were dying on the way while some reached there when a baby has died in womb. After

the training we are no longer experiencing such cases, I can manage several cases that come here.' (T.NPC 21)

The improvement of services has resulted in an increased workload. Most of the trainees were not majorly concerned with this, as they are strongly committed to provide good service, but they do note that it if demand continues to rise services could be compromised if staffing levels are not increased.

'…after the training the workload has increased, we just try to cope with it by working more hard and ask for more staff to be added.' (T.NPC 18)

The Leadership course has also led to some positive results; some trainees said they are now confident to face the management for any request/discussion while previously they thought it is a role of a health facility in charge. Here the trainer maintains that this what they taught them in leadership course,

'*We told them now you are leaders because as leaders people will come to you and ask you questions you can't say, I'm not involved because now you are a leader, you should be able to do something.*' (Obstetrician 1)

There is evidence that practice has changed as a result of the ETATMBA training. Indeed, cascadees have even changed practice as a result of our trainees sharing their new skills and knowledge.

'…we have changed before they went for the training we were working in old ways, when they came they have been instructing us for example management of obstructed labour, we just rushed and call a doctor but now when a doctor comes he/she finds us already conducted basic services, suppose you have failed then you call a doctor for C-section. If there is a case of eclampsia, I quickly give magnesium sulphate, if a woman has BP I quickly give hydrenism, previously I couldn't do anything I used to be frustrated.' (CA 1)

'*Previously after delivery, a woman was discharged before 24 hours but now she has to stay for 24 hours before she get discharged . She is then supposed to come back after 7 days for post natal services and we never followed them up. Now everything has changed we keep them for 24 hours and follow them up after.*'(CA 5)

'…the knowledge has been of a great help because previously it was difficult for us to make decisions we had to call a doctor for decision but now I can decide with the absence of a doctor. He/she has instructed me what to do, if I fail I call his/her for final decision.' (CA1)

Here the trainer narrates how he communicated with trainees who told him how they managed to overcome some facilities challenges and being able to work.

'…generator problems, black out they can't sterilize their instruments. So, what I usually tell them is yes, the generator is broken down but we can't see failing to do surgery so what we can do we take that instrument to the district hospital sterilize then bring back to your health facility so we sterilize and bring them and then you take them back to your facility you keep on doing this until the solution is found.' (Obstetrician 1)

'*…their generator broke down so they were really desperate. What these guys did, they didn't involve the area commissioner/ District Commissioner so they just went to local party chairman and the MP (Member of Parliament) of this area. Local party chairman and the MP are elected leaders so they really have to fight for their people; they used the money they collected from their people… they also called the engineer and asked for contribution, this worked very fast, such effort wouldn't have been done by the DMO*.' (Obstetrician 3)

5.4.7 Sustainability

During the interviews we elicited trainers and managers' perspectives about the sustainability of the training, most seemed optimistic that the training can be sustained but certain strategies need to be set. One manager thinks they need to integrate the training in their Council plans.

'…we need to put this in our Council Comprehensive Health Plan (CCHP) because anything that is donor oriented can't be sustained, so when a donor leaves everything ends there. So we shall include this training in our CCHP.' (MA 2)

Trainers think the training will be sustainable basically because they didn't train new cadre; it was rather the up-skilling of existing cadre.

'We didn't train a new cadre /special cadre, these people have been employed it is like they are on job training who may go back and ask for another salary etc., they went back to the same work places and the ministry is supposed to keep them in terms of salaries, insurance etc. I think the course is sustainable in the sense that we didn't train a new cadre.' (Obstetrician 1)

'*I think it is sustained because it stimulates the MoH to think of such a comprehensive training. But to sustain it in terms of medical supplies when they have a breakdown of a generator who is going to do that? Should we wait for the donor to come and support and when the donor moves away everything collapses*?' (Obstetrician1)

'Ideally when we started we thought we are going to take only those whose theatres are functioning but again we thought since this is a new idea in the ministry then we should train people first because you can put up a building and there is people is like a chicken and egg, the building will stay there and they will stay we don't have personnel. Training is much difficult than the building, you can put up a building in 6 months but you train AMO for 2/3 years then training them to be proficient to do safe C-section, it isn't 6 months it is much more than that, so we solved staff issue first.' (Obstetrician 1)

5.4.8 Recommendations

In the later parts of the interviews we explored the recommendations the trainees and trainers may have about the ETATMBA programme. In clinical training it was suggested that more time be given to some training topics including the management of obstetric complications such as PPH, antepartum haemorrhages, (pre-)eclampsia, and hypertension during pregnancy. The majority of trainees said more time is needed for topics on anaesthesia and the completion of partograms.

