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Impact of an educational intervention on WHO surgical safety checklist and pre-operative antibiotic use at a referral hospital in southwestern Uganda

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Abstract

Introduction: The World Health Organization (WHO) recommends adherence to its surgical safety checklist (SSC) to optimize patient safety and reduce cesarean surgical site infection (SSI). Educational interventions combined with audit and feedback mechanisms on the checklist use by clinicians have the potential to improve adherence and clinical outcomes. Despite the increase in cesarean delivery rates, there is a paucity of data on how such interventions can improve adherence in resource-limited settings.

Objective: We performed a quality improvement project to measure the impact of an educational intervention with daily audit and feedback procedures on rates of WHO SSC adherence, including pre-operative antibiotic administration and SSI at Mbarara Regional Referral Hospital maternity ward in Uganda.

Methods: The study involved chart abstraction of WHO SSC and pre-operative antibiotic use during cesarean deliveries and signs of subsequent SSI in three phases. First, we conducted a retrospective review of all charts from May to June 2018 (pre-intervention phase). Second, we instituted an educational intervention on the WHO SSC and pre-operative antibiotics use, followed by a daily audit of charts and feedback to clinicians from July to August 2018 (the intervention phase). Third, we reviewed charts from September to October 2018 (the post-intervention phase). The WHO SSC adherence, pre-operative antibiotic administration and SSI rates were measured as the proportion of the total cesarean deliveries per study phase and then compared across the three phases.

Results: We reviewed 678 patients' charts (200 in the pre-intervention phase, 230 in the intervention phase and 248 in the post-intervention phase). The mean patient age was 25 years. The use of the WHO SSC was 7% in the pre-intervention phase compared to 92% in the intervention phase ($P < 0.001$), and 77% in the post-intervention phase ($P < 0.001$). Pre-intervention antibiotic receipt

was 18% compared to 90% in the intervention phase ($P < 0.001$) and 84% in the post-intervention phase ($P < 0.001$). The documented SSI rate in the pre-intervention phase was 15% compared to 7% in the intervention phase ($P = 0.02$) and 11% in the post-intervention phase ($P = 0.20$).
Conclusions: An educational intervention, daily audit and feedback to clinicians increased the use of the WHO SSC and prophylactic antibiotics for cesarean delivery—although the rates waned with time. Research to understand factors influencing the checklist use and antibiotic prophylaxis including prescriber knowledge, motivation and clinical process is required. Implementation interventions to sustain usage and impact on clinical outcomes need to be explored.

Key words: WHO checklist, educational intervention, audit and feedback, impact, preoperative antibiotics, Mbarara, Uganda

Introduction

Surgical procedures can pose a considerable risk to patients and without appropriate safety measures have the potential for complications, thus potentially compromising patient outcomes [1]. Cesarean delivery remains the most common major surgical procedure performed globally [2]. Postpartum surgical site infections (SSIs) and wound infections are some of the most common complications of cesarean deliveries [3]. Compared to vaginal delivery, cesarean delivery carries a 5- to 20-fold greater risk of postpartum sepsis [4]. Cephalosporins and penicillin are used for cesarean delivery prophylaxis to reduce the incidence of SSI and improve clinical outcomes [5]. SSI prevention is a vital target for quality improvement (QI) projects and the safety of women undergoing cesarean delivery [6]. Moreover, adherence to antibiotic prophylaxis and infection control guidelines reduces postpartum SSIs [4, 7, 8].

