

ORIGINAL RESEARCH ARTICLE

Improving access, quality and safety of caesarean section services in underserved rural Tanzania: The impact of knowledge translation strategies

DOI: 10.29063/ajrh2021/v25i3s.8

Angelo S. Nyamtema^{1,2}, Heather Scott³, Elias Kweyamba^{1,2}, Janet Bulemela^{1,2}, Allan Shayo^{1,2}, Godfrey Mtey¹, Omary Kilume^{1,2}, John C. LeBlanc³

Tanzanian Training Centre for International Health, Tanzania¹; St. Francis University College for Health and Allied Sciences, Tanzania²; Dalhousie University, Canada³

*For Correspondence: Email: anyamtema@ttcih.ac.tz; Phone: +255 787 752 012

Abstract

This research was designed to study different approaches to improve access to, and quality of caesarean section services in underserved Tanzania and translate evidence into practice. In 2016, 42 associate clinicians from five health centers were trained in teams for three months in comprehensive emergency obstetric and neonatal care and anesthesia followed by post-training supportive supervision and mentorship. From 2016-2019, 2,179 caesarean sections were performed in the intervention and 969 in the control health centers. Catchment population-based caesarean section rates increased significantly in all five intervention health centers and were more than 10% in three facilities. The risk of a woman dying from complications of caesarean section in the intervention health centers was 2.3 per 1,000 caesarean sections (95% CI 0.7 - 5.3). This educational program was adopted by the government and can be used to meet the demand for caesarean section services in other underserved areas in Africa. (*Afr J Reprod Health* 2021; 25[3s]: 74-83).

Keywords: Caesarean section, safety, knowledge translation, Tanzania, Africa

Résumé

Cette recherche a été conçue pour étudier différentes approches pour améliorer l'accès et la qualité des services de césarienne en Tanzanie mal desservie et traduire les preuves en pratique. En 2016, 42 cliniciens associés de cinq centres de santé ont été formés en équipes pendant trois mois aux soins obstétricaux et néonataux d'urgence complets et à l'anesthésie suivis d'une supervision et d'un mentorat post-formation. De 2016 à 2019, 2 179 césariennes ont été réalisées dans les centres de santé d'intervention et 969 dans les centres de santé témoins. Les taux de césariennes dans la population desservie ont augmenté de manière significative dans les cinq centres de santé d'intervention et étaient supérieurs à 10 % dans trois établissements. Le risque qu'une femme meure des complications d'une césarienne dans les centres de santé d'intervention était de 2,3 pour 1 000 césariennes (IC à 95 % 0,7 - 5,3). Ce programme éducatif a été adopté par le gouvernement et peut être utilisé pour répondre à la demande de services de césarienne dans d'autres régions mal desservies d'Afrique. (*Afr J Reprod Health* 2021; 25[3s]: 74-83).

Mots-clés: Césarienne, sécurité, application des connaissances, Tanzanie, Afrique

Introduction

Caesarean section is one of the components of comprehensive emergency obstetric and newborn care (CEmONC), the key medical interventions that are used to treat direct obstetric complications that cause the vast majority of maternal deaths around the globe¹. Improving access to quality caesarean section (CS) services in underserved areas are longstanding challenges of maternity care in resource-limited countries. While in 2015,

caesarean delivery worldwide constituted 21% of all births, the use of the procedure was only 4.1% of all births in west and central Africa and 0.6% in South Sudan^{2,3}. In 2018, the national caesarean section rate (CSR) in Tanzania was 8%. Like many other low- and mid-income countries, there are wide within-country disparities in the CSR, particularly by ownership of the health facilities and location ranging from 2% to 25% in the 30 regions of Tanzania⁴. In 2016, the CSR was 12.6% in urban Tanzania, whereas it was only 4.5% in rural areas

where 69% of the population lived^{2, 5}. The World Health Organization (WHO) recommends a population-based rate for caesarean section to be between 10% and 15%⁶. The facility CSR in non-public facilities is twice as high (17% vs. 8%) than in public facilities. Of the 513 public health centers (HCs) that were available in Tanzania in 2017, only 115 (22%) provided CS services, suggesting a significant unmet need in many parts in the country⁷.

As part of the Innovating for Maternal and Child Health in Africa (IMCHA) initiative, a research project (Accessing Safe Deliveries in Tanzania - ASDIT) was designed to study different ways to improve access to CEmONC services in underserved rural Tanzania and to define and execute strategies to successfully translate this research into policy and practice. One of the key components was to improve access to high quality and safe CS services. This program supported the government policy and efforts to expand the number of health centers providing CEmONC services from 12% in 2015 to 50% by 2020⁸.