'…more emphasis to be allocated in training of clinical skills including performing of C-sections. Trainers should not assume that all trainees can perform at the same level, one can practice while never performed such a procedure. '(T.NPC 1)

'…more time to be allocated obstetric complications topic including PPH, eclampsia and antepartum haemorrhages severe anaemia in pregnancy'. (T.NPC 2)

'…there was very little allocated for anaesthesia topic, the topic is very long, it needs adequate time there are several types of medicines to be learnt. There were a lot to be learnt under this topic, we couldn't learn and practice everything under this.'(T.NA 3)

It was also suggested that more time should be allocated for leadership training because for most of trainees this was their first time receiving such training. However, time allocated to different aspects of the training was raised by a number of trainees and trainers.

'…more time to be allocated for topic on leadership because we came here without any knowledge on leadership matters.' (T.NA 9)

'Just basing to what I have said earlier anaesthesia for COs and NMWs should have a longer training on this because it is a sensitive topic. I think the training duration for that was quite inadequate. As I said the trainees have started from different platforms, the other group started` from zero while the other group started while they have some experiences and exposure in their previous trainings and the other group started from the scratch.' (Obstetrician 2)

'…more time to be allocated for practical sessions, theory is important but if we spend more time in classes for theory we can't perform well in practical work.' (T.NPC 26)

'*…if I had to do the training again, first of all I think we should reduce the theory/lectures part, we spent a lot of time in this. I think they are not very interested in lectures, things that are basic aspects of courses like anatomy, physiology etc. they have already learnt these things before. They may forget some things but this should just be like introduction, we should concentrate in teaching new things and problem solving strategies because that will help them to be better clinicians when they go back*. (Obstrestian1)

'*…the emphasis should be on problem solving learning, should be more of imparting of skills and exposure and very much less on didactic because they do not need that e.g. you may talk to them about abortion, eclampsia etc. they did that in their medical courses and they did exams, so that topic was a repetition. I think they need more of hands on skills and clinical mentoring from seniors. For theory I think they need to be updated for evidence based practices because technology is changing so they have to be updated in different aspects*.' (Obstrestian2)

'*….we should allow them to tell us exactly what they face in field, we should give them more time to give us scenarios of what they are exactly facing in the field. E.g. such woman came I did this and this and the woman died or survived; did I do that in a right way*?' (Obstrestian1)

'*…is to set time for them to share experiences so instead of using the whole morning for lectures maybe we use half of the morning hours up to 10:00am 10:00am-12pm we do the new things/areas that they don't know. After lunch to 3pm is for practical work, they can go to theatres and in late evening instead of doing lectures is better to do problem solving issues*.' (Obstrestian1)

The involvement and prior discussions between managers at district/health facility, community leaders and training coordinators was seem as important.

'District management could be involved to make some preparations like building of theatres before we went for the training so that when we come back we should find conducive work environment for us to implement what we have learnt.' (T.NPC 15)

'Also the leadership should be informed because if people are trained then after the training they need to go back and work. A manager should not neglect that; one should not use his/her seniority to restrict a trainee from implementing what he/she has learnt.' (CA 3)

'*I think it was under the anticipation that the councils/districts have a responsibility of building and equip the health centres. I think it is a matter of financial ability; some districts have no financial capacity to do that. But we tried to explain this to the districts for example Prof xx was very much involved on this he tried to speak to DMOs before the training i.e. during the recruitment period because he was involved during the recruitment process*.' (Obstetrician 2)

