



Increasing the availability and quality of caesarean section in Tanzania

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Objective To describe the results of increasing availability and quality of caesarean deliveries and anaesthesia in rural Tanzania.

Design Before-after intervention study design.

Settings Rural Tanzania.

Methods Ten health centres located in rural areas were upgraded to provide comprehensive emergency obstetric care (CEmOC) and the four related district hospitals were supported. Upgrading entailed constructing and equipping maternity blocks, operation rooms and laboratories; installing solar systems, backup generators and water supply systems. Associate clinicians were trained in anaesthesia and in CEmOC. Mentoring and audit of reasons for caesarean section (CS) and maternal deaths were carried out. Measures of interest were compared using analysis of variance (ANOVA) statistical tests.

Main outcome measures Trends in CS rates, proportion of unjustified CS, use of spinal anaesthesia, and the risk of death from complications related to CS and anaesthesia.

Results During the audit period (2012–2014), 5868 of 58 751 deliveries were by CS (10%). The proportion of CS considered to be unjustified decreased from 30 to 17% in health centres ($P = 0.02$) and from 37 to 20% in hospitals ($P < 0.001$). Practice of spinal anaesthesia for CS increased from 10% to 64% in hospitals ($P < 0.001$). Of 110 maternal deaths, 18 (16.4%) were associated with complications of CS, giving a risk of 3.1 per 1000 CS; three (2.7%) were judged to be anaesthetic-associated deaths with a risk of 0.5 per 1000 caesarean deliveries.

Conclusions Increasing availability and quality of CS by improving infrastructure, training and audit of reasons for CS is feasible, acceptable and required in low resource settings.

Keywords Anaesthesia, caesarean section, risk of death from anaesthetic complications, risk of death from caesarean section complications, unjustified caesarean section.

Tweetable abstract Increasing availability and quality of CS in rural Africa is feasible.

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Introduction

Obstetric surgery including caesarean section (CS) is one of the signal functions of comprehensive emergency obstetric care (CEmOC). These are key interventions that are used to treat direct obstetric complications that cause the vast majority of maternal deaths around the globe.¹ Although CS is globally rising, it is still hugely inaccessible in most underserved rural areas in sub-Saharan Africa.^{2–4} Although in urban Tanzania the caesarean section rate (CSR) is 9.6%, it is only 3.2% in rural areas where 69% of the population lives.⁵ Poor access to CS services indicates that a

significant number of women and newborns are losing their lives, and others develop severe morbidity because of the absence of these services.

Although CS is a life-saving intervention and generally safe, unnecessary CS may be hazardous and lead to a significant burden on healthcare systems. If no complications develop during pregnancy or labour, vaginal birth is safer than caesarean birth. The complications of CS to mothers may include infection, haemorrhage, injury to organs, adhesions, extended recovery time, risk of additional surgeries, rupture of uterus in subsequent pregnancies, and complications of anaesthesia.^{6–8}

It has been reported that CS has a much higher mortality for mother and baby in Africa than in industrialised countries.⁹ Higher maternal and perinatal mortality and morbidity in resource limited settings associated with CS have been attributed to delayed interventions, inadequate technology, inadequate surgical and anaesthetic skills, use of general as opposed to spinal anaesthesia and lack of blood for transfusion.¹⁰ These underscore the need for all initiatives aiming at improving availability of CEmOC services to also implement measures to minimise unnecessary CS without compromising pregnancy outcomes.

To test the feasibility of increasing availability and quality of CS services in marginalised rural Tanzania, the World Lung Foundation's Maternal Health Project upgraded extremely remote health centres (HC) and strengthened CEmOC services in related district hospitals. This article provides results of increasing availability and quality of caesarean deliveries and anaesthesia, and how these objectives were achieved in underserved rural Tanzania.