In 2008, the World Health Organization (WHO) developed the surgical safety checklist (SSC) comprising of three parts: (i) before induction of anesthesia, (ii) before skin incision and (iii) before the patient leaves the operating room. The three parts of the checklist make up a total of 19 individual items. The WHO SSC is a perioperative communication and safety tool to improve adherence with basic standards, including the use of preoperative antibiotics and instrument counts [9]. Implementation of the WHO SSC also improved perceptions of surgical safety by the surgical care teams [10]. SSC may substantially reduce the rate of surgical complications such as SSIs from 11.0 to 7.0% [11]. Despite global acceptance and perceived benefits, adherence to WHO SSC in some places is as low as 18% [12, 13]. Barriers to SSC adherence include confusion regarding the proper use of the SSC, pragmatic challenges to efficient workflow, access to resources and individual staff beliefs and attitudes [14–16]. Hierarchical relationships more especially in the low-income settings coupled with introduction of a WHO SSC in a setting characterized by the absence of accountability and transparency could also lead to failure to optimally implement the use of the checklist [17].

Team-based approaches and ongoing regular mentorship centered around the use of the WHO checklist improves its uptake and sustainability [18]. Interventions need to be focused to facility context and investment in teamwork, communication among the team members, corporate learning and improved leadership involvement help to create a receptive environment for successful implementation of initiatives such as the WHO SSC [19]. Education combined with clinical practice audit and feedback mechanisms also have the potential to modify healthcare workers' behavior including SSC use and prophylactic antibiotics administration [20]. Audit and feedback is any summary of clinical performance of health care providers over a specified period of time with the objective of providing information to health care providers, thus allowing them to assess and adjust their performance [21]. Data feedback sessions have the potential to optimize the Hawthorne effect—that is, they may improve clinicians' performance when they become aware of being under observation and audit [22]. QI projects employ audit and feedback sessions for performance evaluation that lead to actionable practices and workflow adjustments [23]. Thus far, few studies have reported viable solutions to achieve basic standards of surgical care, such as SSC in resource-limited settings [24].

In this study, we leveraged the WHO SSC to improve surgical safety and pre-operative antibiotic administration with the goal of improving clinical outcomes. We designed and implemented a combined intervention of an educational lecture combined with daily chart audit and feedback sessions at a regional referral hospital of southwestern Uganda. The objective of the study was to perform a QI project to measure the impact of an educational intervention with daily audit and feedback procedures on rates of WHO SSC adherence, including pre-operative antibiotic administration and SSI at Mbarara Regional Referral Hospital maternity ward in Uganda.

Methods and materials

Study site and design

The intervention was implemented in the Department of Obstetrics and Gynecology at Mbarara Regional Referral Hospital (MRRH), a teaching hospital for Mbarara University of Science and Technology (MUST) with a catchment area of nine million people. The maternity ward performs ∼9200 deliveries annually, with a 40% cesarean delivery rate. Approximately 15% of women are referred from peripheral health facilities.

QI initiative

In 2017, the MRRH Department of Obstetrics and Gynecology established a multi-disciplinary QI committee with the mandate of identifying and trouble-shooting departmental challenges affecting the quality of care and patient safety. The committee includes consultant obstetricians, head midwives, postgraduate trainees and data managers. This organizational structure and leadership forms the basis for an integrated QI culture within the department. Monthly committee meetings are held by the multi-disciplinary leadership team. In addition, there is dedicated time in the departmental agenda for weekly department-wide QI meetings where system challenges are raised and discussed by all department members. In 2018, infection control was identified as a high-priority area for the committee due to high SSI rates, and the high contribution of sepsis to maternal mortality in the department [25]. The QI project designed to target infection control to reduce SSI rates. The

interventions employed were (i) educational intervention and (ii) audit and feedback on the WHO SSC use and pre-operative antibiotic administration.

The MRRH administration routinely provides printouts of WHO SSC and pre-operative antibiotics. MRRH has been using the checklist for almost 10 years. The attending operating theatre nurse designated as being responsible for ensuring completeness of the checklist initiates the WHO SSC. The midwife or resident physician who prepares the woman for cesarean delivery administers pre-operative antibiotics at least 30–60 minutes before the incision is made on the skin.

Sample size

The sample size was not determined a priori. We considered all the charts of the mothers that underwent cesarean section during the study period.

Study procedure

This QI project was divided into three phases: pre-intervention phase (retrospective chart review), intervention phase (educational intervention, audit and feedback and prospective chart review) and post-intervention phase (prospective chart review).