Methods

Project sites

This was a prospective cohort study of CEmONC implementation in five health centers chosen because they were far from the nearest district hospital and represented the different funding and governance models for HCs in Tanzania. Morogoro region had 15 HCs that were either already offering CEmONC or were ready to do so once staff were trained. The first category included 3 publicly funded HCs that had never provided CEmONC services. They had the proper infrastructure (maternity and neonatal wards, a functioning operating theatre and ability to provide emergency blood transfusions), but staff had not received CEmONC training. This group typified the HCs that the Ministry of Health, Community Development, Gender, Elderly and Children (MOHCDGEC) would have to upgrade as it implements its national goal of 50% of HCs in Tanzania offering CEmONC. Two of the three (Kibati and Ngerengere) HCs were randomly allocated to the intervention group. The second category had nine publicly funded HCs that were already providing CEmONC. Using simple random

sampling, two of the nine (Mlimba and Mkamba HCs) were allocated to be control sites and two (Gairo and Melela HCs) to the intervention group in order to study how CS services could be strengthened. The third category contained three HCs affiliated with faith-based organizations (FBOs). They receive both public and FBO funding and are a permanent and integral part of the Tanzanian health system. One of the three (St. Joseph HC) was randomly allocated to the intervention.

Interventions

1. Face-to-face training in CEmONC and anesthesia: Twenty-two associate clinicians from the intervention HCs were trained in teams for three months in CEmONC and anesthesia. The training program was conducted in two cohorts in 2016 at St. Francis Referral Hospital in Ifakara. Assistant medical officers (advanced associate clinicians) were trained in CEmONC while clinical officers and nurse-midwives (associate clinicians) were trained in anesthesia, postoperative care and care of the sick and premature newborn. Curricula were built on training programs for associate clinicians previously delivered at the St. Francis Referral Hospital⁹. Assistant medical officers are clinical officers with a 2-year additional training program in clinical medicine, which includes three months of surgery and three months of obstetrics. They are meant to be general practitioners and are licensed to perform major surgery independently, including CS in Tanzania. At the time of graduation, most still need more hands-on experience in surgery and obstetrics. Clinical officers are mid-level cadres trained in clinical medicine for three years and are not licensed to perform major surgery.

2. Post-training capacity building: Post-training activities included skills capacity-building using eHealth strategies, quarterly supportive supervision visits and continuous mentorship. The eHealth strategies included the eLearning platform residing at the Tanzanian Training Center for International Health (TTCIH) and teleconsultation. Six eLearning modules were developed and uploaded on stand-alone computers in all intervention HCs to reinforce CEmONC skills and knowledge. These modules did not require continuous internet access since this was not available in most HCs. Care providers at the HCs were also linked with St.

Francis Referral Hospital-based clinicians, including obstetricians, a pediatrician and an anesthetist, for virtual consultation for difficult cases. Supportive supervisory visits were done every quarter and included clinical audits for CSs, maternal deaths and morbidities, fresh stillbirths, early neonatal deaths and method of anesthesia. To reinforce skills and knowledge, mentorship activities focused on the statistics, maternal and perinatal outcomes and identified areas of substandard care.

Strategies for research uptake

In order to enhance uptake of the findings, the team developed comprehensive knowledge translation and engagement strategies that were implemented from the proposal development stage, throughout the research implementation stage and beyond. The Regional Medical Officer for Morogoro region, as a decision-maker, was engaged as a co-principal investigator of the project, helping design it and working as liaison between the community, district, regional and national authorities. Through workshops and meetings, the project team regularly shared findings with key stakeholders at district, regional and national levels to provide them with a broader understanding of the project, progress and outcomes. During these meetings, the project team and stakeholders discussed solutions to the challenges and barriers that impacted implementation. Brief reports, policy briefs, fact sheets, documentaries, infographics and mass media channels (social media, blogs, newspapers and national televisions) were used to share key findings with the stakeholders in the country and the region.

To enhance effective use of evidence for policy change the IMCHA Initiative engaged the Eastern Africa Health Policy Research Organization (EA-HPRO). The EA-HPRO was a consortium of three institutions: African Population and Health Research Center (APHRC) based in Nairobi, Kenya, the East, Central and Southern Africa Health Community (ECSA-HC), based in Arusha, Tanzania and Partners in Population and Development Africa Regional Office (PPD-ARO), based in Kampala, Uganda. The EA-HPRO's role was to complement the project team's efforts to integrate evidence into policies and practices in the country. Through training, the organization

strengthened the capacity of research teams in knowledge translation and organized and facilitated national meetings with the decision and policy makers.