Methods

Settings

The Tanzanian health system has a pyramidal referral structure: starting from dispensaries at the bottom, ascending to health centres, district, regional, zonal and national hospital (Figure S1).¹¹ The staffing level at health centres includes midwives, clinical officers (associate clinicians) and assistant medical officers (advanced associate clinicians). Where the infrastructure and staffing level are adequate, HCs are authorised to provide CEmOC services.

Ten HCs, of which nine were located in extremely remote areas, were purposely selected in seven rural districts in Tanzania. The project also supported four district hospitals where these HCs were located. Only one HC was urban (Ujiji HC) and it was upgraded because of the high number of deliveries at Maweni regional hospital, only 2 km away. Three HCs were more than 150 km from nearby hospitals with CEmOC services. Because of either the absence or poor conditions of the roads, mothers with obstetric complications required up to 18 hours to reach CEmOC services. During rainy seasons, it was even more difficult to reach a health facility able to provide CEmOC.

Study design

This was a before–after intervention study design. The interventions involved infrastructure improvements and training with supportive supervision.

Infrastructure

Upgrading healthcare facilities entailed constructing and equipping new maternity blocks, operating rooms,

laboratories, and either constructing and/or renovating staff houses. The project also provided the facilities with basic essential equipment, pharmaceutical supplies and drugs. Solar panels were installed in seven HCs as two HCs were already connected to the national electricity grid. Water supply systems were also improved.

Training and supportive supervision

Nurse-midwives and clinical officers were trained to provide anaesthesia, and assistant medical officers were trained in CEmOC. The detailed description of the training has been reported elsewhere.¹² CEmOC services were launched in these HCs between 2009 and 2011. Like HCs, anaesthesia in district hospitals was also provided by associate clinicians who had been previously trained elsewhere. Additional training was provided through face-to-face and modular eLearning sessions. Monthly supportive supervisory visits were carried out and facilities were connected to 'closed user groups' and educational teleconferences were conducted on a weekly basis. Teleconferences were attended by experienced obstetricians and advanced level associate clinicians specialised in anaesthesia. Challenges and successes related to maternal and newborn care in these health facilities were shared and discussed during the teleconferences.

Data collection

A simple record-keeping system using archive boxes was introduced in all project facilities to keep in order all patient files and partograms that were used for monitoring labour.

Development and validation of audit record form

An audit record form was developed and reviewed by five experienced obstetricians for its relevance and clarity. The form was piloted in 2011 and revised based on the feedback from the team who administered it. The final version had several sections including: (1) background information: initials of the woman, date and time of delivery, number of previous vaginal deliveries, number of previous CS; (2) history of labour: completeness of partogram, presence of strong contractions, status of membranes, time when the membranes ruptured, augmentation with oxytocin and time when started, cervical dilation at time of decision for CS, diagnosis and indication for CS, whether action line was reached, when CS was decided and the type of anaesthesia; (3) pregnancy outcomes: maternal and newborn outcomes; and (4) reviewers' conclusion on whether the indications for CS justified operative management.

Audit of indication for CS

Monthly supportive supervisory visits were carried out for 2–3 days in each health facility by an assistant medical

officer specialised in anaesthesia and an obstetrician or a more experienced assistant medical officer. During the visits the audit was carried out to assess the indications and rationale for conducting CS by reviewing the delivery log books, case files and operation records. CS with inadequate information (in the case notes or partograms) were labelled unclassifiable. Criteria for considering a CS as 'justified' or not were based on the National CEmOC management guidelines for Tanzania, WHO recommendations and other nationally recommended reference books.^{13,14} At the end of the supervisory visit a summary of findings was shared with the local team of care providers. Reasons for categorising caesarean sections as 'unjustified' were also discussed, and together staff and supervisors developed an action plan for intervention. Proposed and implemented interventions included post course training and coaching, provision of learning materials including the job aids for emergency obstetric care and displaying basic algorithms in labour ward with a view to improving decision-making.

