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Original Article

Mixed methods analysis of factors influencing change in clinical behaviours of non-physician anaesthetists in Kenya following obstetric anaesthesia training*

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Summary

Maternal mortality rates in low-middle income countries remain high, with sub-Saharan Africa accounting for two-thirds of global maternal deaths. Inadequate staff training is one of the main contributors to anaesthesia-related deaths and the Association of Anaesthetists developed the Safe Anaesthesia from Education course in collaboration with the World Federation of Societies of Anaesthesiologists to address this training gap. We aimed to evaluate the impact of this course among Kenyan participants. Mixed methodologies and secondary analyses of anonymised data were used to study translation of learning into practice. In total, 103 participants from 66 facilities who attended courses between 2016 and 2017 were analysed. Ninety (87%) participants who were followed up completed knowledge tests. Baseline median (IQR [range]) knowledge test score was 41 (37–43 [21–46]). There was a significant improvement in median (IQR [range]) knowledge test score immediately post-course (43 (41–45 [33–48]); $p < 0.001$) which was sustained at 3–6 month follow-up (43 (41–45 [32–50]); $p < 0.001$ compared with baseline). Eighty-four of the 103 participants were observed in their workplace and capability, opportunity and motivation-behaviour framework was used to study the barriers and facilitators to practice change. Psychological capability and reflective motivation were the main factors enabling positive behaviour change such as team communication and pre-operative assessment, whereas physical and social opportunity accounted for the main barriers to behaviours such as performing the surgical safety checklist. Our study demonstrates that the Safe Anaesthesia from Education obstetric course is relevant in the low-resource setting and may lead to knowledge translation in clinical practice.

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Introduction

The maternal mortality rate (MMR) in low-middle income countries (LMIC) is 239 per 100,000 live births, with sub-Saharan Africa accounting for two-thirds of global maternal deaths [1]. Despite improvements, the MMR in Kenya remains unacceptably high at 353 per 100,000 live births in 2015 [2]. The reasons for the high anaesthetic mortality rate in LMICs are complex [3–6]. The African Surgical Outcome Study showed that mothers are 50 times more likely to die following caesarean section in Africa than in high-income countries, with deaths independently associated with both peripartum haemorrhage and anaesthetic complications [3]. The mortality risk is three-fold higher when general anaesthesia is used compared with a neuraxial technique and two-fold higher when the provider is of non-physician background. In a recent systematic review, anaesthetic complications were reported to account for 2.5% of all maternal deaths in LMICs, with mortality rates as high as 13.8% after caesarean section [4]. The main contributors to anaesthesia-related deaths included: airway complications; aspiration of gastric contents; inadequate staff training; poor pre-operative evaluation; lack of intra-operative monitoring; and equipment failure [4]. The quality of existing anaesthesia training, low number of educators and limited opportunities for continuous medical education (CME) to maintain knowledge and skills are significant barriers to the provision of quality anaesthesia services [7, 8]. In Kenya, the density of physician anaesthesia providers per 100,000 population is 0.44 (compared with 18 per 100,000 in the UK), and most doctors work only in the urban areas [9, 10]. Non-physician anaesthetists provide the majority of anaesthesia care but often work unsupported in isolated rural healthcare facilities, with few opportunities for professional development.

The Association of Anaesthetists developed the Safe Anaesthesia from Education (SAFE) course in 2011 in collaboration with the World Federation of Societies of Anaesthesiologists (WFSA) to address this training gap for anaesthetists in LMICs [11, 12]. The SAFE obstetric course is a three-day obstetric anaesthesia refresher course, which addresses the major causes of maternal death in LMICs (haemorrhage, eclampsia, sepsis) and teaches essential skills in obstetric anaesthesia (see supporting information, Appendix S1). To date, the course has been delivered in 32 countries, training over 2300 providers worldwide. Reports have shown positive outcomes with retention of knowledge and skills in the short term following training but evidence demonstrating translation of knowledge and skills into clinical behaviours is still lacking [13–15]. Demonstrating positive outcomes from educational interventions, and understanding why such interventions do or do not lead to improvement is crucial if programs like SAFE are to meet their objectives to improve the practice of health professionals and enhance patient outcomes. Behavioural science tells us that just because someone has knowledge or is capable of performing a particular behaviour, this does not mean that they will perform that behaviour, but that capability, opportunity and motivation all influence the likelihood of any particular behaviour being performed [16]. These three factors form the basis of the capability, opportunity and motivation model of behaviour (COM-B). The COM-B framework has been used in both primary research and systematic reviews to explore the impact of educational interventions and to understand the barriers and facilitators to carrying out professional practices after training [17–19].