'I think we also need to do is to make sure that we liaise with their superiors during selection and also during the time when they are back for them to be supported at where they work. If they will not be supported by their superiors such as DMO then there is no point, because for example if the DMO doesn't see that this training is important when they go back they become discouraged.' (Obstrestian1)

'*….we need to concentrate is the way they can solve issues about medication and supplies, we trained we gave them new knowledge but when they went back they found supplies were not there, if the facilities are not there this knowledge will disappear. So if there is no theatre and you train someone after 6 months they have forgotten. So we have to make sure that the people we train when they go back the facilities are there i.e. drugs, equipment. So if these things are not there, there is no point of training someone it will be just wastage of resources and time*.' (Obstrestian1)

He also reiterated that among the tasks that were given to trainees following leadership course was to lobby and convince their councils/districts build theatres, some trainees were successful on this.

'*… We taught them on principles of mobilizing Councils, DMOs, they were given tips of lobbying. I heard some of them did that and they managed to build health centres, their councils have provided some funds for upgrading of HCs*.' (Obstetrician 2)

'*We taught them in leadership skills for them to go back and say, I have these skills, I can work in health centre and discuss with the district authority. We thought they should be a catalyst to convince the district authority to upgrade the theatres not us*.' (Obstetrician 1)

A number noted that more time should be to be allocated for internship program. Proper selection of hospitals for internship to be considered, trainees recommend going to health facilities with fewer health workers for them to be able to practice their skills. Also the need for more health workers to be trained and all trainees need regular supportive supervision.

'…more time to be allocated for practical work, the time was not sufficient because you are 20 trainees you get 10 patients, some ended up of not doing the practicals. Particularly during internship, they should chose for us hospitals that have fewer MDs, for instance referral hospitals do not accept health workers of lower cadre to perform certain procedures like surgeries.' (T.NPC 18)

'…such trainings to be provided frequently and also more health workers to be trained.' (T.NPC 24)

'…more health workers from a health facility to be invited for the training, some health workers are closer to retirement for example our midwife trainee is about to retire. This training should be scaled up to whole country, the government should fund. It has really helped in referral we had to put fuel for 80kms drive sometimes we didn't have money for that.' (CA 6)

'...trainers should visit us frequently and see how we perform after the training.' (T.NPC 18)

'More time should be allocated for post-supervision, shouldn't be only one supervision should be maybe after each 3 months. Someone very senior goes to visit and sits with them not just passing but staying for more than 1 day, maybe 3 days you stay at the hospital and see how many patients do they see in a day? What extra work do they have? How do they solve problems after the training are they better, are they worse?' (Obstrestian1)

One trainee commented that they would like the course to be recognized by the Ministry of Health and the ETATMBA certificate to be accredited and recognized. This was reinforced by one of the trainers.

'…the course has really assisted us, it should be officially recognized countrywide. We should also be permitted to teach others after the training.' (T.NPC 18)

'The ministry doesn't recognize this training they say these are just seminars, although we gave them certificates of accreditation but the certificates should also be provided by the ministry saying so and so attended very intensive course 12-16 weeks course. This person needs to be recognized not only by just being given present but also for promotion sake.' (Obstrestian1)

5.5 Discussion (Tanzania)

The main aims of this study were to evaluate the impact on health outcomes (e.g. maternal and perinatal morbidity and mortality) of the training in the facilities where the trainees were based and to explore perceptions of the training from a range of stakeholders. Exploring changes in maternal and perinatal mortality (pragmatically defined in this study as fresh stillbirths and neonatal deaths before discharge from the health care facility) comparing data from before the training was implemented and an endpoint not less than a year after the trainees completed their training. We are pleased to say that we have been successful in achieving these aims. This said the study has highlighted a number of challenges.

Neonatal and perinatal mortality were two of our three primary endpoints in this study. However, it was found that neonatal mortality is not recorded on Ministry of Health monthly summary sheets in facilities and thus was not available for us. Whilst we had the number of stillbirths we were unable to calculate perinatal mortality as we did not have the neonatal mortality figures.

