# Strengthening surveillance and prevention of healthcare-associated infections among mothers undergoing Caesarean sections in Ugandan hospitals and communities.

**CDC HAI PROJECT**
**TECHNICAL REPORT**

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# CONTENTS

# FOREWORD

The burden of healthcare-associated infections (HAIs) remains a significant public health challenge in Uganda, contributing to preventable morbidity, prolonged hospital stays, antimicrobial resistance, and increased healthcare costs. In line with the Ministry of Health's commitment to improving clinical care and safeguarding maternal health, the establishment of a national surgical site infection surveillance program marks a major milestone in strengthening infection prevention and control and enhancing health system resilience.

This first technical report presents the findings, lessons learned, and implementation experiences from the pilot phase of the Caesarean Section SSI Surveillance Program across three regional referral hospitals. It highlights efforts to develop and institutionalize a robust surveillance framework that not only generates actionable data but also empowers frontline health workers to implement quality improvement interventions informed by evidence.

We commend the dedication and collaboration of the Ministry of Health, the Infectious Diseases Institute (IDI), regional referral hospital staff, and the U.S. Centers for Disease Control and Prevention (CDC) in operationalizing this program. Their collective efforts have strengthened capacity for routine surveillance, data-driven decision-making, and root cause analysis, laying a foundation for scale-up and integration within national quality of care and patient safety initiatives.

As we move forward, this report serves both as a record of progress and a call to action for all stakeholders to support the expansion and sustainability of HAI surveillance across Ugandan hospitals. Together, we can improve clinical outcomes, reduce HAIs, and protect the lives of mothers and newborns nationwide.

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## ACRONYMS & ABBREVIATIONS

| | |
|---|---|
| AMR | Antimicrobial resistance |
| ASA | American Society of Anesthesiologists |
| AST | Antimicrobial susceptibility testing |
| AWaRe | Access, watch, reserve |
| CDC | U.S. Centers for Disease Control and Prevention |
| CQI | Continuous quality improvement |
| C/S | Cesarean section |
| HAI | Healthcare-associated infection |
| IDI | Infectious Diseases Institute |
| IPC | Infection prevention and control |
| LMICs | Low- and middle-income countries |
| MOH | Ministry of Health |
| RRH | Regional referral hospital |
| SAP | Surgical antibiotic prophylaxis |
| SSI | Surgical site infection |
| WHO | World Health Organization |

# EXECUTIVE SUMMARY

**Introduction:**

Surgical site infections (SSIs) are among the most common healthcare-associated infections (HAI) globally and a leading cause of postpartum morbidity following caesarean section (C/S) in low- and middle-income countries (LMICs). In Uganda, inadequate post-discharge follow-up, limited laboratory capacity, and inconsistent infection prevention and control (IPC) practices have hindered monitoring of SSI burden and effective prevention.

**Intervention:**

From October 2022, the Ministry of Health and the Infectious Diseases Institute piloted a prospective SSI surveillance system for mothers undergoing C/S at three high-volume regional referral hospitals: Entebbe, Hoima, and Kayunga. The system provided active surveillance from the decision to operate through 30 days post-operation, with structured follow-ups on days 6, 14, and 30 (in-person or by phone). Real-time dashboards facilitated monthly feedback to facility teams, driving continuous quality improvement (CQI) initiatives to prevent SSIs.

**Results:**

***Coverage:*** 6,132 mothers enrolled; 4,923 (80%) completed full 30-day follow-up.

***SSI burden:*** Overall incidence of 9.2% (452 cases out of 4,923), consistent with reported rates in LMICs. Most infections detected post-discharge (64% by day 14; highest cases on days 6 and 14).

***SSI risks:*** Maternal age (HR: 0.62; 95% CI: 0.39–0.97; p=0.04) and adherence to all surgical care bundles (HR: 0.61; 95% CI: 0.46–0.82; p<0.001) were significantly protective against SSIs. Over the 30-day follow-up period, the overall survival probability for SSI was 90.3% (95% CI: 0.894–0.911), with the steepest decline in SSI-free survival occurring within the first two weeks.

***SSI prevention:*** Adherence to all surgical care bundles achieved in only 13% of cases initially, improving gradually over the period. Adherence to at least three elements reached 48%. Adherence to all bundles was strongly protective against SSIs (OR: 0.63, 95% CI: 0.47–0.85, p=0.0024). Surgical Antibiotic Prophylaxis (SAP) was administered in 54.9% of cases; correct timing (1–59 minutes pre-incision) in only 36.4% of those receiving it; and characterized by over-reliance on Watch and broad-spectrum antibiotics.

**Conclusion:**

Structured SSI surveillance is feasible in Uganda and systematic implementation can reduce SSI burden, improve patient outcomes, and strengthen data use. Early declines in SSI rates highlight the value of data-driven CQI, staff engagement, and low-cost prevention bundles. Sustained improvements require addressing practice and structural gaps and antimicrobial stewardship. The program provides a scalable model for national expansion, contributing to

enhanced maternal outcomes, patient safety, and health system resilience in Uganda.

# 1.0. PROGRAM OVERVIEW

## 1.1. Introduction

Healthcare-associated infections (HAIs) remain a major public health threat in Uganda and other low- and middle-income countries (LMICs), with surgical site infections (SSIs) among the most frequently encountered.[1] Women undergoing cesarean section (C/S) deliveries are particularly vulnerable due to enhanced risks. SSIs are associated with longer hospital stays, readmissions, increased healthcare costs, and significant maternal morbidity and mortality.[2]

Globally, the incidence of SSIs in LMICs is estimated to be more than three times higher than in high-income countries.[3] Among women undergoing C/S, reported SSI rates range from 5% to 35%, although true burden is likely underestimated due to poor surveillance systems, inadequate post-discharge follow-up, limited laboratory capacity, and inconsistent Infection Prevention and Control (IPC) practices.[1] Importantly, most SSIs are preventable through adherence to evidence-based surgical and IPC measures.[2] Surveillance systems that generate timely, actionable data and directly inform prevention strategies have shown to reduce SSIs rates by over 60%,[4] and are widely recognized as indicators of healthcare quality and patient safety.[5]

In Uganda, disease surveillance systems are gradually developing and expanding; however, surveillance of HAIs remains limited.[6] To address this gap, the US Centers for Disease Control and Prevention (CDC), in partnership with the Makerere University Infectious Diseases Institute (IDI), has supported the Ministry of Health (MOH) to implement SSI surveillance in three regional referral hospitals (RRHs) to improve monitoring and practices. These facilities serve as pilot sites to strengthen surveillance capacity, inform evidence-based prevention interventions, and support national IPC efforts. This report documents the annual progress achieved between May 2024 and May 2025 in establishing and operationalizing SSI surveillance across the pilot sites.

## 1.2. Program Objectives

### *1.2.1. General objectives*

1. To determine the epidemiology and risk factors of C/S SSIs in a network of RRHs in Uganda.
2. To determine the effectiveness of prevention measures to reduce C/S SSIs.

### *1.2.2. Specific objectives*

1. Determine the burden and outcomes of C/S SSI using standardised metrics that generate comparable data.
2. Implement evidence-based infection control and clinical quality improvement measures to reduce C/S SSI.

3. Determine the prevalence of potential risk factors associated with C/S SSI to target interventions.
4. Assess the effectiveness of preventive measures for C/S SSI and identify emerging gaps in infection control.
5. Identify best practices for reducing C/S SSI to support program scale-up to other surgeries or facility settings in Uganda

#### *1.2.3. Expected outcomes*

The program resulted in trained multidisciplinary staff, availability of operational tools and standard operating procedures, functional site dashboards, and regular ward improvement team and continuous quality improvement (CQI) reviews, culminating in measurable improvements in surgical care bundle adherence and reductions in SSI incidence.

### 1.4. Program Legacy and Impact statement

The SSI Surveillance Program represents the first structured sentinel surveillance initiative focused on caesarean sections in Uganda. It has played a pivotal role in strengthening early detection and timely intervention for SSIs, generating actionable data that enhances patient safety, informs evidence-based clinical and IPC interventions, and supports national IPC efforts. By demonstrating the feasibility and impact of structured surveillance, this pilot program provides a model for scaling SSI monitoring across additional health facilities and surgical procedures. The insights gained will directly inform MOH's Health's efforts to expand similar surveillance initiatives nationwide and contribute to the development of a robust, integrated national HAI surveillance system, ultimately improving maternal and surgical outcomes across Uganda.

### 1.5. Operations/funding

The C/S SSI surveillance program is led by the Uganda Ministry of Health, through the Department of Clinical Services, in partnership with the Makerere University Infectious Diseases Institute. The program is funded by CDC, reflecting a collaborative effort to strengthen SSI surveillance and improve maternal health outcomes in Uganda.

# 2. METHODS AND APPROACHES

## 2.1. Setting

This HAI program implements active, prospective surveillance of SSIs among C/S patients in three RRHs in Uganda: Entebbe RRH, Hoima RRH, and Kayunga RRH. Entebbe RRH, located in the central region, mainly serves an urban population, while Kayunga RRH (north-central) and Hoima RRH (western region) cater predominantly to semi-urban and rural populations **(Figure 1)**. These facilities are high volume hospitals with substantial patient loads and annual deliveries **(Table 1)**, selected based on: presence of functional IPC committees, buy-in from facility administration, and IPC committees, established IPC programs capable of acting on surveillance findings, and the presence of a designated staff nurse to work alongside the surveillance officer. Additional considerations included the facility teams' willingness to implement IPC actions based on surveillance data and the availability of sufficient human and material resources to sustain surveillance activities beyond the project timeline.

