Reducing the rate of post-cesarean surgical site infections at Remera Rukoma Hospital: a quality improvement analysis using PDSA and fishbone diagram

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ABSTRACT

Surgical site infections (SSIs) following cesarean sections (CS) are a significant global health concern, with varying prevalence rates across regions. At Remera Rukoma Hospital in Rwanda, the CS infection rate was 2.025% from July to December 2023, prompting a quality improvement project to reduce it to 1% by June 2024. The hospital's target of a 1% surgical site infection rate for cesarean sections aligns with World Health Organization standards, positioning it as a potential regional leader in infection control while significantly improving patient safety and maternal health outcomes.

The project utilized a comprehensive approach, employing the Fishbone diagram to identify root causes across patient, surgical team, and hospital environment factors. Targeted interventions were implemented, including improved pre-operative cleaning, staff training on infection prevention, and enhanced environmental hygiene. Progress was monitored monthly using the Plan-Do-Study-Act cycle.

The project successfully reduced the average CS infection rate to 0.45% from January to June 2024, with four months achieving 0% infection rates. Key factors in this success included strengthened aseptic practices, optimized antibiotic prophylaxis, and improved teamwork. Continuous monitoring, regular staff education, and data-driven improvement cycles are recommended to sustain these positive outcomes.

INTRODUCTION

Surgical site infection (SSI) is one of the most common complications following cesarean section (CS) [1]. A recent World Health Organization (WHO) report highlighted that CS has become increasingly common in both developed and developing countries for a variety of reasons [1-4].

Cesarean section (CS) is the commonest obstetric surgical procedure, its global rates including both emergency and elective range from 5 to 20% and the rates continue to rise in both developed and developing countries [1,5].

Recent systematic reviews and meta-analyses have shown that the estimated global prevalence of post-caesarean surgical site infections is 5.63%

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with the highest prevalence in sub-Saharan Africa (11.91%) and the lowest prevalence in North America (3.87%) [1,6]. C-section site is associated with high maternal morbidity and mortality rate of up to 3% [1]. According to the 2019–20 Rwanda Demographic and Health Survey, 15% of births in Rwanda are delivered by Caesarean section [7]. The Centers for Disease Control and Prevention defines surgical site infection (SSI) as an infection that develops in the surgical site within 30 days of the procedure [1,8].

Despite being one of the most preventable types of healthcare-associated infections, surgical site infections (SSIs) continue to pose a substantial economic challenge to healthcare systems worldwide [6]. Research from various countries demonstrates that SSIs not only lead to considerable financial strain on patients and their families but also significantly diminish the overall quality of life for those affected [6]. SSIs led to unnecessary fatalities and extended hospitalization periods, including ICU stays and hospital readmissions, consequently escalating antimicrobial resistance and long-term disability rates [9].

Adherence to fundamental practices like proper hand hygiene, skin preparation, appropriate antibiotic use, minimally invasive techniques, shorter surgeries, better hemostasis, and temperature regulation can potentially prevent half of all surgical site infections [6]. Women who did not receive prophylactic antibiotics (35.5%) developed SSI more often than those who did ($P < 0.0001$) [5]. These findings suggest that emergency C-sections and inappropriate antibiotic prophylaxis are risk factors for developing SSI [5]. The development of SSI is associated with many factors rather than one factor [1]. Additionally, infection occurring after delivery may lead to substantial physical and emotional burdens on the mother and to a significant financial burden on the health care system [10].