Pre-intervention phase (retrospective cohort design)

Medical records of women undergoing cesarean delivery between May and June 2018 were retrieved. Trained midwives audited women's charts to assess for WHO SSC documentation, including pre-operative antibiotic administration, and SSI following cesarean delivery.

A WHO SSC was considered complete if all the three parts of the checklist (before induction of anesthesia, before skin incision and before the patient leaves the operating room) were fully filled. To evaluate pre-operative antibiotic administration, chart reviewers abstracted information for both written prescription and evidence of antibiotic administration in the treatment sheet. If a woman had chorioamnionitis, she received treatment with gentamicin and ampicillin.

In the chart of every mother, it is routine practice to write about the status of the cesarean wound on every review. There was documentation of the wound appearance in all of the charts abstracted. SSI was defined as present if any of the following were documented in the chart: localized infection signs including redness, heat or swelling at the incision site, draining pus, abscess, fever with wound tenderness or separation of the incision edges exposing deeper tissues. We included any SSI during the index cesarean delivery admission.

Intervention phase (prospective cohort design)

This phase began July 2nd, 2018 with a single 105 minute educational intervention lecture, given to the Obstetrics/Gynecology and Anesthesia departments by the author (J.N.) at a weekly QI meeting organized by the MRRH QI committee. The lecture covered SSIs (definitions and diagnoses), importance of the WHO SSC for patient outcomes, prophylactic antibiotic use for cesarean delivery, other infection control strategies including alcohol-based disinfectant solutions, post-operative antibiotic stewardship and the plan for daily chart audit for cesarean deliveries. The role of multi-disciplinary team education, WHO SSC training, the importance of team leadership, ongoing feedback and identifying local champions were extensively discussed. The session also included a dialog about the roles and responsibilities regarding the WHO SSC and pre-operative antibiotic administration, including selection of QI champions; these individuals conducted chart audits for all cesarean deliveries daily and gave feedback during the intervention phase (July to August) to the clinical team on WHO SSC use and completeness, including pre-operative antibiotic administration.

Post-intervention phase (prospective cohort design)

To assess intervention sustainability, chart audits were continued prospectively from September to October 2018 for women undergoing cesarean delivery.

Statistical analysis

The two primary outcomes were the proportion of WHO SSC completed and the proportion of women administered with pre-operative antibiotics. These proportions were calculated as the number of completed WHO SSCs and number of charts with documented evidence in the treatment sheet of pre-operative antibiotic administration divided by the total number of cesarean deliveries performed. The secondary outcome was in-hospital SSI. The proportion of women with incident SSI in each of the three phases was calculated as a proportion of the women with chart-documented signs of SSI divided by the total number of cesarean deliveries performed in each phase. The exposure variable of interest was the two-component intervention of education and chart audit feedback sessions. The chi-squared statistic was used to compare the frequency of outcomes before, during and post-intervention periods. $P < 0.05$ was considered statistically significant.

Ethical consideration

Ethics approval for retrospective chart review, prospective chart audits and QI interventions was obtained from the MUST Research Ethics Committee (09/05-17) and Partners IRB (2019P003781).

Results

Summary of chart review, patient and clinician characteristics

A total of 58 healthcare workers from the departments of obstetrics (48) and anesthesia (10) attended the educational lecture (intervention). All 200 charts for cesarean deliveries during the pre-intervention phase were retrieved from the records department (Figure 1). The average length of stay on the ward by the participants was 4 (±2.9) days. During the intervention phase, 230 cesarean delivery charts were prospectively reviewed and 248 charts in the post-intervention phase. In total, 678 cesarean charts were reviewed between May and October 2018. These represent all the charts for the cesarean deliveries during the study period. In phase one, these charts were retrieved from the records department, while in phases two and three the charts were retrieved from the postnatal ward daily. Mean patient age was 25.3 years and 83% were married (Table 1). The majority of the women were multiparous (43.4%). Cesarean delivery was considered emergent for (95.1%) and 96.8% delivered live births.