**Table 1. Characteristics of study hospitals**

| | Bed capacity | Bed occupancy rate, % | Annual admissions | Annual OPD attendance | Annual deliveries |
|---|---|---|---|---|---|
| Entebbe RRH | 200 | 46 | 10,395 | 57,999 | 4,323 |
| Hoima RRH | 267 | 93 | 27,099 | 94,265 | 7,308 |
| Kayunga RRH | 300 | 77 | 19,008 | 73,906 | 4,114 |

Source: Annual Health Sector Performance Report 2023/24[7]

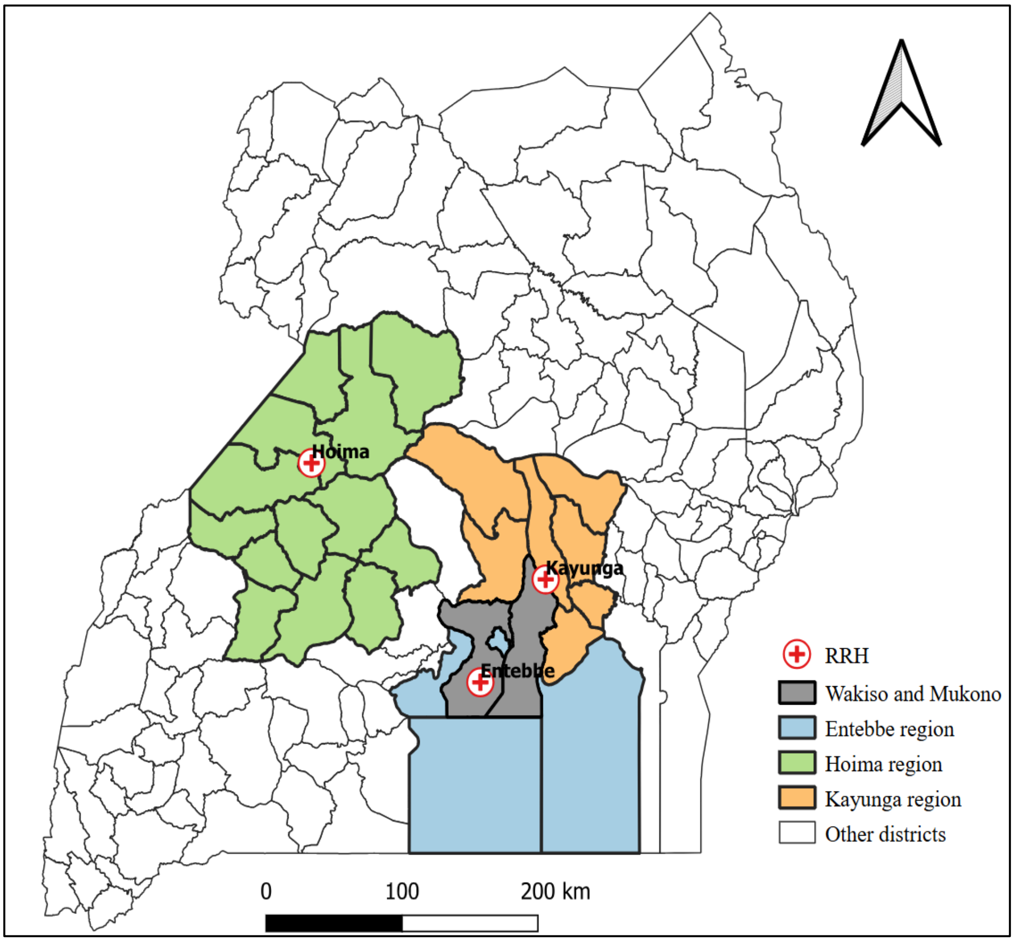



**Figure 1. A map of Uganda showing location of study hospitals and their coverage**

### 2.2. Study population

The target population included women of childbearing age who underwent C/S delivery at Entebbe RRH, Hoima RRH, and Kayunga from May 2024 to June 2025. All women delivering by C-section at these hospitals were eligible for inclusion, with no exclusions applied.

### 2.3. Case definition

A surgical site infection was defined according to World Health Organization (WHO) criteria as the presence of one or more of the following within 30 days after surgery: purulent discharge from the surgical wound, including abscess formation; wound dehiscence or reopening; or fever accompanied by spreading, painful erythema surrounding the surgical site.

### 2.4. Intervention

#### *2.4.1. Approaches*

The intervention consisted of a comprehensive program combining active SSI surveillance with targeted prevention activities implemented through a CQI approach. Early surveillance data identified critical gaps in adherence to recommended surgical and infection prevention practices, which necessitated the implementation of targeted improvement measures. In response, the project designed and rolled out a complementary surgical care bundle comprising key IPC components such as pre-operative patient showering, appropriate skin preparation and hair removal, patient education on hygiene and wound care, and surgical antibiotic prophylaxis (SAP). Implementation of the bundle followed a structured QI process and included the establishment of a standardized SAP protocol, staff training, strengthened documentation, and systematic monitoring of adherence to all bundle elements. Additional efforts were made to improve the availability and accessibility of antibiotics in maternity units and to enhance the completeness and accuracy of data.

#### *2.4.2. Monitoring*

The intervention was monitored through quarterly surveys using standardized surveillance tools, which tracked SSI incidence as well as implementation of the surgical care bundle. SSI assessments were conducted at three follow-up time points: post-operative days 6, 14, and 30, to determine the occurrence of infections. All data were integrated into a dashboard accessible to participating facilities, providing real-time feedback to hospital staff during weekly meetings, work improvement team sessions, and CQI committee meetings. The SSI dashboard was updated monthly to track progress, highlight trends, and support rapid decision-making, thereby promoting sustained staff engagement and ownership of the improvement process. Program implementation was jointly monitored by MOH, IDI, and CDC. Quarterly on-site visits were conducted to review study materials, including patient report forms, confidentiality procedures, and data entry practices, and to support facility teams in developing actionable plans to address low-performing areas. National regulatory authorities and CDC investigators also periodically reviewed program compliance to ensure adherence to all relevant requirements.

### 2.5. Data collection

Data collection was conducted using paper-based SSI surveillance forms and post-discharge interviews developed with guidance from MOH, IDI, practicing obstetricians, and facility staff from the labor ward, theatre, and postnatal wards. Data collection began in the labor ward when the decision for C/S was made and continued through the intraoperative and postnatal periods, extending into the post-discharge phase up to 30 days after surgery. Follow-up assessments, conducted either in person or by phone, were performed on post-operative days 6, 14, and 30 to determine the status of the surgical site. Completed forms were entered into an electronic Open Data Kit (ODK) system. Throughout the surveillance period, data were collected on patient demographics; surgical care bundle components such as blood glucose levels, preoperative antibiotic administration, patient bathing, and health education on wound care and hair removal; as well as clinical information including C/S type, indication for surgery, ASA score, and detailed wound assessments for purulent discharge, fever, pain, and swelling.

### 2.6. Data management

The project established a robust data management system to ensure the production of high-quality, reliable HAI surveillance data for decision-making. The system maintained strict standards of data security, integrity, and accessibility, and adhered to all relevant compliance requirements. It also enabled efficient data entry, integration, cleaning, and validation, as well as timely analytics and reporting to support ongoing monitoring and program improvement.

### 2.7. Study variables

This study collected both SSI and HAI prevention variables to assess SSI trends and adherence to IPC and clinical care standards across the three implementation hospitals. Denominator variables were collected in accordance with the surveillance protocol to enable monitoring of SSI trends over time. These variables were essential for calculating monthly SSI rates and for identifying associated factors. They included the total number of caesarean sections performed, the number of C/S patients successfully followed up, the type of C/S (elective or emergency), surgeon profiles, and relevant patient risk factors. Denominator data were obtained from standardized surveillance forms completed for every eligible surgical patient throughout the surveillance period. Accurate and consistent completion of these forms was critical for generating reliable SSI rates and supporting valid comparisons and trend analyses across hospitals and over time.

HAI prevention variables assessed adherence to evidence-based surgical care practices. Surgical care bundle variables included whether patients showered preoperatively, the method of hair removal, the type of skin preparation agent used, confirmation that the skin was dry before incision, and whether patients received pre- or postoperative hygiene and wound-care education. Anesthesia safety variables included the patient's preoperative physical status measured using the American Society of Anesthesiologists (ASA) classification, the cadre of anesthesia provider, and whether preoperative blood glucose testing was performed. Surgical antibiotic prophylaxis (SAP) variables captured whether preoperative prophylaxis was administered, the timing of SAP (with correct timing defined as 1–59 minutes before skin incision), the use and duration of postoperative antibiotics, and the specific antibiotic agents prescribed. Postoperative antibiotics were further classified using the WHO AWaRe framework (Access, Watch, or Not Recommended) to evaluate patterns of antimicrobial use and identify potential overuse of broad-spectrum agents.