Interestingly, the number of actual births has reduced overall between 2011 and 2013. The reduction has been seen mostly at the district hospitals with numbers increasing at health centres. The process evaluation/qualitative results seem to support this finding as interviewees noted that there were fewer home births and greater attendance at upgraded health centres, where women felt they would get better care. There has been a slight increase in fresh stillbirth but again most of this is at the district hospitals rather than the health centres. This may suggest that health centres are referring more women with this problem out but for macerated stillbirth the numbers have increased in both district hospitals and health centres with the latter being the biggest rise, so this may not be the case.

Maternal deaths have reduced: it is not a significant reduction but there is a downward trend. This too is supported by the results of the process evaluation/qualitative results where trainees and managers note reductions in the numbers of deaths. This could be simply a reflection of the reduction in maternal mortality reported in recent years across Tanzania and a control group would be necessary to be able to ascertain whether this was due to the ETATMBA training. Multivariate analysis with statistical modelling will also be required to understand trends and to account for any confounders.

Looking at the three key birth complication data (post-partum haemorrhage, obstructed labour and sepsis) all are seen to rise from 2011 to 2013 in both district hospitals and health centres with one exception. Sepsis rates in health centres reduce. Whilst we do not have data on the causes of maternal deaths it seems probable that enhanced facilities and the ETATMBA training may be contributing to this fall by successfully dealing with birth complications and helping women survive, as these are topics covered in the ETATMBA training programme. Indeed, procedures like caesarean section were often the default procedure and we see a general reduction here, although not significant, a trend that could suggest that the up-skilling of the staff has encouraged careful consideration before embarking on surgery. Once again we need to be cautious with only before and after data as there is no control to detect temporal trends that might be occurring across Tanzania.

One may be a little surprised by the positive nature of the clinical results when one looks closely at the results of the survey of the facilities in early 2014 and how many facilities were not given the upgrade that was promised. The plan was to provide upgraded facilities in remote areas with staff who had received ETATMBA training. Many trainees were just returned to district hospitals or back to facilities that were not upgraded.

The cadre of AMOs and NMWs seem to be a hard working dedicated group of individuals whose hard work and dedication is still poorly rewarded with little or no housing provision in the poorer areas where

health needs are greatest. This and the poor basic fundamental infrastructure across the facilities with the lack of running water and electricity supply constitute a huge problem. Transport and communication links are also poor with fuel, lack of functioning vehicles and few landline telephones making it very difficult to move difficult cases to centres with specialist care. These problems are echoed by the interviewees whose frustration with these difficulties shows through. Often it seems that the most basic of equipment or drugs are not available and infection prevention services are extremely poor. Basic items like soap for hand washing are absent. However, sepsis rates although rising slightly overall are not significantly different to baseline (2011) levels, suggesting that infection is not out of control. It appears from the interviews that the leadership training was rated highly. Many said that it was a new concept to them but it appears they were applying it into their workplaces and it had enabled several to manage difficult situations. The reports of these trainees engaging in local politics to effect change to benefit health centres and improve services is a clear example of leadership in action.

This study has a number of limitations not least that one of the primary outcomes was not available to us and health facilities not being upgraded. The sample is small and with generally only two trainees in each facility yet a large throughput of cases/births. We are not comparing our facilities to control districts so it is difficult to attribute changes just to ETATMBA training. However, the process evaluation interviews, conducted independently and without the knowledge of the quantitative findings, do support our findings. Post-training support and supervision was sub-optimal with trainers unable to visit trainees and only able to provide support via the telephone due to the large geographical area and seasonal inaccessibility.

The ETATMBA training was successfully implemented and appears to have been well liked by the trainees. We do, however, interpret these results with an air of caution and present what we have found. There are trends in the data which suggest an improving picture. There is also evidence from the process evaluation/qualitative study that the training has changed practice supported with data from managers and cascadees. But it seems that the full impact of the training at a community level was not achieved as trainees were returned to either different health facilities or returned to health facilities which had not been upgraded so the new knowledge and skillsets were unable to be practiced.