All maternal deaths were audited and any maternal death associated with CS and/or anaesthesia were identified. A death was judged anaesthetic-associated if it resulted from the medications used, method chosen, or the technical manoeuvres performed, whether iatrogenic in origin or resulting from an abnormal patient response.¹⁵

Analysis

Indications for CS were classified into four groups as follows: group 1—reasons related to one previous scar; group 2—reasons related to obstructed labour (cephalopelvic disproportion/obstructed or prolonged labour/arrest of descent/abnormal lie); group 3 (≥ 2 previous caesarean deliveries); and group 4 (other reasons). The list of other reasons included those related to antepartum haemorrhage, (pre-)eclampsia and any other cause of non-reassuring fetal heart rate. For each case, one category was assigned—the one considered most applicable by the group of assessors. A woman with one previous CS and antepartum haemorrhage and/or fetal distress fell into group 1 (reasons related to one previous scar). Data were cleaned and consistency checks were done using Microsoft EXCEL. Data analysis was done using STATA (version 12). Comparisons before and after the interventions were performed for the institutional CSR, proportion of unjustified caesarean sections, proportion of spinal anaesthesia, and the risk of death from complications related to CS and/or anaesthesia. These parameters were statistically compared using ANOVA (*F*-Test) with *P*-values at 0.05. When the null hypothesis in a one-way ANOVA was rejected, Scheffe's method of pair wise multiple comparison was performed to identify whether proportions were different over time. As none of the HCs had graduate physicians and all CS were decided and performed by assistant medical officers, analysis of the

justification of indication for CS based on who made the decision or who performed it, was not done.

Results

Background characteristics

From 2009 to February 2012, a total of 67 associate clinicians and advanced associate clinicians from 14 health facilities were trained in CEmOC and anaesthesia. Of these, 23 (34%) were assistant medical officers from the HCs who were trained in CEmOC, 35 (52%) were nurse-midwives and nine (13%) were clinical officers who were trained to provide anaesthesia. CEmOC services were introduced at different periods between 2009 and 2012 (Figure S2).

Spontaneous and vacuum-assisted vaginal deliveries

On average, within the first year of delivering CEmOC services, the number of monthly deliveries increased by 129%, from 280 to 641 deliveries per month in the nine rural HCs combined. Details on deliveries have been reported elsewhere.¹⁶ From 2011 to 2014, the overall vacuum-assisted vaginal delivery (AVD) rates increased from 0.3% (28 per 10 741 deliveries) to 2.4% (216 per 8874 deliveries) in all health centres and from 0.0% (4 per 8638 deliveries) to 1.0% (89/8504 deliveries) in district hospitals. Only three HCs (Mwaya, Mlimba and Kibiti) increased AVD rates to five or more percentage points (4.9–8.2%). Only one (Utete) of four district hospitals increased its assisted vacuum delivery rate to 5%, i.e. from 0.1% (1 per 914 deliveries) in 2011 to 5% (47 per 932 deliveries) in 2014.

Practice of caesarean section and anaesthesia

Although the overall caesarean section rate in all supported hospitals combined tended to decrease, from 20% (1 year before the introduction of CS services in health centres) to 11% (5 years later), the decrease was not statistically significant (*F*-test = 1.03; *P* = 0.41) (Figure 1). Between 2012 when audit was introduced and September 2014, a total of 5868 (10%) caesarean sections out of 58 751 deliveries were performed in all health facilities. In all, 5% (3119) of all CS conducted during this period were audited and, of these, 105 (3%) were judged unclassifiable due to inadequate documentation, missing case notes and/or partograms. The major indications for CS were related to obstructed labour (57–69%), failed trial of labour for previous scar (11–19%), two or more previous caesarean deliveries (9–15%) and other reasons (9–11%). In Tanzania, two or more previous caesarean deliveries is considered an absolute indication for CS.