### 2.8. Data analysis and Statistical methods

Data from all the study hospitals were exported into R for cleaning and analysis, and PowerBI for visualization dashboards generation. Categorical variables were summarized using frequencies and percentages, while continuous variables were summarized using medians and interquartile ranges (IQR). SSI incidence was calculated as the number of confirmed SSIs detected during the 30-day follow-up period divided by the number of C/S patients with completed follow-up in a given month or across the study period. Denominator data were derived from facility C/S totals and validated through surveillance forms. Incidence rates were stratified by time of detection (baseline, day 6, day 14, day 30), enabling assessment of the temporal pattern of SSIs. Logistic regression analysis assessed associations between SSI occurrence and key prevention variables. Time-to-event analysis included survival analysis using Kaplan–Meier estimators to assess the probability of remaining SSI-free over 30 days. Differences in survival curves were assessed using the log-rank test. A Cox proportional hazards model estimated the hazard ratios for risk factors associated with time to SSI. Statistical significance was defined as $p<0.05$ and 95% confidence intervals reported.

### 2.9. Ethical considerations

This was an active prospective surgical site infection surveillance of C-section patients in RRHs in Uganda aimed to improve the safety of healthcare by enhancing surveillance for SSIs following C-section delivery. Since the study's activities were primarily designed to improve safety of healthcare and not to generate generalizable knowledge, the study did not meet the US federal definition of "research" under 45 CFR 46.102(l) or as defined by the US food and Drug Administration. The protocol was submitted to the IDI Research Ethics Committee (IDI-REC REF 2023-79) and the US Centers for Disease Control and Prevention for non-research determination. All program activities were conducted under the authority of the standard of care as recommended by the Uganda MOH of routine public health care and quality improvement.

# 3.0. RESULTS

## 3.1. Study participants and demographics

### *3.1.1. Participants enrolled*

**Figure 2** presents the enrollment of study participants between May 2024 and May 2025. A total of 6,132 women were enrolled across all study sites. Of these, 780 participants were excluded from further analysis, including 6 who died during the follow-up period and 774 who were lost to follow-up. This left 5,352 participants who remained eligible for continued monitoring. By the end of the study observation period, an additional 429 participants had not yet completed their scheduled follow-up assessments. Consequently, 4,923 participants successfully completed the full follow-up process required for outcome evaluation. A total of 452 (9.2%) mothers developed SSI through-out the observation period; identified at baseline (n = 12), at day 6 (n = 178), at day 14 (n = 184), and at day 30 (n = 78) (see **Appendix I** for details).

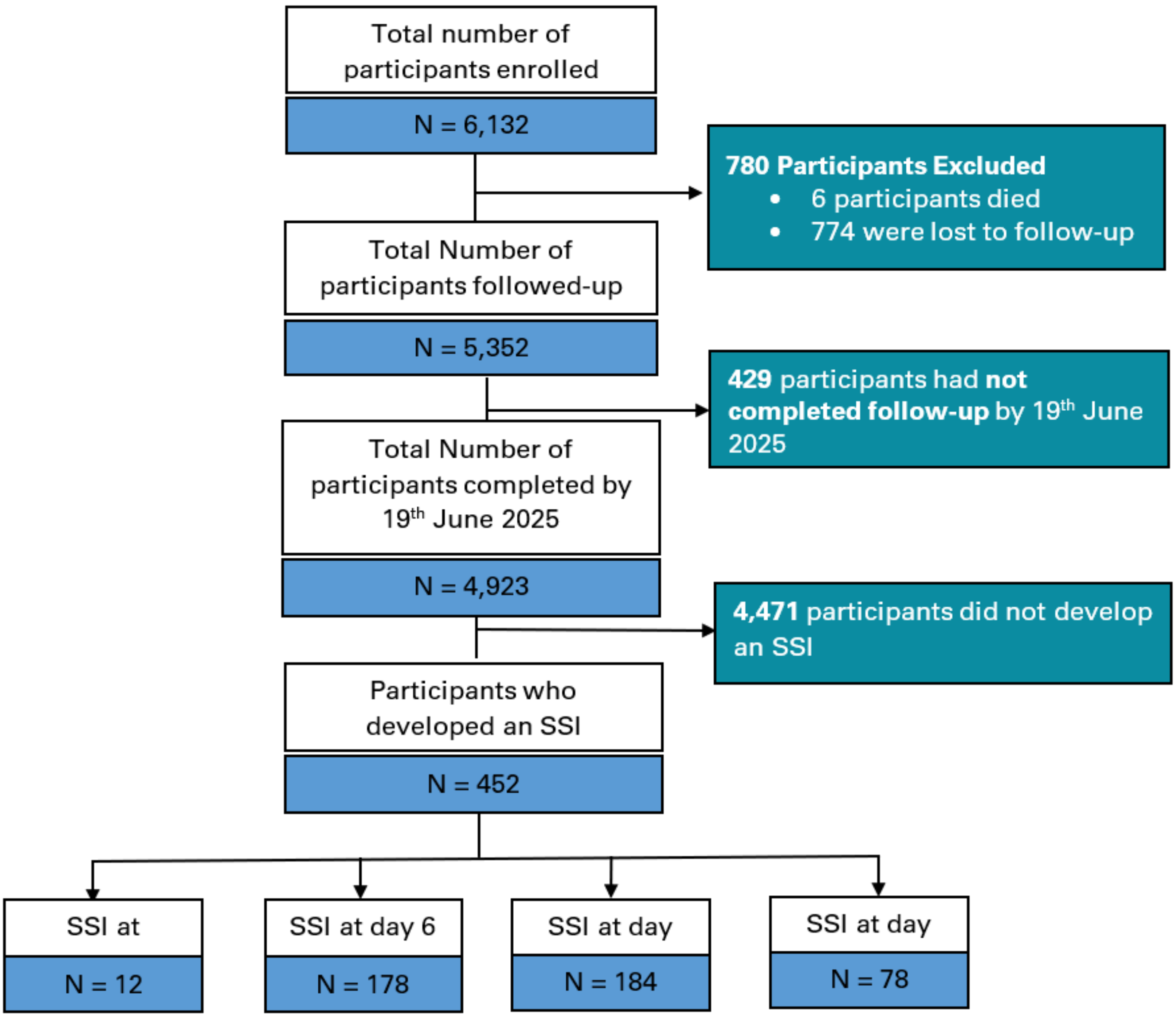



**Figure 2. Study participants enrolled**

*3.1.2. Participant demographics*

**Table 2** summarizes the demographic characteristics of the 4,923 mothers who completed follow-up across the study hospitals. Participants were distributed relatively evenly across the study sites and most of them resided within the host districts of the participating facilities (Wakiso, Hoima, and Kayunga, with additional contributions from neighboring districts, as illustrated in **Figure 3.** A total of 1,535 mothers (31.2%) of mothers were referred from other health care facilities. The median age of participants was 25 years (IQR 22–30), reflecting the characteristically young obstetric population in Uganda. Most women were HIV negative (93.6%), while only 6.1% were HIV positive. Emergency caesarean sections made up the vast majority of procedures (90.1%), compared with only 9.9% that were elective. Approximately half (50.6%) of all caesarean sections performed due to previous scar, obstructed labor, and fetal distress. Intern doctors performed the largest share of surgeries (56.9%), followed by medical officers (19.7%) and senior house officers (13.5%), while specialist obstetricians performed a relatively small proportion (5.2%) of all procedures (see **Appendix II** for details.