Data collection

Data were collected from the log books for Health Management Information System (HMIS), operating theatre log books, and individual case files (which included partographs that were used for monitoring labour). A systematic sampling technique was used to select five CSs per month per HC for comprehensive audit. The objective of the audit was to determine the indication and assess the clinical justification for the CS. The audit of CSs helped the team to assess the quality of CS decision-making in order to improve care. The audit team comprised of obstetricians, a pediatrician, an anesthetist, members of the regional and council health management teams (RHMT & CHMT) and care providers. The team developed topics for post training capacity-building based on clinical issues needing attention that were identified in the audit. The indications for CS were classified according to maternal, fetal and combined maternal and fetal indications.

1. Maternal indications included: Obstructive reasons (obstructed labour, cephalopelvic disproportion, fetal malpresentation/abnormal lie), hemorrhagic indications, hypertensive disorders and previous caesarean deliveries.
2. Fetal indications included: Cord prolapse and non-reassuring fetal heart rate or fetal distress.
3. Combined maternal and fetal indications, when there were maternal and fetal indications for CS delivery.

Data analysis

Data were collected using a mobile data collection app called CommCare. Data were extracted from the server into Excel Microsoft office and analysed using Stata (version 15). Because we intentionally designed this study to capture the diversity of HC types in Tanzania, the main analyses were based on before and after comparisons among the intervention and control HCs. Control center data were meant to represent secular trends and, by design, were not strictly comparable to intervention HC data. Multiple statistical tests were therefore used to assess the impact of the intervention model

on HC deliveries over time, CSRs and proportion of justifiable CSs. A one-way ANOVA test was used to determine the statistical differences of the average monthly deliveries. Chi-square tests for CSRs and proportions of justified of CSs between and within the intervention and control HCs. The level of significance was set at $p \leq 0.05$.

Results

Introduction of caesarean section services at health centers

Provision of CS services was strengthened at Gairo and Melela HCs, such that services are now consistently and regularly provided. Caesarean section services were introduced at Ngerengere and Kibati HCs in October 2016 and August 2017, respectively. Services were introduced in Kibati in year two of the project (i.e., 2017) for reasons related to unavailability of electricity. The intervention HCs experienced a substantial increase in the number of women coming for delivery care after they began providing CS services and strengthening the CEmONC services (Figure 1). Average monthly HC deliveries increased significantly within the first year of the intervention, from 192 (95% CI 179 – 204) to 253 (95% CI 230 - 276), one year before the intervention started and year one of the intervention respectively. There was no significant change of average monthly deliveries in the control HCs within this period i.e. 251 (95% CI 233 - 269) and 276 (95% CI 253 – 299). Average monthly deliveries increased significantly across the years of intervention in the intervention facilities.

In 2019, the catchment population ranged between 8,649 at Melela and 235,725 at Gairo HCs. The population-based caesarean section rates increased significantly in all five intervention HCs and were above 10% in three (60%) facilities (Table 1).

The overall numbers of CSs in the intervention and control HCs during the intervention period (July 2016 to June 2019) were 2,179 and 969, respectively. While the health facility-based CSRs in the intervention HCs ranged from 6% to 29% following the introduction and/or strengthening of CS services, the rate dropped from 6% to almost zero percent (0.3%) at the control center site Mkamba HC (Figure 2). The CSR

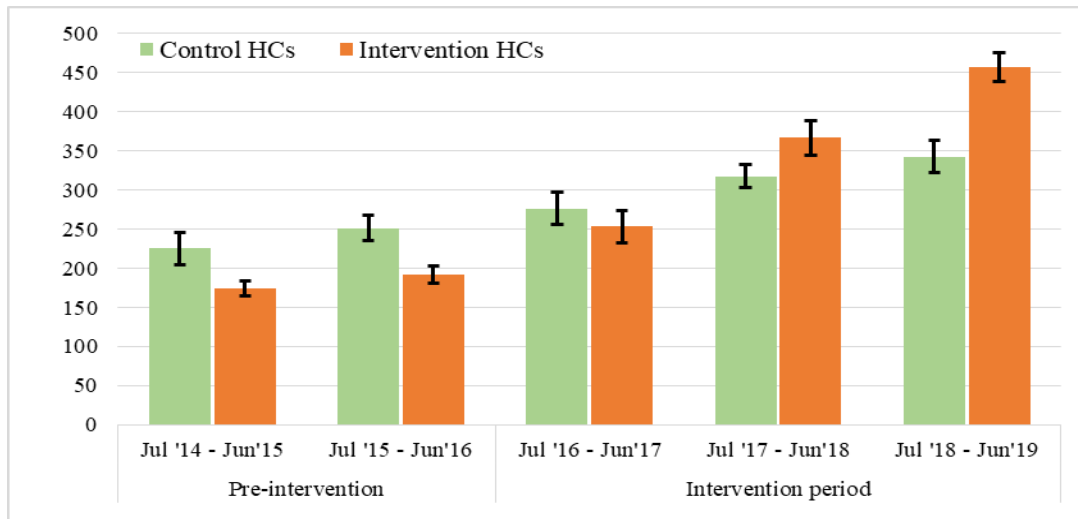
decline at Mkamba HC was largely due to renovation of the operating room that occurred during the intervention period. In some intervention HCs, provision of CS services was at times interrupted due to absenteeism of the trained staff and/ or lack of essential pharmaceutical supplies, blood for transfusions and/or anesthetic drugs.