The introduction of clinical audit with its examination of indications for CS was associated with a statistically significant decrease in the overall proportion of unjustified caesarean deliveries in both HCs and district hospitals

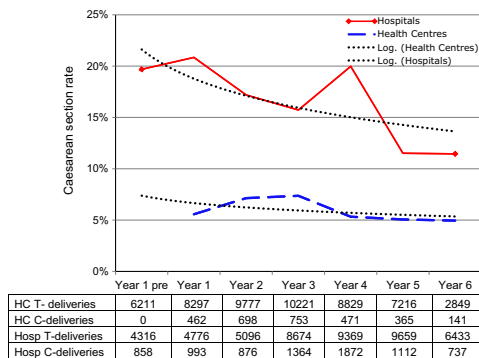


Figure 1. Trends in caesarean section rate after introducing and strengthening CEmOC services in health centres and in district hospitals.

(Figure 2). The overall proportions of unjustified indications for CS decreased from 37% to 20% in district hospitals (F -test = 57.41; $P < 0.001$) and from 30% to 17% in HCs (F -test = 4.12; $P = 0.02$). A statistically significant reduction of unnecessary CS was observed for two groups of indications: the group of reasons related to one previous caesarean delivery and the group of reasons related to obstructed labour. There was no statistically significant difference in the rate of decrease of unjustified caesarean deliveries between hospitals and HCs (F -test = 0.26; $P = 0.61$).

After the introduction of CS audit, the practice of spinal anaesthesia for CS increased significantly from 10% to 64% (F -test = 26.65; $P < 0.001$) in district hospitals (Table 1). Women who were not given spinal anaesthesia were given mainly bolus or drip of ketamine.

Safety of caesarean section

During the audit period a total of 110 maternal deaths occurred in the target health facilities. Cause of death could

Table 1. Trends in proportion of caesarean sections where spinal anaesthesia was used

Health facility/Year	Number of audited C-sections	Cases received spinal anaesthesia	%	ANOVA (F -test); P -value
Health centres				
2012	255	145	57	F -test = 0.25
2013	450	274	61	$P = 0.78$
2014	298	157	53	
Hospital				
2012	549	54	10	F -test = 26.65
2013	955	612	64	$P < 0.001$
2014	522	277	53	

not be established in nine (8%) women due to inadequate documentation, 18 deaths (16.4%) were related to complications of CS; a risk of 3.1 maternal deaths per 1000 caesarean deliveries (Figure 3). The most common cause of maternal death among those related to caesarean section was intraoperative haemorrhage (10 deaths) (1.7 maternal deaths per 1000 caesarean deliveries). Maternal deaths from anaesthetic-associated complications were three (0.5 maternal deaths per 1000 caesarean deliveries). All three events of anaesthetic-associated maternal deaths were judged to be complications of high spinal anaesthesia and were attributed to inadequate manpower and lifesaving equipment including resuscitation materials. One of the three anaesthetic-associated maternal deaths occurred at an upgraded health centre and two at hospital level. The risk of dying (maternal deaths) from complications of caesarean section in WLF supported health facilities decreased from 3.8 per 1000 caesarean deliveries in 2012 to 1.3 per 1000 caesarean deliveries in 2014 (Figure S3).

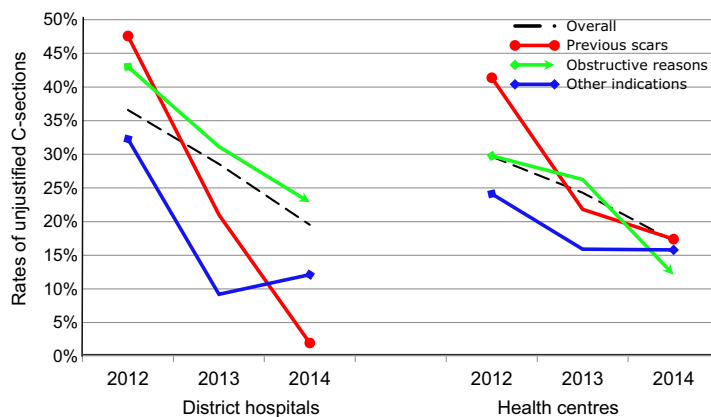


Figure 2. Trends in percentage of caesarean sections considered unjustified (by indication) following introduction of audit in 14 health facilities in Tanzania.