Remera Rukoma Hospital is a district hospital in Kamonyi district, Rwanda, serving a large population and performing a significant number of cesarean deliveries with an average of 12 deliveries and 5 C-sections per day. Despite advances in surgical techniques and infection control measures, the hospital continues to experience an alarmingly high rate of surgical site infections (SSIs) among women undergoing Cesarean sections at Remera Rukoma Hospital, in fiscal year 2022-2023 C-section infection rate was 1.7%, from July to December 2023 C-section infection rate was 2.025%, presents a critical healthcare challenge that demands immediate attention. This elevated rate not only poses a significant threat to patient safety and well-being, potentially leading to prolonged recovery times, increased pain, and life-threatening complications for mothers and newborns but also places a substantial burden on the hospital's limited healthcare resources. The increased need for extended hospital stays, additional treatments, and potential readmissions strains both medical supplies and staff capacity.
Furthermore, this high SSI rate negatively impacts the hospital's reputation within the community, potentially eroding trust in its maternity services. The situation also raises concerns about the overall quality of care, suggesting possible gaps in infection prevention protocols, surgical techniques, or post-operative care practices. Addressing this issue is crucial for improving immediate patient outcomes and mitigating long-term health consequences, reducing the socioeconomic impact on families, and upholding the hospital's commitment to providing high-quality maternal healthcare services. This project's target was to reduce the surgical site infection rate among the mothers who underwent C-sections at RRH from 2.025% in January to 1% on 30 June 2024. This target is particularly significant as it aligns with global health standards. The World Health Organization recommends that SSI rates following cesarean sections in low- and middle-income countries should be below 5%, with rates of 1-2% considered excellent benchmarks for quality care [11]. Achieving a 1% infection rate would not only enhance patient safety and reduce maternal morbidity at Remera Rukoma Hospital but also position it as a regional leader in infection control, potentially influencing healthcare practices across Rwanda and East Africa.

Comprehensive Problem Analysis

Reducing the C-section surgical site infection rates at Remera Rukoma Hospital utilizes a comprehensive approach, employing the Fishbone (Ishikawa) diagram method to identify root causes across three main categories [12]. Patient Factors, Surgical Team Factors, and Hospital Environment

Factors. Patient Factors contributing to the high SSI rate included inadequate pre-operative preparation, such as poor abdominal washing and insufficient vaginal cleaning for women in labor. Prior to intervention, patients were not consistently educated about proper hygiene practices, and there was no clear protocol to separate mothers with infected wounds from those scheduled for C-sections, leading to increased infection risks. During the "Do" phase of the PDSA cycle, educational sessions were introduced to improve patients' awareness of hygiene practices, and stricter pre-operative protocols were implemented, ensuring better abdominal and vaginal cleaning. Additionally, mothers with infections were isolated from those undergoing surgery, minimizing cross-contamination risks.

Surgical Team Factors reveal several critical issues, including non-adherence to guidelines for prophylactic antibiotic administration, inadequate decontamination procedures in the operating room, insufficient patient transfer equipment, and improper use of personal protective equipment (PPE). Prior to intervention, there was inconsistent compliance with antibiotic timing protocols and decontamination processes, and staff were not fully trained on proper PPE use or IPC (Infection Prevention and Control) practices. During the "Do" phase of the PDSA cycle, targeted interventions were implemented: surgical staff were retrained on IPC protocols, with specific focus on timely antibiotic administration and proper PPE usage. Decontamination procedures were standardized, and new patient transfer equipment was procured to ensure safe and sterile transfers. These changes aimed to bridge the knowledge gap and improve adherence to IPC practices across the surgical team.

Hospital Environment Factors contributing to elevated SSI rates include poor patient bed hygiene, inadequate cleaning of the operating room, the presence of antibiotic-resistant bacteria, and overcrowding. Before interventions, bed hygiene protocols were inconsistent, operating room cleaning lacked standardization, and overcrowding was common, making infection control difficult. In the "Do" phase of the PDSA cycle, several corrective actions were implemented: enhanced cleaning protocols for patient beds and operating rooms were introduced, focusing on high-touch areas and using disinfectants effective against resistant bacteria. Additionally, bed spacing was adjusted to reduce overcrowding where possible, and hospital staff were retrained on the importance of maintaining these new standards to control the spread of infection. These steps were crucial in addressing the environmental root causes of SSIs.