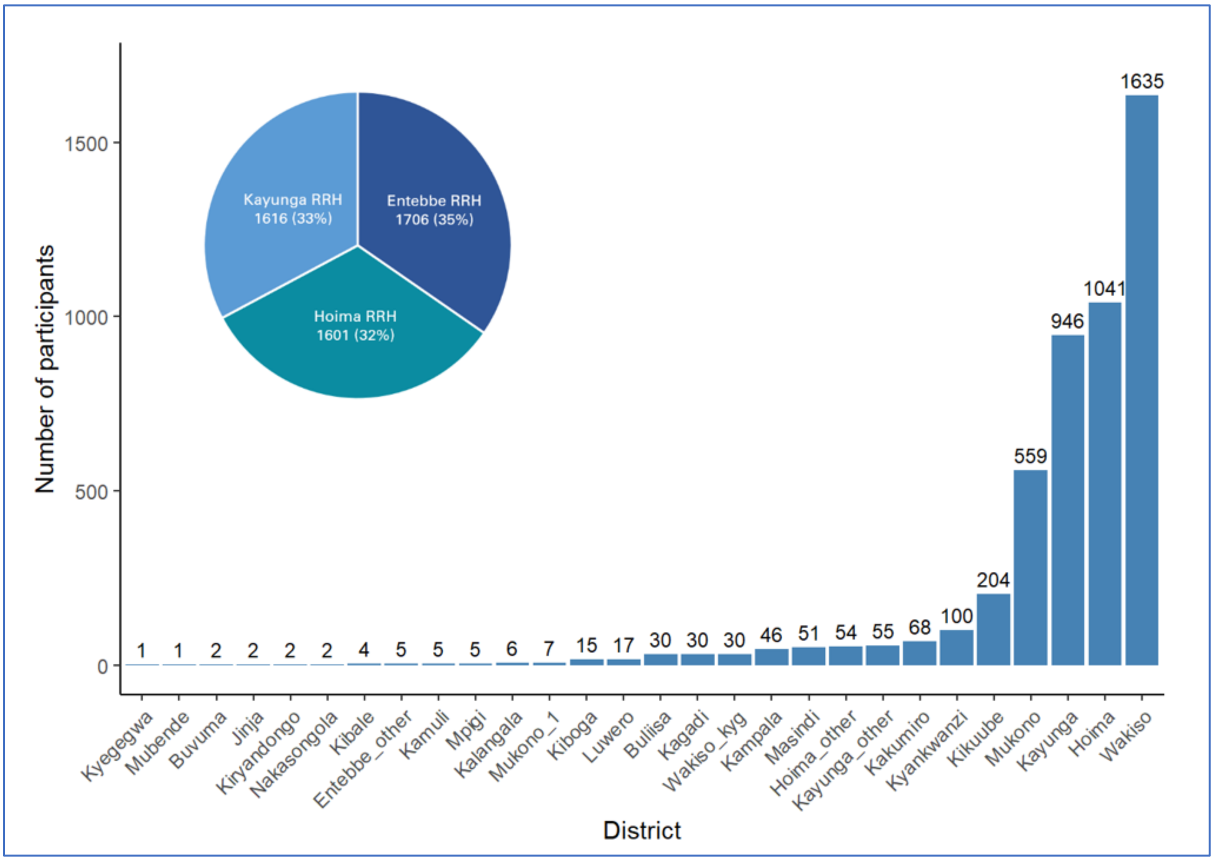



**Figure 3. Study participants by hospital and residence district**

**Table 2. Demographic characteristics of the study participants**

| Demographics | Entebbe RRH | Hoima RRH | Kayunga RRH | Total |
|---|---|---|---|---|
| **Age in years** | | | | |
| Median (IQR) | 27.00 (8.00) | 25.00 (10.00) | 24.00 (8.00) | 25.00 (8.00) |
| Q1, Q3 | 23.00, 31.00 | 20.00, 30.00 | 21.00, 29.00 | 22.00, 30.00 |
| **C-section type** | | | | |
| Elective | 235 (13.77%) | 109 (6.81%) | 143 (8.85%) | 487 (9.89%) |
| Emergent | 1471 (86.23%) | 1492 (93.19%) | 1473 (91.15%) | 4436 (90.11%) |
| **Surgery done by** | | | | |
| Intern doctor | 967 (56.68%) | 880 (54.97%) | 953 (58.97%) | 2800 (56.88%) |
| Medical officer | 655 (38.39%) | 153 (9.56%) | 164 (10.15%) | 972 (19.74%) |
| Other surgery | 0 (0.00%) | 110 (6.87%) | 125 (7.74%) | 235 (4.77%) |
| SHO | 1 (0.06%) | 343 (21.42%) | 318 (19.68%) | 662 (13.45%) |
| Specialist obstetrician | 83 (4.87%) | 115 (7.18%) | 56 (3.47%) | 254 (5.16%) |
| **Anesthesia by** | | | | |
| Anesthetist | 1672 (98.01%) | 1595 (99.63%) | 1596 (98.76%) | 4863 (98.78%) |
| Intern anesthetist | 11 (0.64%) | 2 (0.12%) | 12 (0.74%) | 25 (0.51%) |
| Specialist anesthesiologist | 23 (1.35%) | 4 (0.25%) | 8 (0.50%) | 35 (0.71%) |
| **ASA score** | | | | |
| 1 | 1682 (98.59%) | 647 (40.41%) | 1158 (71.66%) | 3487 (70.83%) |
| 2 | 22 (1.29%) | 875 (54.65%) | 416 (25.74%) | 1313 (26.67%) |
| 3 | 0 (0.00%) | 58 (3.62%) | 42 (2.60%) | 100 (2.03%) |
| 4 | 1 (0.06%) | 15 (0.94%) | 0 (0.00%) | 16 (0.33%) |
| 5 | 1 (0.06%) | 6 (0.37%) | 0 (0.00%) | 7 (0.14%) |
| **HIV status** | | | | |
| Negative | 1607 (94.20%) | 1481 (92.50%) | 1518 (93.94%) | 4606 (93.56%) |
| Positive | 94 (5.51%) | 112 (7.00%) | 94 (5.82%) | 300 (6.09%) |
| Unknown | 5 (0.29%) | 8 (0.50%) | 4 (0.25%) | 17 (0.35%) |
| **Blood glucose done** | | | | |
| No | 1673 (98.07%) | 1600 (99.94%) | 1606 (99.38%) | 4879 (99.11%) |
| Yes | 33 (1.93%) | 1 (0.06%) | 10 (0.62%) | 44 (0.89%) |
| **Prophylaxis given** | | | | |
| No | 958 (58.03%) | 582 (36.35%) | 658 (43.12%) | 2198 (46.00%) |
| Yes | 693 (41.97%) | 1019 (63.65%) | 868 (56.88%) | 2580 (54.00%) |
| Missing | 55 | 0 | 90 | 145 |
| **Did patient shower** | | | | |
| No | 1294 (78.38%) | 1556 (97.19%) | 846 (55.44%) | 3696 (77.35%) |
| Yes | 357 (21.62%) | 45 (2.81%) | 680 (44.56%) | 1082 (22.65%) |
| Missing | 55 | 0 | 90 | 145 |
| **Hair removal done** | | | | |
| No | 1600 (93.79%) | 1564 (97.69%) | 1554 (96.16%) | 4718 (95.84%) |
| Yes | 106 (6.21%) | 37 (2.31%) | 62 (3.84%) | 205 (4.16%) |
| **Patient skin preparation** | | | | |
| Alcohol | 11 (0.64%) | 26 (1.62%) | 57 (3.53%) | 94 (1.91%) |
| Betadine | 8 (0.47%) | 22 (1.37%) | 1547 (95.73%) | 1577 (32.03%) |
| Chlorhexidine | 1687 (98.89%) | 1553 (97.00%) | 12 (0.74%) | 3252 (66.06%) |
| **Skin dry before incision** | | | | |
| No | 39 (2.36%) | 24 (1.50%) | 1418 (92.92%) | 1481 (31.00%) |
| Yes | 1612 (97.64%) | 1577 (98.50%) | 108 (7.08%) | 3297 (69.00%) |
| Missing | 55 | 0 | 90 | 145 |
| **Patient taught hygiene** | | | | |
| No | 29 (1.76%) | 620 (38.73%) | 435 (28.51%) | 1084 (22.69%) |
| Yes | 1622 (98.24%) | 981 (61.27%) | 1091 (71.49%) | 3694 (77.31%) |
| Missing | 55 | 0 | 90 | 145 |

| Demographics | Entebbe RRH | Hoima RRH | Kayunga RRH | Total |
|---|---|---|---|---|
| **Antibiotics post-surgery** | | | | |
| No | 7 (0.42%) | 8 (0.50%) | 48 (3.15%) | 63 (1.32%) |
| Yes | 1644 (99.58%) | 1593 (99.50%) | 1478 (96.85%) | 4715 (98.68%) |
| Missing | 55 | 0 | 90 | 145 |

## 3.2. HAI prevention

### *3.2.1. Adherence to surgical care bundles*

Surgical care bundles are evidence-based sets of simple, proven interventions that, when implemented together and reliably for every eligible patient, significantly reduce the risk of SSI. Adherence to patient showering, hair removal, skin preparation, patient hygiene education, SAP, and ensuring dry skin before incision was monitored for all mothers. Adherence to surgical care bundles is shown in **Figure 4.** Adherence to all surgical care bundles was achieved in only 13% of cases, while adherence to at least 3 bundles was achieved in 48% of cases. A trend analysis showed a positive trend, with gradual improvement observed across all facilities over the course of the study period (see **Appendix III** for details).