Indications, justifications and quality of management of labour among women that delivered by C-section

From July 2016 to June 2019, a total of 674 CSs from the intervention HCs and 68 from a control HC were audited by experienced obstetricians and midwives from the RHMT and CHMT to determine whether the interventions were performed based on justifiable clinical indications. The leading group of indications for CS consisted of obstructive reasons. They contributed 41% and 46% in the intervention and control HCs, respectively (Table 2). In the intervention group, 136 women had other indications (i.e., fetal distress and previous scars) in addition to obstructive indications. When these women were combined, obstructive reasons represented 61% (413) of all CSs in the intervention HCs.

When assessing the clinical justification of CS, out of 674 CSs that were audited in the intervention HCs, 27 (4%) were considered unclassified due to absence of essential documents (e.g., partographs) and/or inadequate documentation. During the intervention period, overall proportions of justified CSs in the intervention facilities ranged between 80% (95% CI 75% - 85%) and 88% (95% CI 83% - 92%) (Figure 3). One of the control HCs, namely, Mkamba, had only 23 CSs during the intervention period. Thus, Mkamba was dropped from the individual facility CS proportional analysis. The proportions of CSs that were performed with justifiable indications in the control HCs during this period were 74% (95% CI 64% - 84%) in year one and 78% (95% CI 67% - 89%) in year three.

The major reason for an unjustified CSs was incorrect diagnosis, particularly for obstructed labour. When partographs showed a lack of appropriate augmentation of labour with oxytocin and a failure to give an adequate opportunity for vaginal delivery in women who were diagnosed with cephalopelvic disproportion, we assessed this



Note: HCs = health centers; pre-intervention period was July 2014 – June 2016, and intervention period was July 2016 – June 2019

Figure 1: Average monthly health center deliveries before and during intervention period

Table 1: Caesarean sections as a proportion of all births in intervention and control catchment populations before and after intervention

Health center	2015				2019			
	Catchment population	Expected deliveries	CS (CSR)	95% CI of CSR	Catchment population	Expected deliveries	CS (CSR)	95% CI of CSR
<i>Intervention HCs</i>								
St. Joseph	33,569	1,125	182 (16)	14 - 18	40,027	1,265	482 (38)	35 - 41
Ngerengere	14,000	469	0 (0)	0.0 – 0.8	20,000	632	31 (5)	3.4 - 6.9
Kibati	8,900	298	0 (0)	0.0 – 1.2	10,183	322	60 (19)	15 - 23
Melela	9,542	320	0 (0)	0.0 – 1.1	8,649	273	33 (12)	8 - 17
Gairo	201,231	6,741	128 (2)	1.6 – 2.3	235,725	7,449	459 (6)	5.6 – 6.7
<i>Control HCs</i>								
Mkamba	7,586	254	90 (35)	30 - 42	8,861	280	28 (10)	7 - 14
Mlimba	45,000	1,508	201 (13)	12 - 15	52,000	1,643	429 (26)	24 - 28

Note: CS = caesarean section, CSR = caesarean section rate. Expected deliveries were computed from the catchment populations using the crude birth rates of 33.5 births per 1000 population in 2015 and 31.6 births per 1000 population in 2019 in Morogoro region¹⁰

as incorrect management. In addition, women who had one previous caesarean delivery with an appropriately grown baby were not always given the opportunity to have a vaginal birth. Management of labour was judged to be substandard in 8% (55) of women whose CSs were justified. The major areas of substandard care included delayed caesarean intervention, sub-optimal monitoring of labour using a partograph and sub-optimal preoperative preparation of women for caesarean deliveries. Sub-optimal preoperative preparation of women for caesarean deliveries included inadequate hydration of patients with obstructed labour.