6 Conclusions and recommendations

The chronic shortage of medical doctors in Africa and continuing difficulties with retention is not going to go away anytime soon. In the meantime people in Africa need a reasonable standard of healthcare. Task shifting and indeed task shifting of non-physician clinicians is a viable alternative [12,13,14,15,16,17,18]. The ETATMBA project across Malawi and Tanzania has shown that it is possible to up-skill this cadre and produce clinicians who lead: the results are improved clinical practice and an enthusiastic and committed workforce.

Whilst the ETATMBA training models in the both countries were different the training was well received. There is both quantitative and qualitative evidence that clinical practice has changed and that the change is positive. Aspects of the training are highly regarded by the trainees in both countries include the new skills and knowledge but in particular the leadership aspects of the training which have made this unique.

Healthcare solutions in Africa, particularly in countries like Malawi and parts of Tanzania, where resources are scarce need to recognize this and strive for improved resources whilst building a system that is workable within its constraints. Whilst highly technological solutions may work in the UK, Europe or the USA the model in sub-Saharan Africa needs to be much simpler. Indeed, ETATMBA shows us that to produce sustainable change in health services in doctorless, rural Africa, clinicians such as NPCs and nurse midwives must be trained as leaders and find solutions and resources to overcome the basic resource, equipment and infrastructure problems.

ETATMBA has shown us across two countries that the training of NPCs/AMOs can have a direct impact on lives and we believe that over the coming years this cadre will help to improve healthcare across Africa. All that is needed is a commitment to provide training and to ensure that they are practicing evidence based medicine. Training that challenges them and makes them consider solutions to everyday problems of working in a low resource environment.

We make the following recommendations:

- The continued up-skilling of non-physician clinicians and nurse midwives in obstetrics and neonatal care. However not restricting it to these areas rather consider the value across all areas of healthcare
- An essential component of any training has to be leadership training (as this gives the skills and confidence to problem solve)
- The cadre needs to feel valued as they are providing an important service and are often very loyal staying in local areas (unlike doctors who leave)
    - A clear career pathway and recognition
    - Reasonable remuneration, including wages and accommodation (if appropriate)
- Provide good quality national and international support to the people trained with local mentors and a support network
- Further work to look at the cost effectiveness of empowering this cadre, the longer term efficacy, sustainability and retention
- Encourage the improvement of basic infrastructure (roads, communication, fresh running water, diesel and electricity) rather than high-cost highly technological solutions that will sit unused and frustrate and demoralize all cadres of health workers and disappoint sponsors