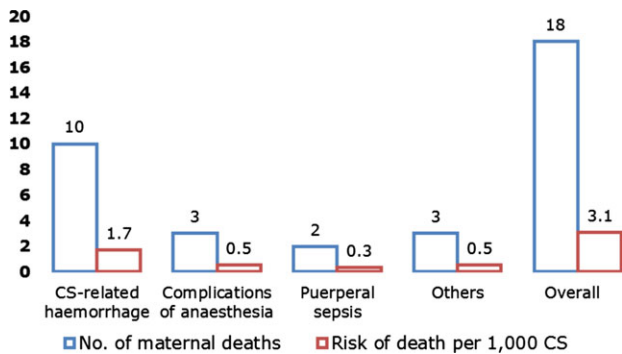


Figure 3. Risk of maternal death from complications of caesarean section.

Discussion

Main findings

Introduction of clinical audit, supportive supervision, on-the-job training, and face-to-face and teleconference-based mentoring and coaching resulted in a reduction of the proportion of CS considered unjustified and an increase in the practice of spinal anaesthesia for CS. The proportion of unjustified CS decreased from 30% to 17% in HCs ($P = 0.02$) and from 37% to 20% in hospitals ($P < 0.001$); and the practice of spinal anaesthesia for CS increased from 10% to 64% in hospitals ($P < 0.001$). The risk of dying from complications of caesarean section decreased from 3.8 per 1000 caesarean deliveries in 2012 to 1.3 per 1000 caesarean deliveries in 2014.

Strengths and limitations

These results come from 14 rural health facilities located in 8.2% (7) of rural districts, which suggests a reasonable number of facilities in rural Tanzania for answering questions related to intervention feasibility. The uptake of spinal anaesthesia for caesarean deliveries was affected by periodic stock-outs of related drugs, hence uptake did not reach expected levels in these facilities. The fact that cause of death could not be established in nine (8%) of all maternal deaths posed a limitation on the accuracy of the risk of death from caesarean deliveries and anaesthesia reported in this study. This is a before–after comparison with multiple interventions and direct attribution of change is difficult but plausible. Indications for CS were not categorised based on emergency or elective basis, and the choice as to which group women with more than one indication fell may not meet universal agreement.

Interpretation

The observation that 37% of all CS were considered to have been performed for indications considered unjustified, suggests an alarming rate of unnecessary caesarean deliveries in district hospitals in Tanzania. High rates of

unnecessary and potentially preventable CS are prevalent in countries with low and high CSR.^{17–20} This suggests that CSR may not be a useful process indicator for monitoring the quality of EmOC. However, our findings suggest that unnecessary CS can be reduced by multifaceted interventions that enhance best practices among healthcare providers. Like other reports, introduction of post course training with face-to-face interactions and eLearning, weekly teleconference-based coaching, monthly supportive supervision, the re-introduction of vacuum-assisted vaginal delivery and audits of caesarean sections improved decision-making and significantly reduced unnecessary caesarean sections.^{16,21–24} Our findings strongly suggest the need for establishing regular senior staff supervision and clinical audit to help junior doctors and associate clinicians to improve their decision-making.