The Association of Anaesthetists and WFSA, in partnership with the Kenyan Society of Anaesthesiologists, delivered a national SAFE obstetric anaesthesia training programme in 2016 with follow-up and mentorship for course participants. The aim of our study was: to assess the educational impact of the SAFE training program; to investigate whether SAFE training translated into changes in clinical behaviours in the workplace; and to explore the barriers and facilitators to the adoption of recommended anaesthetic care by providers who had been trained on a SAFE obstetric anaesthesia course.

Methods

The SAFE training courses were delivered for educational and service improvement purposes. All data relating to training outcomes were collected in accordance with local and UK ethical principles, and with the knowledge and consent of participants. Data were anonymised for secondary analyses for research purposes. The Chair of the Research Ethics Committee at the University of Manchester deemed that ethical approval was not required for the secondary analysis of anonymised data.

Experienced physician anaesthetists from East Africa, South Africa, UK and USA delivered the pilot SAFE course according to standard guidelines [14]. The pilot course was delivered in Nairobi in February 2016 after a one-day 'training the trainers' course to increase the local faculty pool. Three further regional courses were delivered over the next 6 months, with minimal external faculty support. Non-physician anaesthesia providers from a variety of urban, semi-rural and remote medical centres were invited as course participants. Evaluation was standardised for SAFE

courses with knowledge and skills tested at baseline, immediately post-course and at 3–6 months following training.

The knowledge test included 50 true/false questions related to the course materials. Each candidate was also tested on one of the following four skills: maternal cardiopulmonary resuscitation (CPR); rapid sequence induction (RSI) for emergency caesarean section; management of eclampsia; and neonatal resuscitation (tests available in the supporting information, Appendix S2). Skill testing was delivered using an objective structured clinical examination (OSCE) via low-fidelity simulation. Each skill was scored out of 10 using a standardised scoring sheet. Due to the challenges of road travel in rural Kenya, transport of simulation manikins was not feasible. Repeat testing of RSI, maternal CPR and eclampsia skills during the follow-up was conducted by viva using the same standardised scoring sheet. Neonatal life support skill was conducted using the same OSCE conditions as during the SAFE course.

A UK-based 'SAFE fellow' who is an obstetric anaesthetist registered with Kenya Medical Practitioners and Dentists Council (KMPDC), conducted follow-up visits 3–6 months after SAFE training between August 2016 and January 2017. Participants based in areas with declared famine or political instability were not visited. Each hospital visit ranged from 2 h to 8 h and included a tour of the facilities, observation and mentoring in theatre, and a meeting with the medical superintendent when possible. Candidates completed a questionnaire including baseline characteristics to describe their training and access to CME, the impact of the SAFE course and utility of the SAFE pocket reference handbook that had been given to each candidate during the course. Questions were answered on a five-point Likert scale (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree). Hospital case-loads were estimated from available theatre records. Practice in theatre was observed where feasible. If clinical situations arose and the candidate sought assistance from the fellow, help was provided and mentoring offered. The mentoring visit also included review of the logbook, that each candidate was given when they attended the training course. In this logbook, the candidates had been asked to enter a clinical case log when they thought the SAFE course had helped make a difference in the clinical management of the patient (see supporting information, Appendix S3). Both observed practice and logbook cases were discussed with reference to the SAFE training and these were recorded as written reports. Field notes were made contemporaneously, and these were used to contextualise observations.

Qualitative semi-structured interviews were conducted to gain an understanding about change in clinical practice following SAFE training, in particular relating to anaesthesia for caesarean section, management of the sick parturient and neonatal resuscitation. Verbal permission was obtained before audio recording to ensure accurate and complete data capture. Interview responses were recorded in field notes. Complete verbatim transcription from audio recording was not possible due to time and opportunity barriers; recordings were listened to for clarification of information when writing up notes from the interviews.