METHODS

To address these root causes, the quality improvement analysis project involved a series of targeted interventions, applied systematically through the Plan-Do-Study-Act (PDSA) cycle. This process was enhanced by mentorship from the USAID-Tubeho team from JHPIEGO, who guided the hospital team on infection prevention and control (IPC) practices, gap identification, intervention design, and effectiveness monitoring. During the "Plan" phase, root causes of SSIs were identified using Fishbone diagram analysis, and specific interventions were designed for each category. Importantly, feedback mechanisms were established to gather insights from both internal (staff) and external (patients) stakeholders, ensuring a comprehensive understanding of the challenges and potential solutions.
Patient-focused actions included introducing thorough pre-operative cleaning protocols, with an emphasis on abdominal washing and vaginal cleaning for women in labor. Patients were also educated on proper hygiene practices, and infected mothers were separated from those scheduled for C-sections to reduce cross-contamination. A patient feedback system was implemented, including post-discharge surveys and follow-up calls, to gather insights on their experiences and identify areas for improvement in patient care and education.

For the surgical team, the project focused on reinforcing compliance with prophylactic antibiotic guidelines, improving operating room decontamination procedures, and addressing knowledge gaps through IPC training. Personal protective equipment (PPE) availability was improved, and staff were trained on its proper use. Regular staff meetings and anonymous suggestion boxes were introduced to encourage open communication and gather feedback on the implementation of new protocols and potential challenges faced by the team.

In the "Do" phase, these interventions were rolled out: enhanced operating room cleaning procedures were implemented, focusing on high-touch surfaces and disinfectants targeting antibiotic-resistant bacteria. Regular IPC training sessions were conducted for the surgical team to ensure adherence to updated protocols. The hospital environment was improved by standardizing patient bed hygiene and addressing overcrowding in the maternity wards by reorganizing patient flow. Bacterial cultures were performed to guide targeted treatment, and efforts to expand maternity facilities were initiated to reduce patient congestion.

Throughout this phase, continuous feedback was solicited from both staff and patients. Staff were encouraged to report any difficulties in implementing new procedures or suggestions for improvement through regular team huddles and a dedicated feedback channel. Patients were interviewed at various stages of their hospital stay to gather real-time feedback on their care experience and the effectiveness of the new hygiene protocols. Monthly monitoring and data collection followed to track progress, and adjustments were made as necessary to ensure continuous improvement. The data collected included not only infection rates but also staff compliance metrics and patient satisfaction scores, providing a holistic view of the project's impact.

The USAID-Tubeho team from JHPIEGO played a crucial role in this process, providing ongoing mentorship to the hospital team. They assisted in analyzing the feedback received, identifying additional gaps, and refining interventions based on both quantitative data and qualitative feedback from stakeholders. This collaborative approach ensured that the interventions remained responsive to the needs of both staff and patients, while aligning with best practices in IPC.

RESULTS

As illustrated in Figure 1, the increase in infection rates from January to February was likely influenced by several factors identified during the quality improvement analysis. In January, the hospital had just initiated interventions targeting the root causes of surgical site infections (SSIs). Factors such as inadequate pre-operative hygiene practices, gaps in adherence to prophylactic antibiotic administration, and poor operating room cleaning protocols were still being addressed. The high rate of 1.7% in January reflects the initial stages of implementation, where challenges such as staff adaptation to new protocols and procedural changes were still being optimized. However, by February, the interventions—such as stricter adherence to pre-operative cleaning, improved surgical protocols, and enhanced staff training—began to take effect, leading to a significant drop to 0%. This improvement reflects the successful execution of the "Do" phase of the PDSA cycle, where corrective actions were put into place and had a notable impact on infection control.