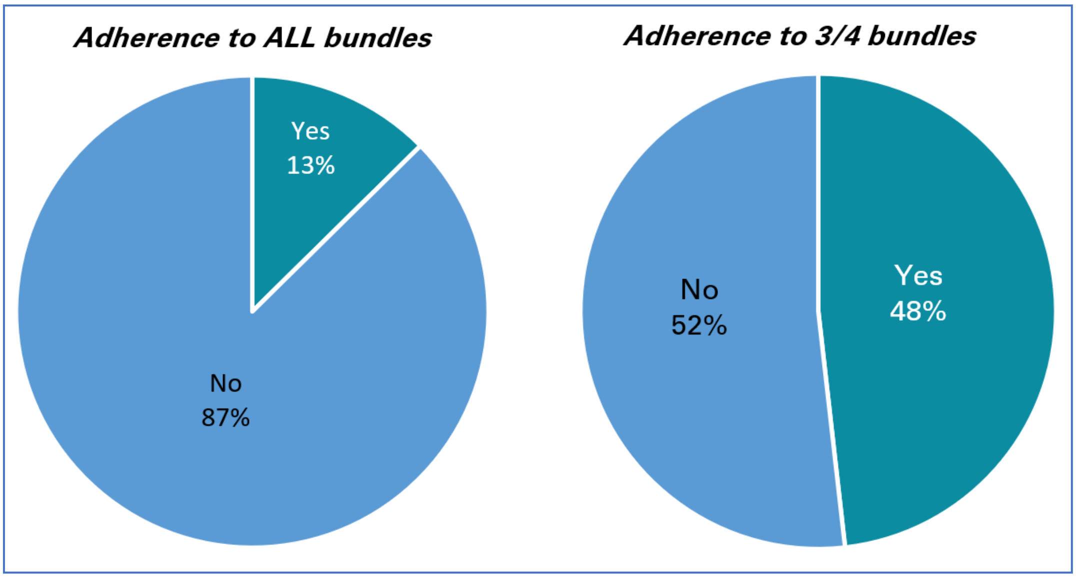



**Figure 4: Adherence to surgical care bundles**

### *3.2.2. Anesthesia safety*

Anesthesia ensures optimal patient physiological stability during surgery, minimizing peri- and post-surgical complications including HAIs. Anesthesia safety variables monitored in the study are shown in **Table 2.** Across the three hospitals, in nearly all procedures (98.8%) conducted, anesthesia was provided by anesthetists, with only a small proportion handled by intern anesthetists (0.51%) or specialist anesthesiologists (0.71%). Most patients (70.8%) were classified as ASA I, indicating they were generally healthy at the time of surgery, while 26.7% were categorized as ASA II and 2.03% as ASA III. Only a very small proportion fell into higher-risk categories. Preoperative blood glucose testing was rarely performed, documented in just 0.89% of patients, highlighting a notable gap in recommended perioperative safety practices.

### *3.2.3. Surgical antibiotic prophylaxis*

SAP is critical for the prevention of HAIs, and when the appropriate antibiotic is administered within the optimal 1 to 59-minute window before skin incision, it significantly reduces the risk of SSIs. **Figure 5** shows adherence to correct SAP duration across facilities. A total of 2,702 women (54.9%) received SAP; however, only 983 of these women (36.4%) received antibiotics within the optimal timing window, highlighting a critical gap. Among the hospitals, Hoima RRH reported the highest adherence, with 54.5% of mothers receiving SAP within the correct window. Entebbe RRH showed moderate adherence at 33.1%, while Kayunga RRH had the lowest adherence, with only 19.6% of mothers receiving SAP at the appropriate time. Trends in correct SAP duration varied over the observation period, showing a general slow decline across most study hospitals, with only Hoima RRH demonstrating a notable improvement over time. Ceftriaxone, metronidazole, and ampicillin were the three most commonly prescribed antibiotics, highlighting an over-reliance on Watch and broad-spectrum antibiotics (see **Appendix IV** for details).

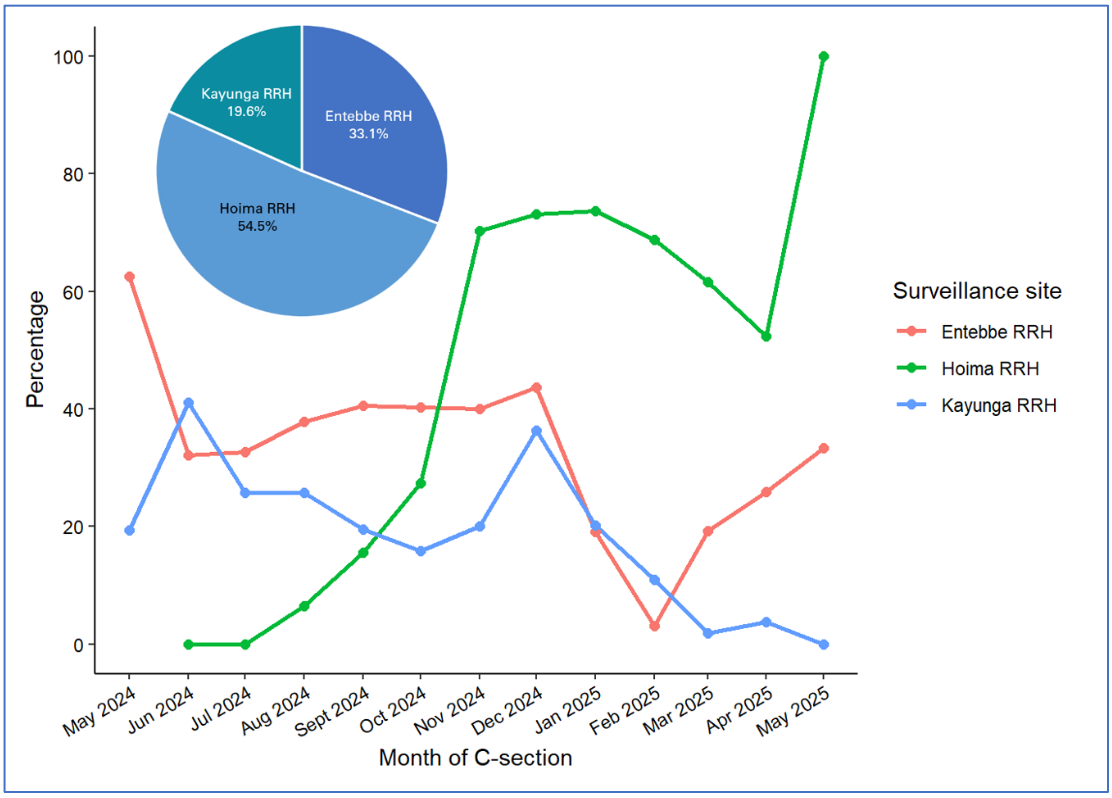



**Figure 5. Adherence to correct SAP duration across facilities**

### 3.3. Surgical site infection outcomes

#### *3.3.1. Incidence of SSIs*

Participants were followed up on day 3 (baseline), day 6, day 14, and day 30, and evaluated for SSIs. Among the 4,923 mothers who completed the full 30-day follow-up, 452 (9.2%) developed an SSI. Cases were relatively evenly distributed across the study hospitals. The highest number of SSIs was observed on day 14 (184 cases), followed by day 6 (178 cases) and day 30 (78 cases), with the fewest cases diagnosed at baseline (12 cases) **(Table 3)**. SSI occurrence was significantly higher among participants who did not receive antibiotic prophylaxis (p=0.002) and among those who did not report showering before surgery (p=0.002). Infection rates were also elevated in women who did not have alcohol-based skin preparation prior to caesarean section compared with those who received Betadine or Chlorhexidine (p=0.023). In addition, patients who did not adhere to all surgical care bundle experienced significantly higher SSI rates (p=0.014). A detailed stratified analysis is provided in **Appendix V**.

**Table 3. SSI outcomes outcomes (N=4923)**

| Follow-up / Infection | Entebbe RRH | Hoima RRH | Kayunga RRH | Total |
|---|---|---|---|---|
| **Baseline** | | | | |
| No | 1,680 (99.94%) | 1,582 (99.43%) | 1,529 (99.87%) | 4,791 (99.75%) |
| Yes | 1 (0.06%) | 9 (0.57%) | 2 (0.13%) | 12 (0.25%) |
| **Day 6 infections** | | | | |
| No | 1,556 (96.47%) | 1,294 (95.85%) | 1,192 (94.83%) | 4,042 (95.78%) |
| Yes | 57 (3.53%) | 56 (4.15%) | 65 (5.17%) | 178 (4.22%) |
| **Day 14 infections** | | | | |
| No | 1,537 (94.82%) | 1,269 (95.27%) | 1,212 (97.04%) | 4,018 (95.62%) |
| Yes | 84 (5.18%) | 63 (4.73%) | 37 (2.96%) | 184 (4.38%) |
| **Day 30 infections** | | | | |
| No | 1,604 (97.21%) | 1,503 (99.27%) | 1,420 (98.54%) | 4,527 (98.31%) |
| Yes | 46 (2.79%) | 11 (0.73%) | 21 (1.46%) | 78 (1.69%) |
| **Total SSI infections** | | | | |
| No | 1,518 (88.98%) | 1,462 (91.32%) | 1,491 (92.26%) | 4,471 (90.82%) |
| Yes | 188 (11.02%) | 139 (8.68%) | 125 (7.74%) | 452 (9.18%) |

#### *3.3.2. Trends of SSIs*

Trend analysis showed an overall decline in SSI rates with minimal variability across facilities. The most substantial reduction occurred during the initial months, reflecting the early impact of the intervention, after which SSI levels remained consistently below 15% for the remainder of the observation period **(Figure 6).**