Anonymised data were analysed using mixed methods to study translation of learning into practice. Further statistical analyses were also performed on the test scores. A Shapiro-Wilk test indicated a significant departure from normality in the knowledge and skills test scores ($p < 0.05$). Therefore, the non-parametric Friedman test was used for comparison of repeated measures of knowledge and skill test scores at baseline, post-course and follow-up, with post-hoc analysis with Nemenyi test to measure statistical significance. The Nemenyi test assessed the difference between group-ranked means and was developed to account for a family-wise error to control type-1 error inflation; therefore, no additional correction on the threshold p value of 0.05 was necessary [20]. The semi-structured interviews and hospital reports captured changes in practice behaviours. To summarise these changes, thematic codes were generated and reported using simple counts. Iterative inductive content analysis was performed by two clinically qualified researchers. A framework analysis was performed in which the researchers identified behaviours that are relevant to anaesthetic care. Observed practice and logbook reports were also coded and rated as being either positive or negative, depending on whether the clinical practice was in line with SAFE course teaching or not. The facilitators and barriers which resulted in positive and negative behaviours were analysed according to the COM-B framework and reported into six categories: capability (physical, psychological); opportunity (physical, social); and motivation (reflective, automatic) [16]. Agreement on behaviour coding was calculated and discrepancies were resolved by consensus. The process was iterative with the discrepancy rate decreasing from 48% to 0%. Pareto analysis of the COM-B categories was performed by tallying the numbers of counts from each facilitator and barrier to identify the most important factors that contributed to the observed positive and negative behaviours. [21]

Results

During the study period, 174 anaesthesia providers attended the Kenya SAFE training programme. Follow-up visits were made to 66 facilities across 36 counties 3–6 months after training and follow-up mentorship was provided for 103 course participants (Table 1). Eight candidates were met away from their place of work.

Surgical activity data from theatre records were available in 47 out of 66 facilities (71%). In the remaining 19 facilities, theatre records were either unavailable or incomplete. Data from the 47 facilities revealed a total of 13,536 surgical cases performed over the 3 months preceding the follow-up visit, of which 6943 (51%) were caesarean sections. Out of the 47 facilities, 42 had records of the 5968 anaesthesia techniques: 5343 (90%) had a neuraxial technique; and 625 (10%) had general anaesthesia.

Table 1 Baseline characteristics of participants attending Safe Anaesthesia from Education (SAFE) courses (n = 103 from 66 hospitals). Values are number (proportion). CME, continuing medical education.

Sex; male	77 (75%)
Age; years	
25–30	4 (4%)
31–40	42 (41%)
41–50	44 (43%)
> 50	11 (10%)
Not answered	2 (2%)
Role	
Clinical officer anaesthetist	77 (75%)
Kenya registered nurse anaesthetist	16 (15%)
Physician anaesthetist	4 (4%)
Anaesthetic assistant	1 (1%)
Not answered	5 (5%)
Years of experience	
< 5	37 (36%)
5–10	33 (32%)
> 10	29 (28%)
Not answered	4 (4%)
CME	
Yes (anaesthesia related)	35 (34%)
Yes (non-anaesthesia related)	30 (29%)
None	34 (33%)
Not answered	4 (4%)
Hospital level	
Tier-3: county/subcounty hospital	42 (64%)
Tier-4: regional and national referral hospital	9 (14%)
Mission hospital	8 (12%)
Private hospital	7 (10%)

Ninety (87%) participants who were followed up completed the knowledge tests. Baseline median (IQR [range]) knowledge test score was 41 (37–43 [21–46]). There was a significant improvement in median (IQR [range]) knowledge test score immediately post-course (43 (41–45 [33–48]); $p < 0.001$) which was sustained at follow-up (43 (41-45 [32–50]); $p < 0.001$ compared with baseline). For skills tests, 89 (86%) participants were followed up. There was an improvement in all four skills when comparing post-course scores to baseline, but this was only sustained at follow-up testing for RSI and eclampsia management (Table 2).