Use of the WHO checklist and pre-operative antibiotics (Table 2 and Figure 2)

The rate of WHO SSC use increased from 6.5% in the pre-intervention phase to 91.7% in the intervention phase ($P < 0.001$).

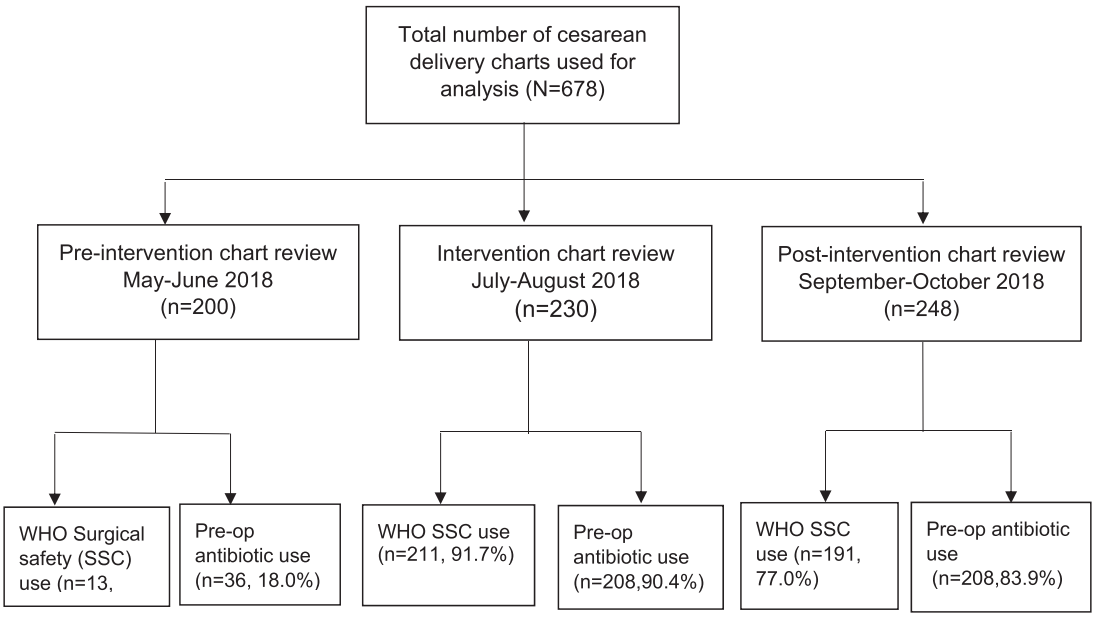

Figure 1 Chart review by study phase of educational intervention on WHO surgical safety checklist use and pre-operative antibiotic administration at a regional referral and teaching hospital in southwestern Uganda (2018).

Table 1 Sociodemographic and obstetric profiles of women undergoing cesarean delivery before, during and after promoting WHO SSC use and pre-operative antibiotic use at regional referral and teaching hospital in southwestern Uganda (2018)

Characteristics	Total ($n = 678$)	Pre-intervention ($n = 200$)	Intervention ($n = 230$)	Post-intervention ($n = 248$)
Age				
14–19	100 (14.7)	27 (13.5)	34 (14.8)	39 (15.7)
20–24	237 (35.0)	64 (32.0)	75 (32.6)	98 (39.5)
25–34	286 (42.2)	90 (45)	102 (44.3)	94 (37.9)
35–49	55 (8.1)	19 (9.5)	19 (8.3)	17 (6.9)
Parity				
Primipara	291 (42.9)	86 (43.0)	100 (43.5)	105 (42.3)
Multipara	294 (43.4)	95 (47.5)	98 (42.6)	101 (40.7)
Grand multípara	93 (13.7)	19 (9.5)	32 (13.9)	42 (16.9)
Marital status				
Married	562 (82.9)	166 (83.0)	194 (84.4)	202 (81.5)
Cesarean delivery				
Emergent	645 (95.1)	185 (92.5)	223 (97.4)	242 (97.6)
Fetal outcome				
Live birth	656 (96.8)	194 (97.0)	225 (97.8)	237 (95.6)
Residence				
Rural	490 (72.3)	139 (69.5)	166 (72.2)	185 (74.6)

All values indicate the number (percent) of women with each characteristic.