Safety of caesarean sections

Of the 2179 CSs performed during the study period in the intervention HCs, a total of five women died from immediate complications of caesarean section and anesthesia. Of these, two had severe intraoperative hemorrhage, two had complications of anesthesia and one had severe preeclampsia and an asthma attack preoperatively. The risk of a woman dying from complications of caesarean section in these HCs was 2.3 per 1,000 caesarean deliveries (95% CI 0.7 - 5.3). The risk of a woman dying from complications of anesthesia in the intervention HCs was 0.9 per 1,000 caesarean

Table 2: Indications for caesarean sections in the health centers from July 2016 to June 2019

	Intervention HC		Control HCs	
	N	(%)	n	(%)
Maternal indications				
Obstructive reasons	277	(41)	31	(46)
Obstetric hemorrhage	17	(3)	7	(10)
Previous CS delivery	74	(11)	13	(19)
Multiple maternal indications	62	(9)	3	(4)
Fetal indications				
Non-reassuring FHR	46	(7)	3	(4)
Cord prolapse	2	(0)	1	(1)
Combined (maternal & fetal) indications	110	(16)	0	(0)
Others [†]	86	(13)	10	(15)
Total	674	(100)	68	(100)

Note: CS = caesarean section; HC = health center; FHR = fetal heart rate; [†]Other indications included hypertensive disorders, postmaturity, premature rupture of membranes and oligohydramniotic with contraindications for induction or failure of induction

deliveries (95% CI 0.1 – 3.3). Maternal deaths in the control HCs were not audited due to either documentation or absence of case files.

Assisted vaginal deliveries

Although the educational training program included training in assisted vaginal deliveries, the uptake of this intervention was low. The proportions of assisted vaginal deliveries (by vacuum) during the baseline and intervention periods in the intervention HCs were 0.0% (1) and 0.4% (50). In the control HCs, they were 2.0% (113) and 1.4% (156). There was regular break down and poor maintenance of the vacuum extractors had poor maintenance, broke down regularly and graduates lacked confidence using them.

Uptake of the CEmONC educational and mentoring programs

As a result of knowledge translation and engagement strategies, the Ministry of Health, Community Development, Gender, Elderly and Children used the ASDIT project training curriculum prototype to develop a standardized national competency-based curriculum for emergency obstetric and newborn care (EmONC). The curriculum for EmONC predated the intervention and there were minor enhancements only. The new curriculum is a national document

that is currently used by all stakeholders in the country for training associate clinicians in EmONC. During the project implementation period, the government of Tanzania rehabilitated and constructed other new health centers for CEmONC service provision, increasing the proportion from 12% of 718 in 2015 to 37% of 1,205 in 2020¹¹. Similarly, the Morogoro health management team adopted the ASDIT project mentorship model with clinical audit for maternal deaths.

Discussion

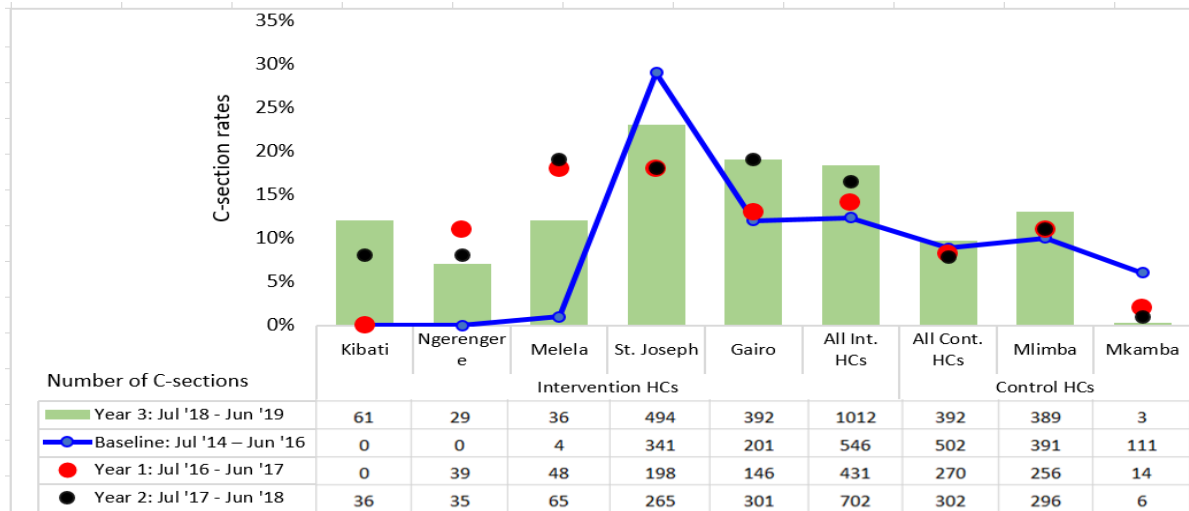
Increasing availability of caesarean section services

Three out of five intervention HCs had caesarean section rates of more than 10%, which is in the range of “met need” for CS in the catchment population. Findings from this study suggest that provision of CS services in underserved rural areas in resource-limited settings is feasible using available human resources for health and with a safe training curriculum that upgrades the skills of associate clinicians, thereby relieving the need to rely on scarce physician resources. These findings strongly suggest that with adequate resources, CS services can be safely expanded in underserved rural Tanzania and in many other Sub-Saharan countries using similar programs.