Responses to the questionnaires relating to the impact of attending the SAFE course showed a median (IQR [range]) score of 5 (4–5 [1–5]) (strongly agree) on the Likert scale for all areas: change in practice; usefulness of SAFE reference pocket handbook; self-efficacy in obstetric anaesthesia; neonatal resuscitation; ability to request for equipment and drug; and interaction with colleagues. Eighty-one (79%) course participants used the SAFE pocket handbook more than once weekly and 46 (45%) participants used the handbook on a daily basis (see supporting information, Fig. S4).

A total of 1173 improvements in practice were identified from analysis of follow-up interview with 103 participants. The six areas of behaviour change that were reported most frequently were: anaesthetic management of obstetric emergencies; airway management; neonatal resuscitation; pre-operative preparation; anaesthetic technique; and drug dosages (Fig. 1, supporting information, Appendix S5 and Fig. S6).

Eighty-four out of 103 (81%) participants followed up were observed at their place of work. A total of 253 behaviours were recorded in field notes and categorised into thematic areas (see supporting information, Fig. S7). Out of the observed behaviours, 145 (57%) were positive, that is, in keeping with SAFE course training. The most frequently occurring positive behaviour categories were: pre-operative preparation; sterile technique for spinal anaesthesia; teamwork; communication; and advocacy for change. The most frequently occurring negative behaviour categories related to: performing WHO surgical safety checklist; failure to check block height after spinal anaesthesia; patient monitoring; and blood handling. Observed behaviours and logbook case discussions were linked where possible to facilitators or barriers according to the COM-B framework. These factors were identified in

Table 2 Breakdown of skill test scores of participants attending SAFE training at baseline, post-course and at follow up. Values are median (IQR [range]).

	Baseline	Post-course	p value	Follow-up	p value
Maternal CPR (n = 22)	7 (3–8 [1–9])	9 (7–10 [5–10])	< 0.001	7 (7–8 [5–9])	0.221
Neonatal resuscitation (n = 24)	4 (2–5 [1–8])	9 (7–9 [5–10])	< 0.001	6 (5–7 [4–9])	0.070
Eclampsia management (n = 22)	5 (4–5 [2–8])	7 (7–9 [5–10])	< 0.001	7 (6–8 [5–9])	< 0.001
RSI (n = 21)	6 (5–7 [1–10])	8 (7–9 [5–10])	< 0.001	8 (8–9 [7–10])	< 0.001

CPR, cardiopulmonary resuscitation; RSI, rapid sequence induction; SAFE, Safe Anaesthesia from Education.

165 out of 253 (65%) of the behaviours. For a particular behaviour, more than one facilitator or barrier could exist.

Pareto analyses revealed that the most frequently occurring facilitating factors that enabled positive behaviours were psychological capability and reflective motivation (Fig. 2a), whilst physical and social opportunity accounted for the main barriers leading to negative behaviours (Fig. 2b).

Discussion

We conducted a comprehensive mixed methods analysis of routine data obtained from follow-up of Kenyan participants who attended the SAFE course. The initiative focussed on obstetric anaesthesia (caesarean section was the single most common operation identified), and included a follow-up mentorship programme. The course was delivered to mainly non-physician clinical officer anaesthetists working in rural areas, who form the backbone of the anaesthesia workforce in Kenya. Lack of quality training, supervision and CME for non-physician providers is known to contribute to professional isolation [6–8], unsafe practices, high anaesthesia-related mortality and provider burnout; this highlights the importance of courses such as SAFE in this context [22].

It is essential to evaluate the impact of any educational intervention, particularly where donor funding is involved. The Kirkpatrick model is a well-known tool for evaluating educational programmes. It describes four levels of outcome: level 1 – reaction (e.g. satisfaction); level 2 – learning (e.g. increase in knowledge or skills); level 3 –