The use of the pre-operative antibiotics for cesarean delivery increased from 18% in the pre-intervention phase to 90.4% during the intervention phase ($P < 0.001$). From the intervention phase to the post-intervention, the use of the checklist decreased from 91.7% to 77.0% ($P < 0.001$) and pre-operative antibiotic use decreased from 90.4% to 83.9% ($P = 0.033$).

SSI rates

The rate of SSI was 14.5% before the intervention was introduced and declined to 7.4% during the intervention phase ($P = 0.017$). The rate increased to 10.5% during the post-intervention period ($P = 0.198$).

The pre-operative antibiotics used for cesarean delivery

During the study, the most commonly administered pre-operative antibiotics were ampicillin (431, 63.6%), ampiclox (216, 31.9%), ceftriaxone (21, 3.1%) and benzyl penicillin (10, 1.5%). Thus, penicillin was the most common antibiotic class (657, 96.9%).

Discussion

Statement of principal findings

The use of the WHO SSC, including pre-operative antibiotic administration for cesarean deliveries, increased markedly following the

Table 2 Comparison of WHO SSC completion, pre-operative antibiotic administration and SSI rates in the pre-intervention and intervention phases; pre- and post- intervention and intervention and post-intervention phases

Outcomes	Pre-intervention, $n = 200$ (%) vs intervention, $n = 230$ (%)	Pre-intervention, $n = 200$ (%) vs. Post-intervention $n = 248$ (%)	Intervention, $n = 230$ (%) vs post-intervention, $n = 248$%)
WHO SSC completion	13 (6.5), 211 (91.7)	13 (6.5), 191 (77.0)	211 (91.7), 191 (77.0)
P-value	*<0.001*	*<0.001*	*<0.001*
Pre-operative antibiotic administration	36 (18.0), 208 (90.4)	36 (18.0), 208 (83.9)	208 (90.4), 208 (83.9)
P-value	*<0.001*	*<0.001*	*0.033*
Presence of SSI	29 (14.5), 17 (7.4)	29 (14.5), 26 (10.5)	17 (7.4), 26 (10.5)
P-value	*0.017*	*0.198*	*0.238*

WHO SSC–World Health Organization Surgical Safety Checklist; vs–versus; *P*–value–probability value which shows the level of statistical significance.