Despite a large body of literature on the potential benefits of regional anaesthesia, fewer than 10% of all CS before 2012 were performed under spinal anaesthesia in district hospitals. Although general anaesthesia is also safe, the risk ratio compared with regional anaesthesia has been reported to be 1.7. Use of regional anaesthesia for caesarean delivery is associated with improved maternal safety,²⁵ as it eliminates fatal complications of aspiration, failed intubation and inadequate ventilation. In view of these problems, anaesthetic practice has shifted to rely more heavily on regional anaesthesia for caesarean delivery, thereby minimising the need for invasive airway management in obstetrics.^{26–28} In the USA, studies have reported that up to 93% of all caesarean deliveries are performed under regional anaesthesia.²⁹ As in many other countries, in Tanzania, the professional association of anaesthesiologists and training institutions encourage and train residents and assistant anaesthesiologists on regional anaesthesia techniques including spinal anaesthesia. It has been reported that in sub-Saharan Africa the majority of anaesthetics are provided by associate clinician anaesthetic providers who work alone, unsupervised, and have limited training.³⁰ The main factors for non-use of spinal anaesthesia for caesarean delivery were not explored in this study but are likely to include lack of skills, lack of standard guidelines for obstetric anaesthesia, and inadequate mentoring and coaching for junior care providers in rural health facilities including district hospitals.

The risk of 0.5 anaesthetic-associated maternal deaths per 1000 CS was lower than the 2.5–3.7 anaesthetic-associated maternal deaths per 1000 caesarean deliveries reported in Nigeria and 2.1 per 1000 caesarean deliveries in Zimbabwe.^{31,32} This relatively low risk can be explained partly by close supervision, mentoring and coaching provided by the project team during this period. However, the risk was relatively higher than that reported from South Africa (0.1 per 1000 caesarean deliveries) and high income

settings like the USA, where case-fatality rates for general anaesthesia are 6.5 per million and for regional anaesthesia as low as <1 per million.^{33,34} Our relatively high risk of maternal deaths from caesarean delivery and anaesthesia can be attributed to a wide range of social, economic, political and technological health determinants. Although an inadequately skilled workforce in operating rooms and short supplies of life support equipment and pharmaceuticals may partly explain these risks, quite often in remote rural areas, women arrive in a moribund state too late for successful intervention, or have developed complications due to delayed diagnosis and intervention.³⁵

CS continues to remain the most common major surgical procedure in resource-limited countries. Given the critical shortage of anaesthetists at present, it is unrealistic to expect that a trained physician anaesthetist can staff every remote healthcare facility. Until then, associate clinicians will remain the backbone and hope of anaesthesia in rural areas. Associate clinicians already play a vital role in the provision of CS and anaesthesia, but greater numbers are needed. They also require more capacity-building and a well-resourced workplace environment to achieve the desired level of safety.^{35–37}

Conclusion

Increasing the availability and quality of caesarean deliveries using associate clinicians is a feasible, acceptable and required intervention in most resource-limited settings. However, initiatives aiming at scaling up such services in under-served rural areas should be accompanied with strategic efforts geared at improving the quality and safety of caesarean procedures. These findings strongly suggest that CS audit, focused supportive supervision, on-the-job training, and face-to-face and teleconference-based mentoring and coaching have a great potential to improve standards of practice and hence outcomes of caesarean deliveries and obstetric anaesthesia in resource-limited settings.

Disclosure of interests

None declared. Completed disclosure of interests form available to view online as supporting information.

Contribution to authorship

AN, NM, SD, HM were involved in the conception and design of the study. AN analysed the data and drafted the manuscript. AN, NM, SD, HM, AS, RR, CK, CN, OI, CL, IK and JvR were involved in the project implementation, and reviewed and approved the manuscript.

Details of ethics approval

Permission to conduct research was obtained from the Ministry of Health and Social Welfare and the Prime

Minister's Office and Local Government officials. There was no need for patient consent because this study did not collect patient data; no author had direct contact with patients at any point in time. During clinical audits, patients' names were anonymised by health providers at the facility. As the research conducted related directly to rectifying urgent service delivery problems and was based on routine health care operations, this study did not require Institutional Review Board approval. However, all national and international ethical considerations were observed during implementation of the research.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

- Figure S1.** Structure of the Tanzanian health system.
- Figure S2.** Timeline for introduction of CEmOC services in WLF-supported health centres.
- Figure S3.** Trends in the risk of maternal death from complications related to caesarean section. ■

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