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8 References

1. WHO. The World Health Report: Working together for health. Geneva: World Health Organisation, 2006.
2. Anyangwe SC, Mtonga C. Inequities in the global health workforce: the greatest impediment to health in sub-Saharan Africa. International journal of environmental research and public health 2007;**4**(2):93-100.
3. UNICEF. State of the World's Children. New York: United Nations Children and Education Fund, 2009.
4. Ronsmans C, Graham WJ. Maternal mortality: who, when, where, and why. Lancet 2006;**368**(9542):1189-200.
5. Lawn JE, Kinney M, Lee AC, et al. Reducing intrapartum-related deaths and disability: can the health system deliver? International journal of gynaecology and obstetrics: the official organ of the International Federation of Gynaecology and Obstetrics 2009;**107 Suppl 1**:S123-40, S40-2.
6. Hill K, Thomas K, AbouZahr C, et al. Estimates of maternal mortality worldwide between 1990 and 2005: an assessment of available data. Lancet 2007;**370**(9595):1311-9.
7. Hogan MC, Foreman KJ, Naghavi M, et al. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5. The Lancet 2010;**375**(9726):1609-23.
8. Ministry of Health. Malawi 2010 EmONC Needs Assessment Final Report: Republic of Malawi Ministry of Health 2011.
9. Niermeyer S, Andrade Mollinedo P, Huicho L. Child health and living at high altitude. Archives of disease in childhood 2009;**94**(10):806-11.
10. Graham W, Hussein J. The right to count. Lancet 2004;**363**(9402):67-8.
11. Bryce J, Boschi-Pinto C, Shibuya K, et al. WHO estimates of the causes of death in children. Lancet 2005;**365**(9465):1147-52.
12. Bergstrom S. Who will do the caesareans when there is no doctor? Finding creative solutions to the human resource crisis. BJOG : an international journal of obstetrics and gynaecology 2005;**112**(9):1168-9.
13. Chilopora G, Pereira C, Kamwendo F, et al. Postoperative outcome of caesarean sections and other major emergency obstetric surgery by clinical officers and medical officers in Malawi. Human resources for health 2007;**5**:17.
14. McCord C, Mbaruku G, Pereira C, et al. The quality of emergency obstetrical surgery by assistant medical officers in Tanzanian district hospitals. Health Aff (Millwood) 2009;**28**(5):w876-85.
15. Mullan F, Frehywot S. Non-physician clinicians in 47 sub-Saharan African countries. Lancet 2007;**370**(9605):2158-63.
16. Pereira C, Bugalho A, Bergstrom S, et al. A comparative study of caesarean deliveries by assistant medical officers and obstetricians in Mozambique. British journal of obstetrics and gynaecology 1996;**103**(6):508-12.
17. Pereira C, Cumbi A, Malalane R, et al. Meeting the need for emergency obstetric care in Mozambique: work performance and histories of medical doctors and assistant medical officers trained for surgery. BJOG : an international journal of obstetrics and gynaecology 2007;**114**(12):1530-3.
18. Wilson A, Lissauer D, Thangaratinam S, et al. A comparison of clinical officers with medical doctors on outcomes of caesarean section in the developing world: meta-analysis of controlled studies. BMJ 2011;**342**:d2600.
19. van Amelsfoort JJC, van Leeuwen PAM, Jiskoot P, et al. Surgery in Malawi – the training of clinical officers. Tropical Doctor 2010;**40**(2):74-76.
20. Wilhelm TJ, Thawe IK, Mwatibu B, et al. Efficacy of major general surgery performed by non-physician clinicians at a central hospital in Malawi. Tropical Doctor 2011;**41**(2):71-75.
21. Bradley S, McAuliffe E. Mid-level providers in emergency obstetric and newborn health care: factors affecting their performance and retention within the Malawian health system. Human resources for health 2009;**7**:14.
22. McAuliffe E, Bowie C, Manafa O, et al. Measuring and managing the work environment of the mid-level provider - the neglected human resource. Human resources for health 2009;**7**:13.

23. WHO. WHO recommendations: optimizing health worker roles to improve access to key maternal and newborn health interventions through task shifting. Geneva: World Health Organisation, 2012.
24. Graham W, Cairns J, Bhattacharya S, et al. Maternal and Perinatal Conditions In: Jamison DT, Breman JG, Measham AR, et al., eds. Disease Control Priorities in Developing Countries (2nd edition), 2006:499-530.
25. Ellard D, Parsons S. Process evaluation: understanding how and why interventions work. In: Thorogood M, Coombes Y, eds. Evaluating health promotion Practice and methods. 3rd ed. Oxford: Oxford University Press, 2010.
26. Ellard D, Simkiss D, Quenby S, et al. The impact of training non-physician clinicians in Malawi on maternal and perinatal mortality: a cluster randomised controlled evaluation of the enhancing training and appropriate technologies for mothers and babies in Africa (ETATMBA) project. BMC pregnancy and childbirth 2012;**12**(1):116.
27. Brennan A-M. ETATMBA: Enhancing human resources and the use of appropriate technologies for maternal and perinatal survival in sub-Saharan Africa. Secondary ETATMBA: Enhancing human resources and the use of appropriate technologies for maternal and perinatal survival in sub-Saharan Africa. [Web Pages] 20 Nov. 2013. http://www2.warwick.ac.uk/fac/med/about/global/etatmba/about/.
28. Ritchie J, Spencer L. Qualitative data analysis for applied policy research. . In: Bryman A, Burgess R, eds. Analysing Qualitative Data London: Routledge,, 1994.
29. Pope C, Ziebland S, Mays N. Qualitative research in health care: Analysing qualitative data. BMJ 2000;**320**(7227):114-16.