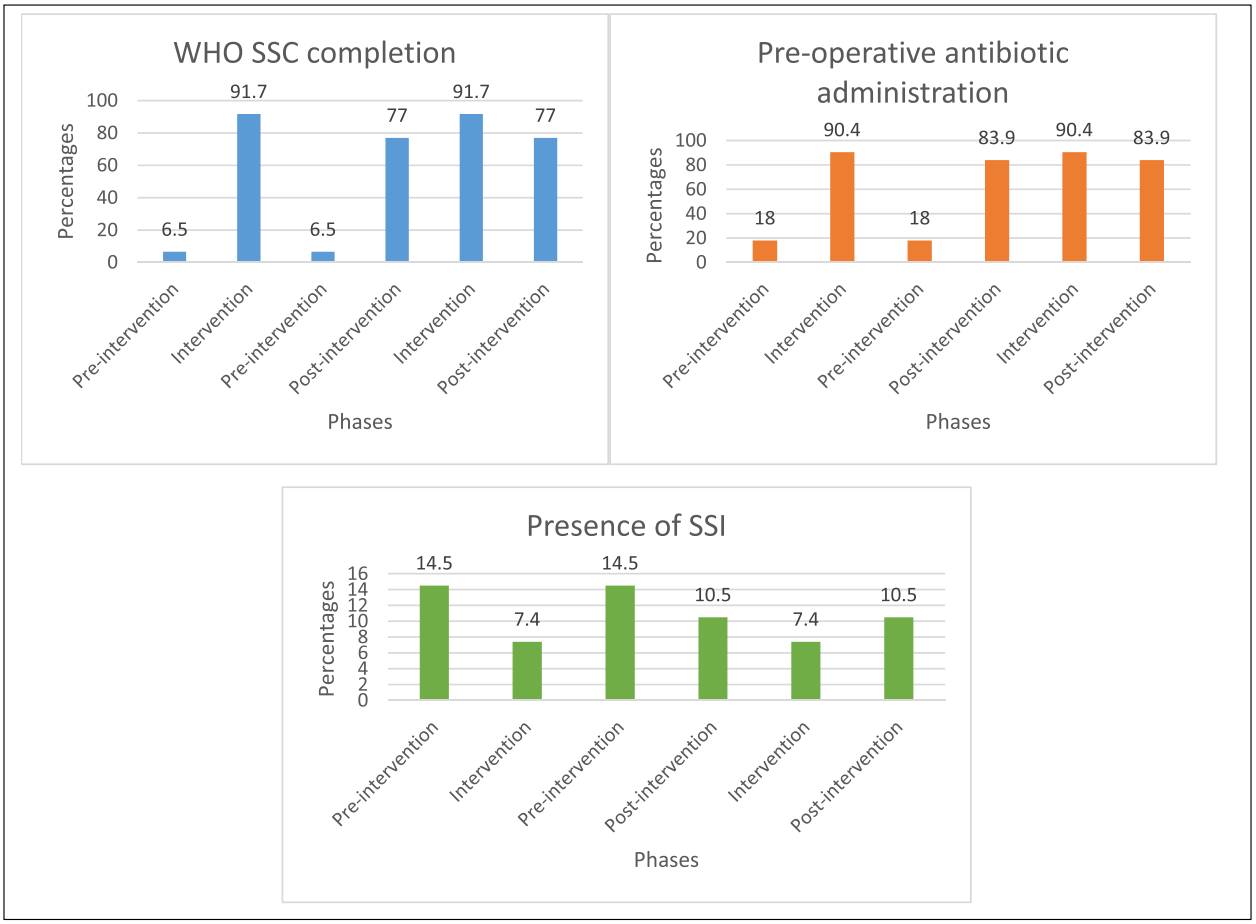

Figure 2 Rates of WHO SSC completion, pre-operative antibiotic administration and presence of SSI before, during and post-intervention period at Mbarara Regional Referral Hospital.

intervention of an educational lecture combined with daily cesarean chart audit and feedback to the clinical team. However, in the 2 months' post-intervention phase where a daily audit of the mothers' charts and feedback to the clinical team ceased, the rates of use of the checklist and antibiotic prescription and administration subsequently decreased. The rates of occurrence of the signs and symptoms of SSIs also significantly reduced when the intervention was instituted but the SSI rates increased after the intervention phase during the post-intervention phase.

Study strengths

The strength of the study was premised on the fact that improvement in the quality of care offered to women undergoing cesarean delivery leads to improved clinical outcomes. The study was able to reveal the compliance rates to the checklist use during the pre-intervention, intervention and post-intervention phases. It also provided baseline information for future implementation strategies to sustainably increase the use of the checklist and pre-operative antibiotics for cesarean deliveries.