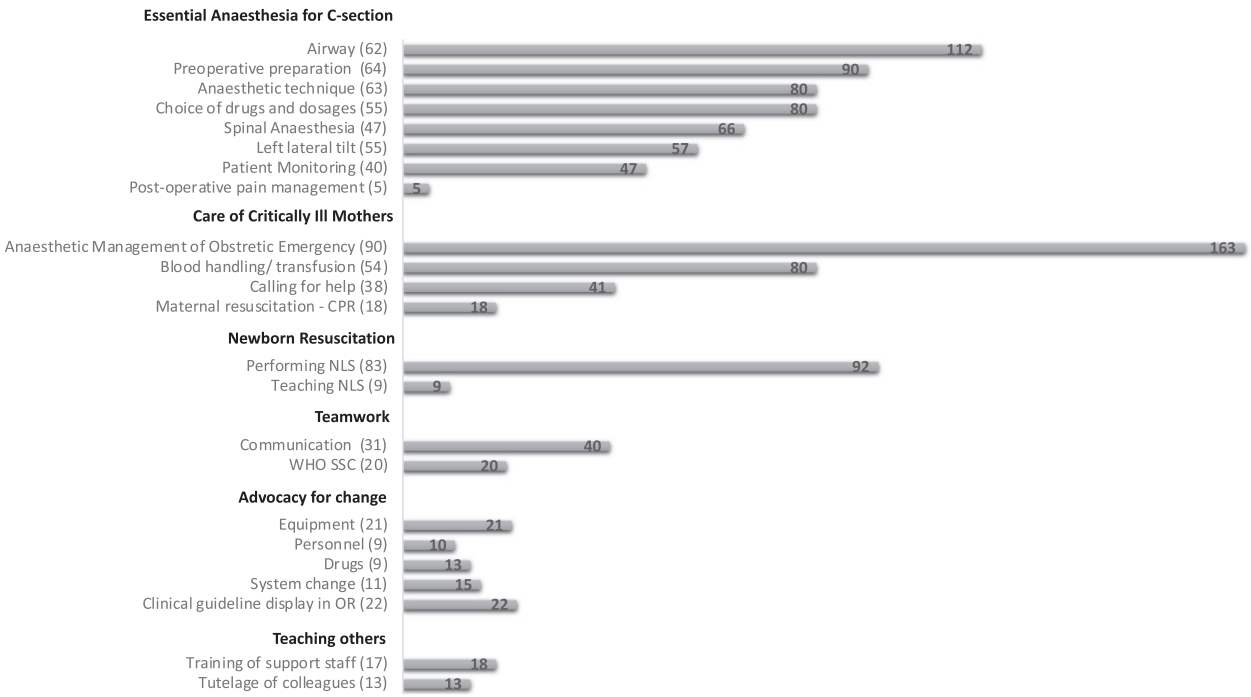

Figure 1 Thematic analysis of reported change in practice behaviours. There were six main thematic areas with 23 subcategories shown on the *y*-axis. n denotes the number of participants who reported the practice change. The x-axis shows the number of times each behaviour subcategory was reported. WHO, World Health Organization.