In line with other studies, at times, some HCs did not provide CS services because they lacked one of the basic requirements for provision of CEmONC, such as blood for transfusions or available anesthetic drugs. In addition, lack of availability of trained care providers was sometimes an issue when they were called away for education or other purposes. Ensuring availability of essential drugs, supplies, equipment and skilled staff is critical for constant provision of CS services. Capacity-building in leadership and management for the heads of the HCs and members of the council health management teams could have contributed to the improvement that was noted later during the implementation of the interventions.

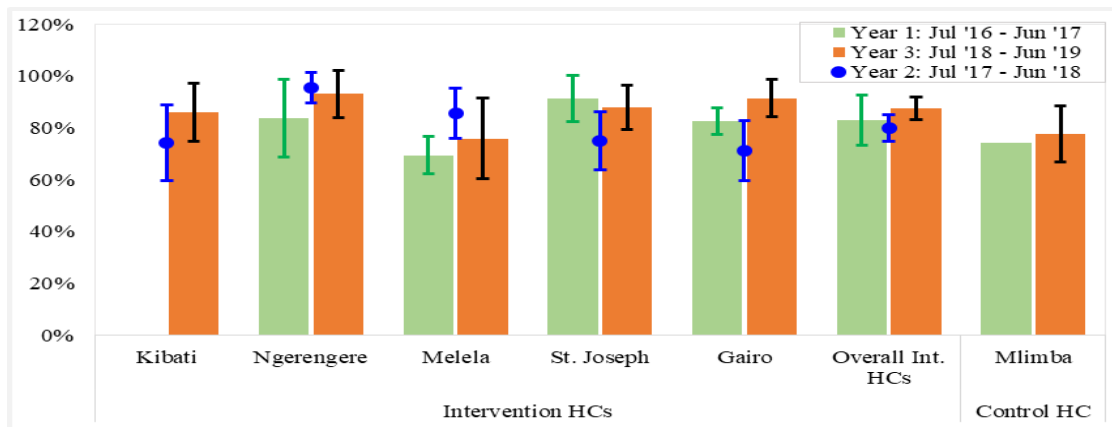
Indications and justifications for caesarean sections

Although caesarean section is an essential life-saving component of delivery care, it carries a risk of complications, resulting in morbidity and



Note: HC = health center, cont. = control, int.= intervention

Figure 2: C-section rates in intervention and control health centers before and during intervention period



Note: HC = health center, cont. = control, int.= intervention

Figure 3: Proportions of C-sections performed with justifiable indications in intervention and control health centers

sometimes mortality. As such, there has been increasing attention on the safety and decision-making process for obstetric surgical interventions. The fact that up to 31% (intervention HCs) and 26% (control HCs) of CSs in year one were performed without justifiable medical indications suggests a need for further education of care providers to strengthen the desirable skills including appropriate management of labour. High population-based CSRs at St. Joseph (38%) and Mlimba HC (26%) in 2019 can be partly explained by increased utilization of services by women from outside the catchment populations and small proportions of CSs performed without justifiable medical indications. Since CS services are needed in underserved areas, expansion should be coupled

with efforts to strengthen decision-making to reduce unnecessary caesarean sections⁵. Appropriate use of instrumental deliveries could also reduce unnecessary CSs performed in the second stage of labour.

Safety of caesarean sections at health centers

The risk of a woman dying from complications of caesarean section in these HCs (i.e., 2.3 per 1,000 caesarean deliveries) was similar to that reported in other rural areas in Tanzania^{12,13}. This risk is significantly lower than the national caesarean section mortality rate of 15 per 1000 caesarean deliveries reported in Sierra Leone in 2016 and 7.9 - 10.9 per 1,000 CS reported in various studies done in low-income countries¹⁴⁻¹⁶. Nevertheless, the risk

of maternal death is many times higher than in high-income countries. For example, it was 0.13 per 1,000 CS (18 times higher) in 1997 in The Netherlands¹⁷. While the relative risk of mortality from complications of caesarean section reported in this study is significant and can be improved, the undocumented risk of maternal and perinatal mortality from poor access to these services in underserved rural areas is likely much higher. These findings reinforce the need to scale up caesarean section services in underserved rural areas while addressing the quality of caesarean sections. The fact that the major causes of maternal deaths related to caesarean section were intraoperative hemorrhage and anesthetic complications calls for dedicated training in the management of these complications and improving availability of blood products¹⁸.