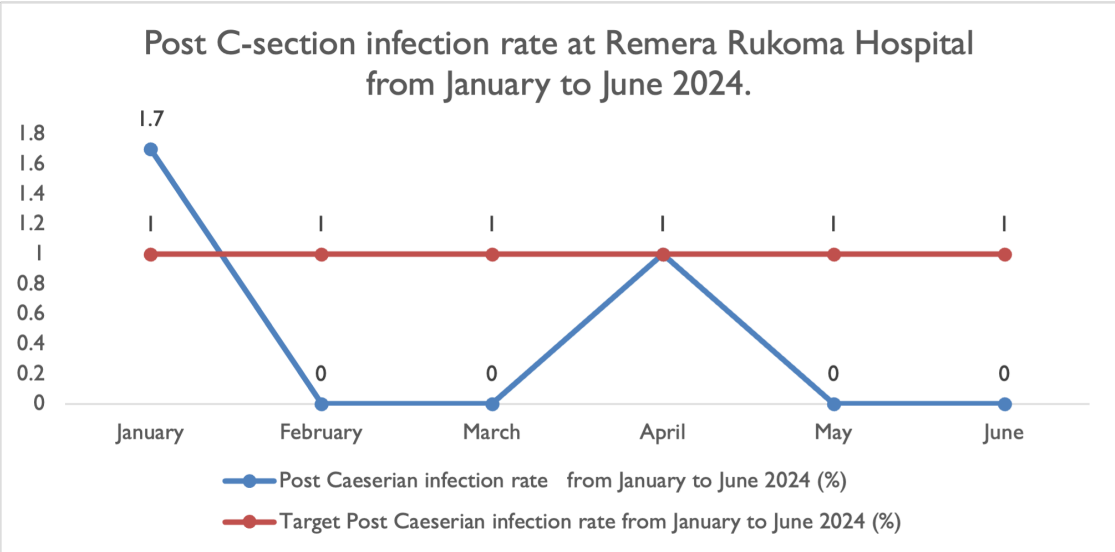

Figure 1: *Trends in C-section infections from January to June 2024*

LESSONS LEARNED

The project to reduce C-section surgical site infections at Remera Rukoma Hospital from 2.025% to 1% between January and June 2024 presented a valuable learning opportunity. The average infection rate from January to June 2024 was found to be 0.45%. While the overall goal was to achieve a 1% infection rate, the initial high of 1.7% in January served as a wake-up call, prompting the need for immediate and focused interventions. The success that followed, with 0% infection rates in February and March, strongly suggests the effectiveness of these implemented changes. These interventions likely centred around three key areas.

Strengthened Aseptic Practices: This might have involved improvements in hand hygiene protocols for healthcare staff. This could include more frequent handwashing with soap and water or alcohol-based hand rub, especially before and after glove changes and patient contact. Additionally, meticulous surgical site preparation procedures may have been implemented, ensuring proper skin antisepsis before incision. Furthermore, the project might have emphasized the proper use of sterile equipment throughout C-section procedures to minimize the risk of contamination.

Antibiotic Prophylaxis Optimization: Another area of focus may have been reviewing and potentially revising the guidelines for antibiotic prophylaxis given to C-section patients. This could have involved ensuring appropriate antibiotic selection based on the specific risk factors of each patient, optimizing the timing of administration (often given shortly before the incision), and adhering to proper dosage recommendations. Streamlining these practices likely contributed to a reduction in infections.

Teamwork and Communication: The project's success likely hinged on effective communication and collaboration among surgeons, nurses, and all other healthcare personnel involved in C-section procedures. Regular discussions, clear protocols, and ongoing training on infection control measures would have ensured everyone was on the same page, consistently adhering to best practices to minimize surgical site infections.

Though the project yielded significant learnings and demonstrably positive outcomes, the initial high infection rate of 1.7% in January underscored the critical need for immediate and targeted interventions. The subsequent success in achieving 0% infection rates in February and March strongly suggests the effectiveness of the implemented changes. These improvements likely centered on reinforcing aseptic practices, optimizing antibiotic prophylaxis protocols, and fostering effective teamwork and communication among healthcare staff. However, the slight rise in infection rate to 1% in April highlights the importance of acknowledging that maintaining a perfect record is an ongoing challenge but also a possible seasonal effect.