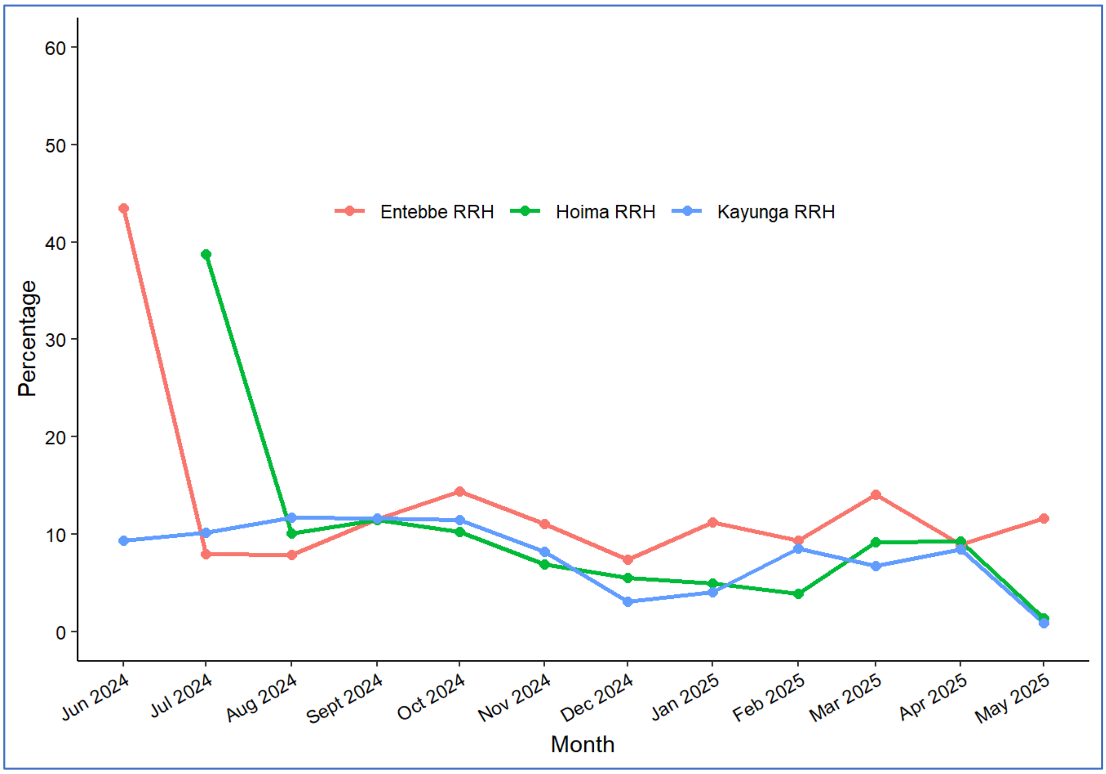



**Figure 6. Adherence to correct SAP duration across facilities**

### *3.3.3. Factors associated with SSIs*

Logistic regression analysis of factors associated with surgical site infection (SSI) showed that adherence to all surgical care bundles was significantly protective, with participants who adhered having lower odds of developing SSI (OR: 0.63, 95% CI: 0.47–0.85, p=0.0024) (see **Appendix V** for details).

### *3.3.4. Time-to-Event Analysis of SSIs*

**Survival analysis**

By day 30, the probability of remaining free from surgical site infection (SSI) was 90.3% (survival probability: 0.9029, 95% CI: 0.894–0.911). The most pronounced decline in survival occurred within the first two weeks, with approximately 64% of all 30-day SSI events occurring by day 14. Survival probability was highest at baseline (day 3; 0.9996) and reached its lowest point on day 30 (0.9029) **(Figure 7)**. Detailed Kaplan–Meier survival estimates and curves are provided in **Appendix VI.**

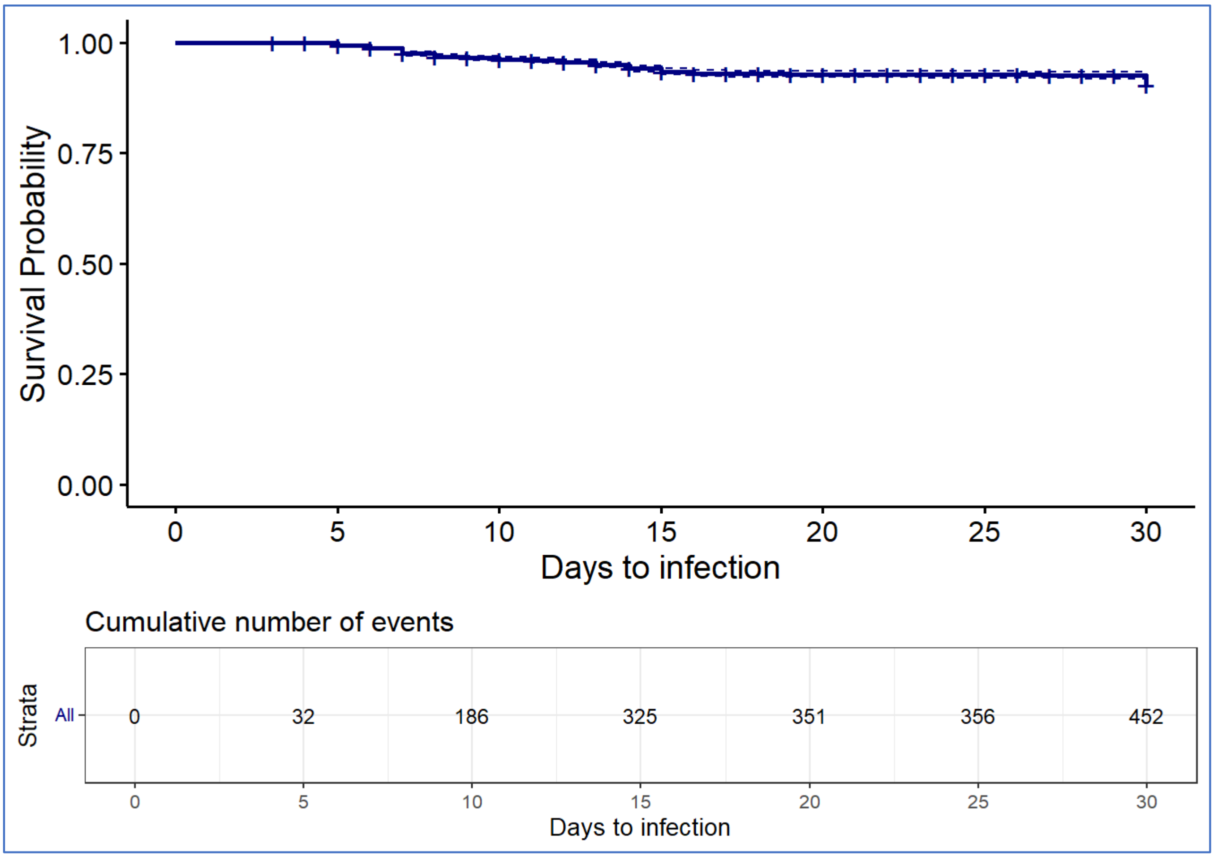


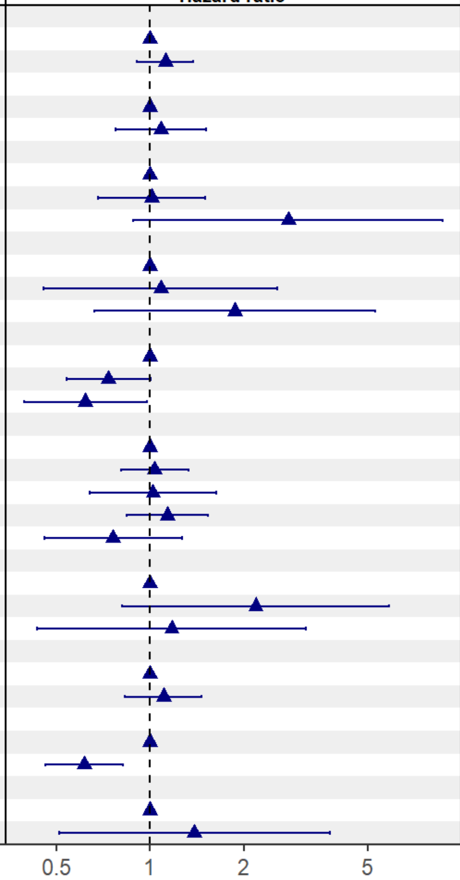

**Figure 7. Overall SSI survival probabilities over 30 days of follow-up**

## Risk analysis

On Cox regression analysis, adherence to all surgical care bundles was strongly protective, with adherent participants experiencing a 39% lower risk of SSI compared to non-adherent participants (HR: 0.61; 95% CI: 0.46–0.82; p<0.001). Maternal age also demonstrated a protective effect, with participants aged 35–50 years having a 38% lower risk of SSI compared to the youngest group (10–19 years) (HR: 0.62; 95% CI: 0.39–0.97; p=0.04) **(Table 4).**