Study limitations

First, we used a historical cohort design and may not have captured the impact of secular trends in the checklist and antibiotic prescription. However, as the historical cohort was assessed in the same year in the same hospital with same staff, we expect minimal bias from this regard. Second, the chart review may have been incomplete and not correlated with what was actually done. For instance, it is also possible that the infection rate may have been higher than what was documented. Data collection was also restricted to in-hospital cesarean surgical wound complications. Measurement of SSI up to 30 days post-cesarean section is recommended to ascertain the full extent of surgical wound infections, yet was beyond the scope of our study [26]. We did not study the implementation dynamics of the intervention and this study was not designed to comment on the causality of the WHO checklist and pre-operative antibiotic use and SSI. It is hypothetically possible that other ongoing interventions such as improvement in other infection prevention practices, such as handwashing, surgical scrub and surgical site disinfection also contributed to observed changes in the SSI rate.

Interpretation within the context of the wider literature

Continuous education, feedback and review of QI processes have been found to greatly impact acceptance and adherence of the users of SSC in resource rich settings [27, 28]. The WHO also emphasizes that multidisciplinary clinical team education and training are crucial for successful checklist use [29]. There is evidence to show that audit of clinical processes and feedback to the clinical teams and individuals improves the performance and adherence to protocol-based care among the healthcare providers and the scope for improvement is greatest in those areas where the existing practice is furthest away from what is desired [23]. Proper intervention and dissemination strategy of the WHO SSC increases adherence and use of the checklist in many settings [27, 30, 31].

The increased use of the checklist could have been a result of the Hawthorne effect where the clinicians were aware that they were under observation and therefore wanted to show their best behavior in providing care according to the prescribed guidelines [32]. Feedback processes to clinicians about particular interventions aimed at improving quality of healthcare delivery results in improved patient outcomes and the absence of such interventions may cause the clinicians to forget some important steps in the delivery of QI processes and leading to poor clinical outcomes [33]. The WHO SSC implementation is however consistently associated with decreased surgical complications such as SSIs [11, 16]. The return to near baseline rates in the use of the WHO checklist and preoperative antibiotics use likely occurred due to cessation of the feedback and audit processes. It is possible that with continued feedback, the high rates of use observed during the intervention period may have been maintained or further improved. However, new strategies will be needed to allow the continuing use of routine feedback to providers given the cost and resource implications of ongoing audit and feedback. *Implications for policy, practice and research:* Maternal and newborn outcomes such as mortality and neonatal sepsis would be important to ascertain. Additionally, the duration of the phases was limited to 2 months. Further changes in behavior may have occurred as time since the intervention increased, thus calling for longer-term studies. Finally, qualitative interviews of clinicians to capture implementation facilitators and barriers to understanding of the factors that contributed to success or failure of intervention components would be informative for adapting of the intervention in new health facility settings.

Conclusions

Education combined with daily audit and feedback to clinical care teams can improve substantially the use of the WHO SSC and prophylactic antibiotics for cesarean delivery which seems sustainable in the short term. Further studies need to assess long-term adherence and determinants to long-term adherence have to be assessed and impact on other outcomes as maternal and perinatal mortality.

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Contributorship

J.N. conceptualized the research idea, collected and analyzed data, drafted the manuscript and participated in critical revisions. L.M.B. conceptualized the research idea, collected and analyzed data, drafted the manuscript and participated in critical revisions. A.A.B. conceptualized the research idea and participated in critical revisions. A.O. conceptualized the research idea and participated in critical revisions. L.T. participated in data analysis and critical manuscript revisions. Y.F. participated in data analysis and critical manuscript revisions. Y.J. participated in data analysis and critical manuscript revisions. H.M.L. participated in data analysis and critical manuscript revisions. B.J.W. conceptualized the research idea and participated in critical manuscript revisions. Y.J. conceptualized the research idea, participated in data analysis and critical manuscript revisions. C.O. conceptualized the research idea and participated in critical manuscript revisions. J.E.H. conceptualized the research idea and participated in critical revisions. J.P.Vg. conceptualized the research idea and participated in critical revisions. We confirm that all authors have read and approved the final version of the manuscript.

Ethics and other permissions

Ethics approval for retrospective chart review, prospective chart audits and QI interventions was obtained from the MUST Research Ethics Committee (09/05-17) and Partners IRB (2019P003781).

Data availability statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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