Innovation to accelerate research uptake

Health systems are expected to use research evidence in policy and practice to improve client and system outcomes; however, many interventions that have been proven efficacious through research never make it into clinical practice to improve care and patient outcomes^{19,20}. Innovations to accelerate uptake of efficacious interventions into policy and practice in healthcare systems are urgently needed. The success of uptake reported in this study can be attributed to a wide range of enablers, including the design of the strategies and implementation processes. Involvement of the decision-maker (i.e., GM) as a co-principal investigator was an innovation that accelerated collaboration with district and regional stakeholders to jointly research and develop solutions. Involvement of the Canadian co-PI (JCL) and Canadian team members also added value to research design, training and project evaluation. Sustained comprehensive stakeholder engagement, from proposal development to the implementation, enhanced ownership of findings and contributed to smooth implementation and uptake. Lessons learnt from this study suggest that inclusion of decision makers in the research at all stages carries a potential impact factor in accelerating evidence uptake^{21,22}.

Selection of interventions that addressed the national priorities and policies was also one of the key success factors for the research uptake. The CEmONC educational and mentoring programs

were considered relevant by policy and decision makers at all levels. Policy and decision makers in resource-limited settings are looking for solutions that are relevant and applicable to their local and national priorities. Our findings suggest that research that addresses concerns both locally and nationally can be readily adopted. To ensure uptake of evidence, research should be framed appropriately and tested in relevant contexts using interventions that can be replicated in day-to-day practice²³.

The fact that supportive supervision and mentoring activities took up to three days per health center, uptake of this package of activities may be considered expensive in resource-limited settings and time consuming in a setting with shortage of skilled staff. A full package involved clinical audit of maternal mortality and morbidities, perinatal mortality and C-sections. Although there was evidence of the positive effect of the package, only one component i.e., clinical audit of maternal deaths, was scaled up in Morogoro region because of limited financial and human resources. Intervention costs and other economic factors, as well as shortage of human resources, are barriers to successfully scaling up public health interventions^{24,25}. These findings suggest the need to share intervention costs to improve scaling up processes.

Ethics and permission

Ethics approval was granted by the National Institute for Medical Research (NIMR) of Tanzania with Ref. No. NIMR/HQ/R.8a/Vol.IX/1986, Dalhousie University Institutional Review Board and the Tanzania Commission for Science and Technology (COSTECH) with Ref. No. CST/AD.69/227/2015. Permission to conduct research in these facilities was obtained from the Prime Minister's Office and Local Government. Patient consent was not obtained as this study did not collect identifiable patient data and no author had direct interaction with patients at any point in time. During clinical audits, patients' names were anonymized.

Conclusion

Women and newborns in resource-limited settings should not die of complications of pregnancy and

childbirth because of lack of access to caesarean section services. The three-month training program for associate clinicians in maternal and newborn emergency care is a safe, effective and an immediate solution that is currently saving the lives of mothers and babies in underserved rural Tanzania. Since more CS service providers are needed in low-income countries, these educational and mentoring programs can be used to meet the demand for caesarean section services in remote areas. Selection of interventions addressing the national priorities, active engagement of a range of implementers, including decision makers and use of participatory approaches, constitute the key success factors for research uptake. These findings bear considerable implications for research implementation science, policy and clinical practice change.

Acknowledgements

This work was carried out with the aid of a grant from the Innovating for Maternal and Child Health in Africa initiative- a partnership of Global Affairs Canada (GAC), the Canadian Institutes of Health Research (CIHR) and Canada's International Development Research Center (IDRC).