## Table 4. Hazard ratio estimates of time to SSI

| Variable | N | Hazard ratio | p |
|---|---|---|---|
| **Referral in** | | | |
| No | 3285 | Reference | |
| Yes | 1493 | 1.12 (0.91, 1.37) | 0.29 |
| **C-section type** | | | |
| elective | 479 | Reference | |
| emergent | 4299 | 1.08 (0.77, 1.52) | 0.64 |
| **HIV status** | | | |
| Negative | 4469 | Reference | |
| Positive | 292 | 1.01 (0.68, 1.51) | 0.95 |
| Unknown | 17 | 2.77 (0.88, 8.70) | 0.08 |
| **Patient skin preparation** | | | |
| Alcohol | 91 | Reference | |
| Betadine | 1487 | 1.08 (0.46, 2.56) | 0.86 |
| chlorhexidine | 3200 | 1.87 (0.66, 5.30) | 0.24 |
| **Age categories** | | | |
| 10-19 | 412 | Reference | |
| 19-35 | 3952 | 0.74 (0.54, 1.00) | 0.05 |
| 35-50 | 414 | 0.62 (0.39, 0.97) | 0.04 |
| **Surgery done by** | | | |
| intern_doctor | 2712 | Reference | |
| medical_officer | 944 | 1.04 (0.81, 1.33) | 0.78 |
| other_surgery | 216 | 1.02 (0.64, 1.63) | 0.93 |
| SHO | 662 | 1.14 (0.84, 1.53) | 0.40 |
| specialist_obstetrician | 244 | 0.76 (0.46, 1.27) | 0.29 |
| **Anesthesia by** | | | |
| anesthetist | 4719 | Reference | |
| intern_anesthetist | 25 | 2.18 (0.81, 5.87) | 0.12 |
| specialist_anesthesiologist | 34 | 1.17 (0.43, 3.17) | 0.75 |
| **Prophylaxis given** | | | |
| No | 2198 | Reference | |
| Yes | 2580 | 1.10 (0.83, 1.47) | 0.50 |
| **Adherence to surgical care bundles** | | | |
| No | 2405 | Reference | |
| Yes | 2373 | 0.61 (0.46, 0.82) | <0.001 |
| **Antibiotics post surgery** | | | |
| No | 63 | Reference | |
| Yes | 4715 | 1.39 (0.51, 3.78) | 0.52 |



## 4.0. DISCUSSION

This pilot SSI surveillance program demonstrated that implementing a structured, prospective surveillance system within Ugandan Regional Referral Hospitals is both feasible and valuable for improving maternal surgical outcomes, mirroring results from other settings.[4] Trends in SSI incidence showed substantial declines during the early months of the program, largely driven by strengthened surveillance, increased staff awareness, and early implementation of prevention bundles. Once the intervention was embedded within routine facility practice, SSI incidence stabilized below 15%, suggesting early effectiveness and growing institutional ownership. Continued CQI engagement, IPC committee oversight, and surveillance data use were essential enablers of this positive trend. The overall SSI incidence was 9.2%, aligning with rates in LMICs.[1] The highest proportion of SSIs was detected at day 14, underscoring the importance of post-discharge follow-up and surveillance, which would have missed more than half of all infections had follow-up been limited to in-facility review.

Maternal age demonstrated a protective association against SSIs, with younger mothers (10–19 years) experiencing the highest infection risk, potentially reflecting greater socioeconomic vulnerability. Adherence to surgical care bundles was strongly protective against SSIs; suboptimal adherence significantly increased infection risk, reflecting persistent IPC gaps previously documented in Uganda.[8] Encouragingly, adherence improved gradually across all hospitals over the study period, highlighting the effectiveness of data-driven monitoring and CQI approaches. However, the protective effect of SAP was compromised by incorrect timing and duration and the over-reliance on Watch and broad-spectrum antibiotics, a known practice in Uganda,[9] enhancing AMR risks and underscoring the need to strengthen AMS.

# 5.0. THE WAY FORWARD

### 5.1. Pathway to Sustainability

Sustaining SSI surveillance will require deliberate institutionalization, predictable resourcing, and integration into routine health system functions. Surveillance activities are formally embedded within facility IPC programs, which promotes clinical ownership, strengthens accountability, and ensures that SSI data directly inform routine quality improvement actions. The study prioritized the implementation of low-cost surgical care bundles to reduce SSI risk, and sustaining these gains is feasible because these interventions represent low-cost, high-impact measures that are relatively easy to implement, scale, and maintain within existing resource constraints. To sustain the use of surveillance data for decision-making, reliable and timely data must be readily accessible to users; accordingly, the project prioritized automated data analysis and visualization through dashboards. To support long-term sustainability, ongoing MOH efforts are focused on transitioning from paper-based tools and ODK platforms to existing integrated electronic medical records, thereby improving efficiency, data quality, and continuity of SSI surveillance.

### 5.2. Lessons learned

Multidisciplinary collaboration and staff engagement in essential for effective HAI surveillance. Active participation by nurses, obstetricians, laboratory personnel, IPC teams, and facility leadership strengthened ownership of surveillance processes and ensured that data translated into action. Ward-level quality improvement initiatives, such as the use of documentation journals, combined with continuous on-site mentorship and the structured integration of rotating interns, enhanced institutional capacity and reduced dependency on individual champions. Regular orientation of new staff, targeted refresher trainings, hand hygiene audits, and feedback sessions, supported by change adoption frameworks, facilitated compliance with evidence-based practices including preoperative bathing, appropriate wound care, timely antibiotic administration, and patient-centered perioperative care.

Equally important was the role of data-driven decision-making in reinforcing accountability and sustaining improvements. Timely visualization of surveillance data through dashboards, graphs, and routine reports improved staff awareness of SSI trends and clarified the impact of specific interventions, thereby motivating adherence to best practices. However, the effective use of data depended on enabling system factors, including adequate staffing, reliable supplies, functional IPC committees, and supportive leadership. The transition toward digital platforms and electronic medical records, while challenging, presented opportunities to improve surveillance efficiency and data quality. Finally, extending SSI prevention beyond the facility through post-discharge follow-up, caregiver education, and patient-centered approaches such as self-wound care proved essential in closing facility–community gaps, strengthening continuity of care, and improving both surveillance completeness and maternal outcomes.

### 5.3. Program Recommendations

Scale SSI surveillance to additional regional referral hospitals, with priority given to high-volume maternity units where the burden and prevention gains are greatest. Develop standardized SAP protocols to optimize timing, duration, and selection. Preoperative bathing and appropriate hair removal practices should be institutionalized through standard operating procedures and reinforced via structured patient education. Hand-hygiene auditing and feedback mechanisms need to be strengthened and formally aligned with IPC committee oversight to ensure accountability. Finally, laboratory capacity for culture and antimicrobial susceptibility testing should be enhanced, with routine production of quarterly antibiograms to inform SAP and AMS decisions. Investments in data systems, including automated dashboards, EMR integration, and routine data review forums are critical to sustaining data use for action.

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7. Republic of Uganda Ministry of Health. Annual Health Sector Performance Report 2023/24. at https://guluhospital.net/wp-content/uploads/2024/10/Annual-Health-Sector-Performance-Report-FY-2023_24-1.pdf (accessed September 10, 2025) (2025).