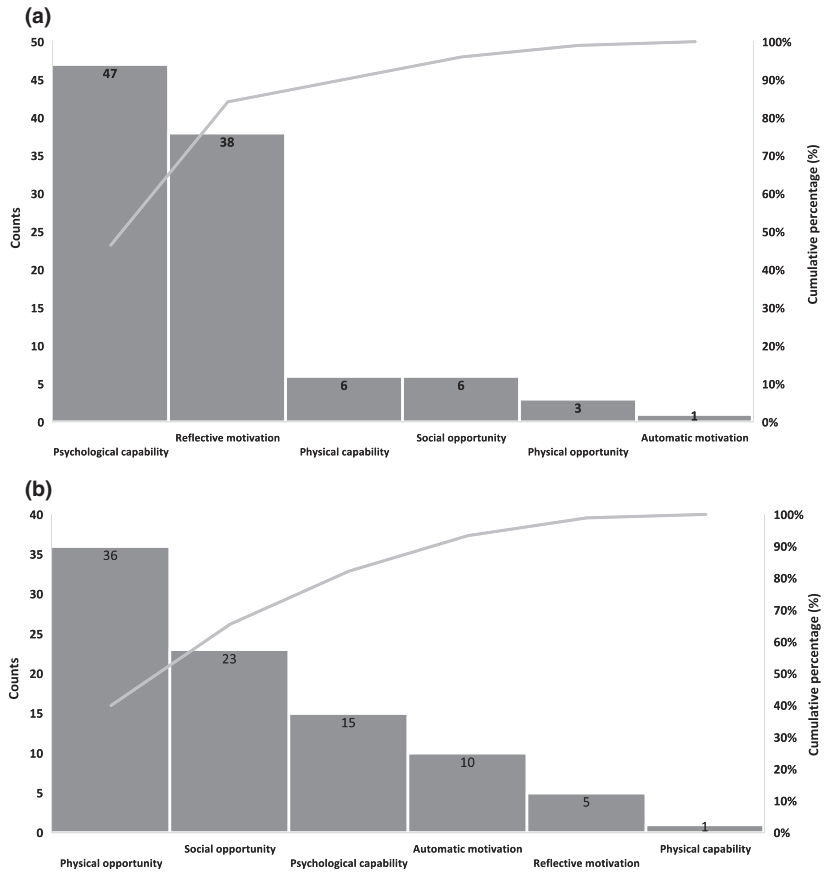

Figure 2 A Pareto chart demonstrating the most to least prevalent factors that (a) enabled and (b) prevented positive behaviour change. The line represents the cumulative total.

behaviour (e.g. utilising knowledge in the workplace); and level 4 – results (e.g. improved patient outcomes) [13]. Previous evaluations of the SAFE courses have described improvements in knowledge and skills as well as changes in behaviour [14, 23, 24]. However, self-reported behavioural change may suffer from recall and social desirability biases and does not provide any insight into what actually happens in the workplace. To our knowledge, this is the first study to use reports of direct observation of participant's clinical practice in addition to self-reports to provide data triangulation for Kirkpatrick level-3 evaluation of the SAFE course.

Adopting a linear approach to a single education intervention in relation to patient outcome is rather simplistic and unrealistic, especially in an environment where resource availability, work culture, multidisciplinary team involvement and healthcare systems are inextricably linked. It is important to measure the effectiveness of the program within its context before attempting to measure the outcome [25, 26]. The COM-B framework has been used to explore the impact of education and to understand the barriers and facilitators to carrying out professional practices after training [17–19]. We applied this framework as part of the secondary analysis of our observational data of the participant's behaviour at their workplace. We found that this offered a good way of summarising highly complex data and provided an insight into why positive and negative behaviours were occurring. The main areas of improvement in clinical practice reported by SAFE participants included: management of obstetric haemorrhage; airway management; and pre-operative preparation. Workplace observation confirmed pre-operative preparation as one of the most frequently occurring positive behaviours. Other observed positive behaviours in our study included team communication and advocacy for system change. Pareto analysis is a way to categorise data so that factors and processes that have the greatest effect on a quality of care outcome can be identified [27]. The results from our Pareto analysis showed that the main drivers of these behaviour changes, and in fact across all other behaviour categories,

were individual psychological capability (i.e. knowledge) and reflective motivation. This suggests that the providers were able to apply the principles taught during SAFE training into clinical practice. However, practices that relied on team effort (e.g. WHO surgical safety checklist) or resources (e.g. patient monitoring, blood transfusion) tended to fall short. Lack of social (i.e. support by co-workers of your actions) and physical opportunities (i.e. presence of resources like personnel, time or equipment) were the main barriers to positive behaviour change in these situations. Furthermore, our data also show that there continues to be deficiencies in psychological (knowledge) and physical (skill) capabilities in fundamental skills such spinal anaesthesia even after training on the SAFE course. We also observed that outdated teaching and habits might have led to negative automatic motivation and routine unsafe practice, for instance, use of a cannula for spinal anaesthesia, or failure to test the height of a spinal block.