References

1. WHO, UNFPA, UNICEF and AMDD. Monitoring emergency obstetric care. 2009.
2. WHO. Births by caesarean section. Global Health Observatory data repository. https://apps.who.int/gho/data/node.main.BIRTHSB_YCAESAREAN?lang=en
3. Boerma T, Ronsmans C, Melesse DY, Barros AJ, Barros FC, Juan L, Moller AB, Say L, Hosseinpoor AR, Yi M, de Lyra Rabello Neto D and Temmerman M. Global epidemiology of use of, and disparities in caesarean sections. *Lancet* 2018; 392: 1341-8
4. MOHCDGEC. Mid Term Review of the Health Sector Strategic Plan IV 2015 – 2020, Report, Ministry of Health, Community Development, Gender, Elderly and Children. 2019.
5. Cavallaro FL, Pembe AB, Campbell O, Hanson C, Tripathi V, Wong KL, Radovich E and Benova L. Caesarean section provision and readiness in Tanzania: analysis of cross-sectional surveys of women and health facilities over time. *BMJ open* 2018; 8: e024216
6. WHO. WHO statement on caesarean section rates. 2015.
7. 18th Joint Annual Health Sector Policy Meeting. Joint Policy Commitment for 2018/19. Available: http://www.tzdp.org.or.tz/fileadmin/documents/dpg_in_ternal/dpg_working_groups_clusters/cluster_2/health/JAHSR_2017/Signed_Policy_Commitments24_Jan_2018.pdf.
8. Ministry of Health, Community Development, Gender, Elderly and Children. The national road map strategic plan to improve reproductive, maternal, newborn, child & adolescent health in Tanzania (2016 - 2020). One Plan II.
9. Nyamtema AS, Pemba SK, Mbaruku G, Rutasha FD and van Roosmalen J. Tanzanian lessons in using non-physician clinicians to scale up comprehensive emergency obstetric care in remote and rural areas. *Hum Resour Health* 2011; 9: 28.
10. Crude birth rate in Morogoro region, Tanzania. Available at <https://tanzania.opendataforafrica.org/search?query=crude%20birth%20rate%20in%20morogoro%20in%202015>.
11. CCM. Ilani ya Chama Cha Mapinduzi kwa ajili ya uchaguzi mkuu wa mwaka 2020. 2020.
12. Nyamtema A, Mwakatundu N, Dominico S, Mohamed H, Shayo A, Rumanyika R, Kairuki C, Nzabuhakwa C, Issa O, Lyimo C, Kasiga I and van Roosmalen J. Increasing the availability and quality of caesarean section in Tanzania. *BJOG* 2016: DOI: 10.1111/471-0528.14223.
13. MOHCDGEC. Comprehensive emergency obstetric care services in upgraded health centers. Final report; 2017.
14. Sobhy S, Arroyo-Manzano D, Murugesu N, Karthikeyan G, Kumar V, Kaur I, Fernandez E, Gundabattula SR, Betran AP, Khan K, Zamora J and Thangaratnam S. Maternal and perinatal mortality and complications associated with caesarean section in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet*. 2019; 393: 1973-82.
15. Holmer H, Kamara MM, Bolkan HA, Alex van Duinen A, Conteh S, Forna F, Hailu B, Hansson SR, Koroma AP, Koroma MM, Liljestrang J, Lonnee H, Sesay S and Hagander L. The rate and perioperative mortality of caesarean section in Sierra Leone. *BMJ Global Health* 2019; 4: e001605. doi:10.1136/bmjgh-2019-.
16. Uribe-Leitz T, Jaramillo J, Maurer L, Fu F, Esquivel MM, Gawande AA, Haynes AB and Weiser TG. Variability in Mortality Following Caesarean Delivery, Appendectomy, and Groin Hernia Repair in Low-Income and Middle-Income Countries: A Systematic Review and Analysis of Published Data. *Lancet Global Health* 2016; 4: e165-74.
17. Schuitemaker N, van Roosmalen J, Dekker G, van Dongen P, van Geijn H and Gravenho JB. Maternal mortality after cesarean section in The Netherlands. *Acta Obstet Gynecol Scand*. 1997; 76: 332-4.
18. Dare JA. Making caesarean section safer for African mothers. *Lancet Global Health* 2019; 7: e402-e3.
19. Melnyk BM, Bullock T, McGrath J, Jacobson D, Kelly S and Baba L. Translating the evidence-based NICU COPE program for parents of premature infants into clinical practice: impact on nurses' evidence-based practice and lessons learned. *J Perinat Neonatal Nurs* 2010; 24: 74-80 doi: 10.1097/JPN.0b013e3181ce314b

20. Curtis K, Fry M, Shaban RZ and Considine J. Translating research findings to clinical nursing practice. *JCN* 2016; 26: 862-72.
21. Milat AJ, Bauman A and Redman S. Narrative review of models and success factors for scaling up public health interventions. *Implementation Sci* 2015; 10: 113. <https://doi.org/10.1186/s13012-015-0301-6>.
22. Yost J, Ganann R, Thompson D, Aloweni F, Newman K, Hazzan A, McKibbin A, Dobbins M and Ciliska D. The effectiveness of knowledge translation interventions for promoting evidence-informed decision-making among nurses in tertiary care: a systematic review and meta-analysis. *Implement Sci* 2015; 10: 98. doi: 10.1186/s13012-015-0286-1.
23. Haines A and Donald A. Making better use of research findings. *BMJ* 1998; 317: 72-5 doi: 10.1136/bmj.317.7150.72.
24. Mangham LJ and Hanson K. Scaling up in international health: what are the key issues? *Health Policy Plan* 2010; 25: 85-96.