WAY FORWARD

While achieving zero C-section surgical site infections in May and June 2024 was a remarkable accomplishment for Remera Rukoma Hospital, it's crucial to recognize the ongoing challenge of maintaining such a perfect patient record. The slight rise to a 1% infection rate in April serves as a reminder that fluctuations can occur. To build upon this success and ensure long-term sustainability, the hospital can implement several key strategies.

Continuous monitoring by establishing a system for ongoing surveillance of C-section infection rates is essential. This allows for early detection of any potential increases, enabling prompt investigation and corrective action. Regular monitoring can involve tracking infection rates by month, department, surgeon, or any other relevant factor to identify areas where additional focus might be needed.

Regular Staff Education and Training: Healthcare personnel involved in C-section procedures require ongoing education and training to reinforce aseptic practices and proper antibiotic use. This can involve regular training sessions focusing on best practices for hand hygiene, meticulous surgical site preparation, and proper sterile equipment handling. Additionally, incorporating refresher courses on antibiotic prophylaxis guidelines can ensure consistent and appropriate antibiotic selection and administration for C-section patients. By prioritizing continuous learning, the hospital can maintain staff vigilance in adhering to infection control protocols.

Data Analysis and Quality Improvement Cycles: Regularly analyzing data on C-section procedures and infection rates is a powerful tool for identifying areas for further improvement. This data can reveal trends, highlight potential weaknesses in protocols, or even suggest opportunities for further optimization. By establishing quality improvement cycles, the hospital can use these insights to refine existing protocols and practices. This might involve implementing changes based on data analysis, monitoring their effectiveness, and then making further adjustments as needed. This cyclical approach allows for continuous improvement and adaptation, ensuring the long-term effectiveness of infection control measures.

To address the reviewer's comment using the Plan-Do-Study-Act (PDSA) method, the project at Remera Rukoma Hospital aimed to reduce C-section surgical site infections (SSIs) to 1% or lower by implementing specific interventions. What are we trying to accomplish? The hospital's goal was to minimize SSIs by addressing issues such as poor hygiene practices, inadequate antibiotic use, and environmental factors like overcrowding. How will we know that a change is an improvement? Success was measured by tracking monthly infection rates, aiming for a sustained reduction to 1% or lower, with regular data collection and analysis to evaluate the effectiveness of each intervention. What changes can we make that will result in an improvement? Key changes included improving pre-operative hygiene procedures for patients, enforcing adherence to antibiotic prophylaxis guidelines, enhancing operating room sterilization, and offering continuous staff training on infection prevention protocols. These steps were implemented systematically, with ongoing monitoring and adjustments based on infection rate data, leading to the hospital's ability to meet or exceed its targets in most months.

CONCLUSION

The Remera Rukoma Hospital's project to reduce C-section surgical site infections (SSIs) demonstrates a successful implementation of the PDSA cycle. In the Planning phase, the team identified the need to reduce SSI rates and designed interventions focusing on aseptic practices and antibiotic prophylaxis. The Do phase involved implementing these interventions, resulting in a 0% infection rate in February and March. The Study phase revealed these positive outcomes but also highlighted a slight increase in April, prompting further analysis. In the Act phase, the team is now refining protocols based on these findings, emphasizing the need for ongoing vigilance and continuous improvement.

This project showcases the power of multidisciplinary collaboration between medical doctors, nurses, anesthesiologists, infection control practitioners, quality improvements officer, cleaning personnels, laboratory technicians, and hospital administrators. Their collective efforts focused on standardizing pre-operative preparation, optimizing antibiotic timing, enhancing intra-operative sterile techniques, and improving post-operative wound care. This collaboration extended to creating and implementing new protocols, conducting training sessions, and establishing a culture of open communication for reporting and addressing potential infection risks. By working together, the team was able to leverage diverse expertise, ensuring a comprehensive approach to SSI prevention.

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