Knowledge and skills of the participants in our study improved post-course and knowledge was retained at long-term follow-up. However, although the differences in knowledge and skill scores reached statistical significance, the absolute differences seen were small, and may not be clinically important. Spread of scores also decreased over time demonstrating an overall improvement of the entire cohort, although effect sizes were moderate. Although the follow-up skill scores remained higher than baseline, at follow-up there was a slight decay across all skill areas apart from RSI. Of note, the neonatal resuscitation score significantly decreased at follow-up when compared with post-course. A single training intervention may be adequate for skills that are put into use daily (e.g. RSI), whereas complex skills (e.g. neonatal resuscitation, eclampsia management) or those that are used infrequently (e.g. maternal resuscitation) will require ongoing refresher training [15, 24, 28]. Neonatal resuscitation is often regarded as the responsibility of the paediatrician in high-income countries and who are readily available during childbirth in the operating theatre. This is often not the case in LMICs, where emergent caesarean section is performed with skeletal staff and the anaesthesia provider is often called upon to perform the task. Our study shows that neonatal resuscitation is among the area of practice change that is reported most frequently by the SAFE course participants. However, follow-up test scores, interviews and observation demonstrate inconsistent understanding and application of the resuscitation algorithm. Follow-up mentorship and training allowed re-training of the participants during a large number of the hospital visits. With task sharing being an unavoidable consequence of human resource deficiency, a model for ongoing training and mentorship for a low-frequency, high-impact skill such as neonatal resuscitation is much needed, to assure delivery of quality patient care [28, 29].

Our findings have important implications for ways to improve the effectiveness of an education program such as the SAFE course. Social and physical opportunity barriers need to be addressed as well as knowledge and skills if practice is to change. Inter-professional team training can help to increase the social opportunity to effect change. Providing SAFE training at pre-service stage may also help to overcome resistance within the work culture and decrease barriers that stem from bad habits (i.e. automatic motivation). Developing a longitudinal program and network to support local medical education leads beyond a one-day train-the-trainer model could be a way to support local champions to provide ongoing mentorship and in-service training to their colleagues. Lack of basic resources (i.e. physical opportunity) to provide safe clinical practice needs to be highlighted continually and quantified accurately to help inform and direct policymakers to mandate appropriate changes to improve healthcare in the public sector. Future studies could make use of a COM-B framework to assess influences on practice, and should also include direct observations of practice both before and after training. Interviews could also be structured around influences on behaviour, using COM-B or more detailed frameworks, such as the theoretical domains framework [30].

There are several limitations to this study. This was an explorative study using secondary analysis of data; there were no baseline data for comparison, and this is required to attribute change in providers' behaviours solely to SAFE course training. Due to time and resource constraints, the follow-up observations were largely opportunistic snapshots of the procedures that took place during the hospital visits. Several circumstances including a national strike, annual leave, variable theatre schedules and institution case-load resulted in incomplete evaluation of some facilities and observation of clinical practice. Data collection was performed by a single member of the study team and is, therefore, subject to reporter and observer bias. In addition, the observation methodology was not structured, so the range of behaviours and contributions of all the COM-B categories may not have been captured comprehensively. The semi-structured interview questions were initially designed for program evaluation and we were therefore unable to apply the COM-B framework to this set of data. Skills testing of RSI, maternal CPR and eclampsia management during follow-up was conducted

using a viva technique due to difficulty in transport of simulation manikins to rural areas, and therefore, the scores are not directly comparable to those gained at baseline. Kenya is a multilingual country with Swahili being spoken more widely than English. There were some language barriers during the interviews and answers had to be prompted by examples which may have led to biased responses. Lastly, our study was conducted in a single country and the heterogeneity in the anaesthesia workforce models within sub-Saharan Africa and on a global scale has to be taken into consideration when applying our findings to other contexts [31].

Our study demonstrates that the SAFE obstetric course is highly relevant in the low-resource setting and may lead to knowledge translation in clinical practice. The COM-B framework provided a systematic way to investigate the complexity of behaviour change after training by identifying facilitators and barriers to behaviour change within the local context. With the need to scale up the anaesthesia workforce in LMICs, new educational programs should be rigorously evaluated to ensure effective use of resources and to demonstrate positive training outcomes.

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Supporting Information

Additional supporting information may be found online via the journal website.

Appendix S1 SAFE curriculum.

Appendix S2 Knowledge and skill tests.

Appendix S3 SAFE course logbook.

Figure S4 Questionnaire responses.

Appendix S5 Interview quotes and COMB framework field note examples.

Figure S6 Breakdown of types of behaviour change under the 'Airway Management' and 'Anaesthetic management of obstetric emergencies' categories.

Figure S7 Observed clinical behaviours.