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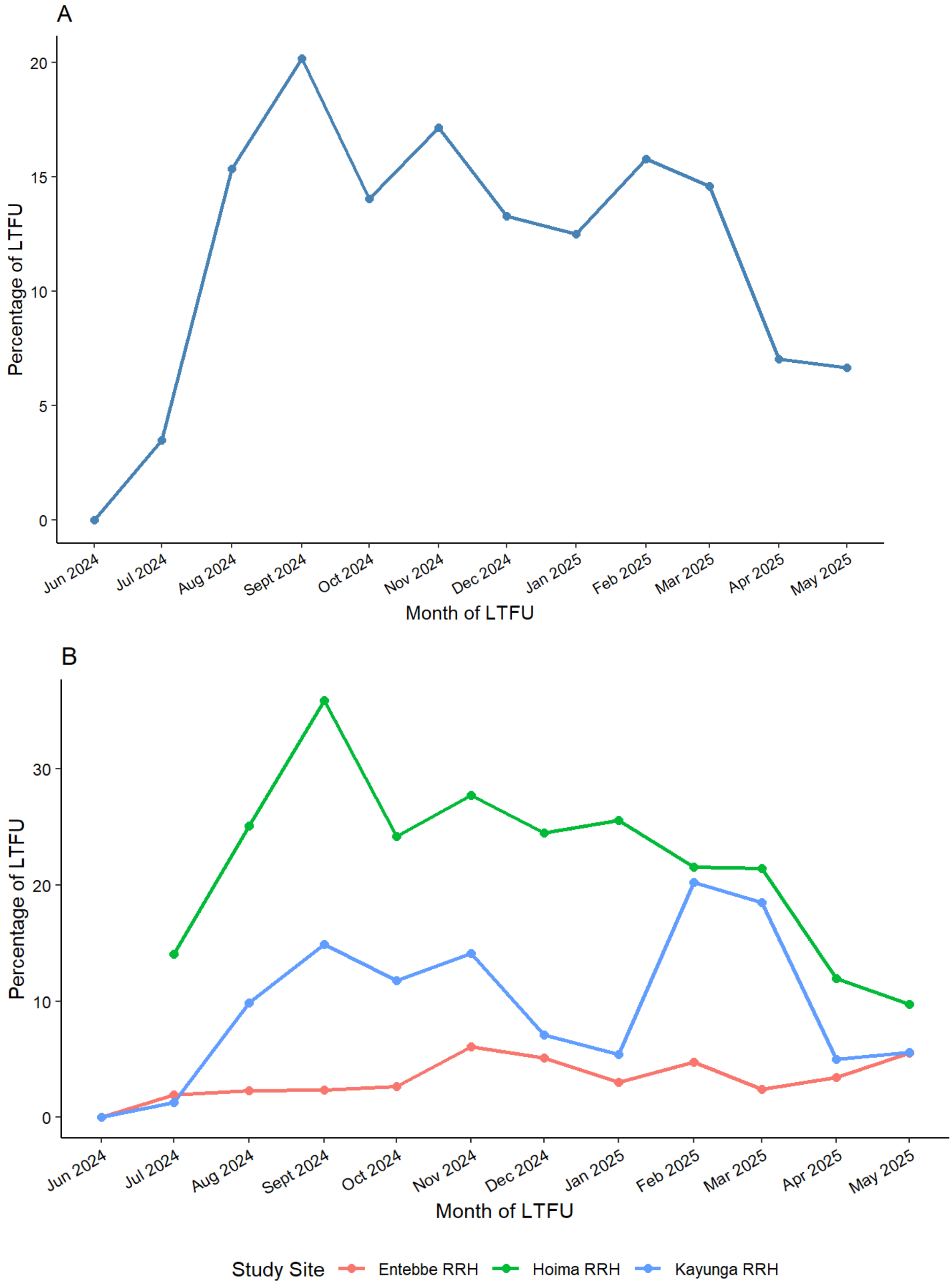
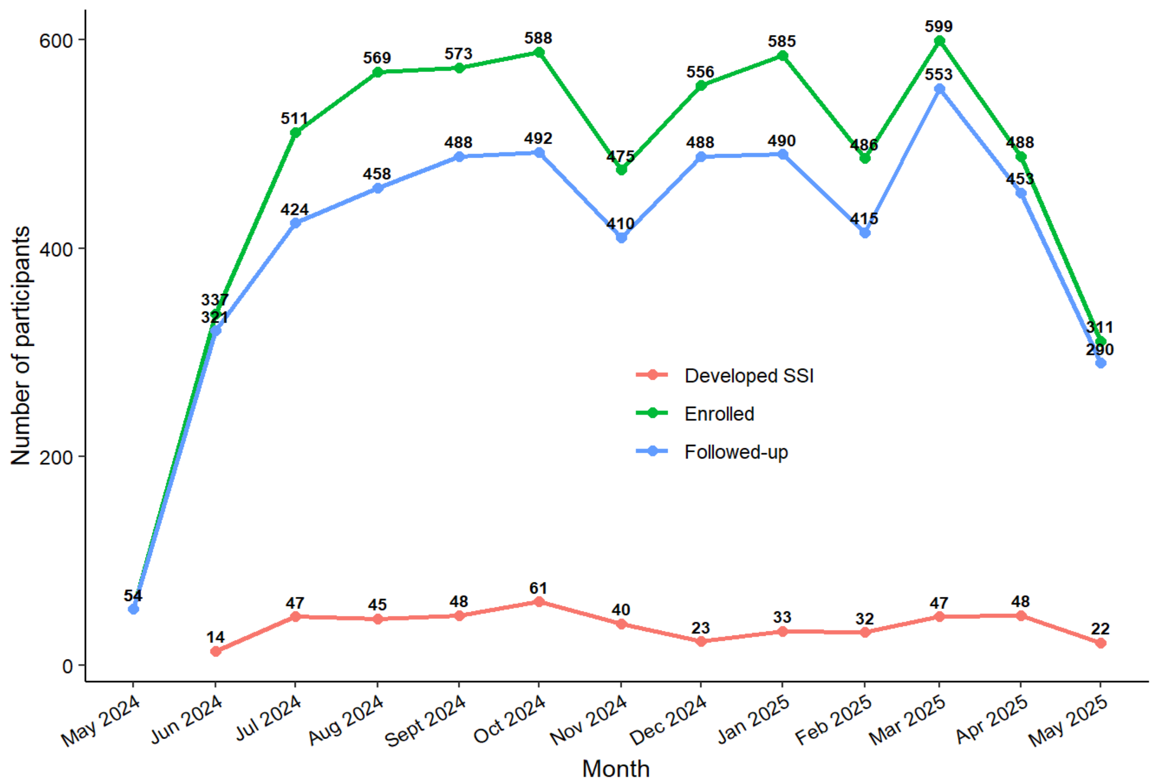
# APPENDICES

## Appendix I. LOST TO FOLLOW-UP

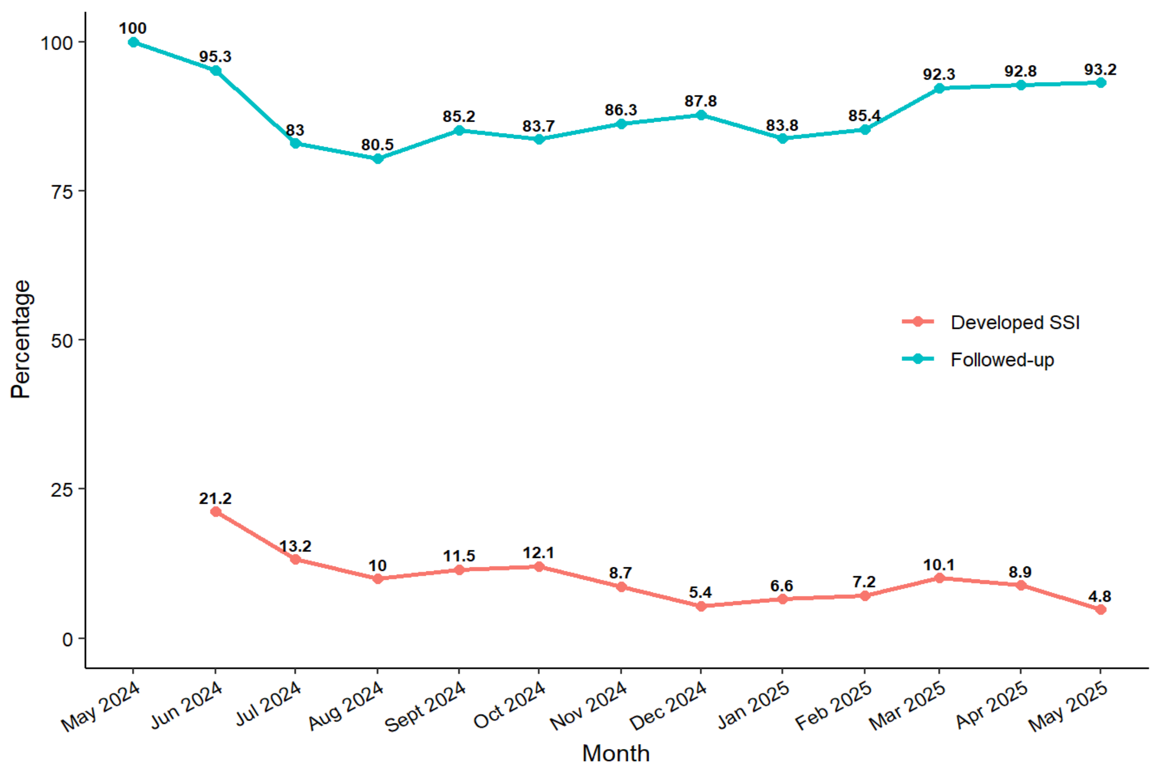
### Trends of lost to follow-up



## Number enrolled, followed-up successfully, developed an SSI

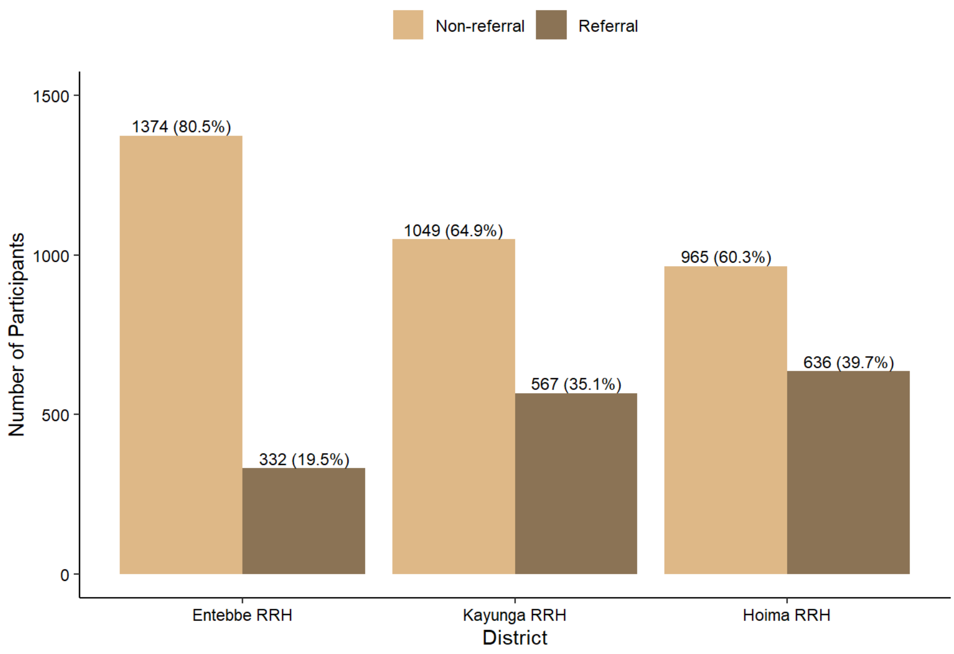



## Percentage followed-up successfully and developed an SSI

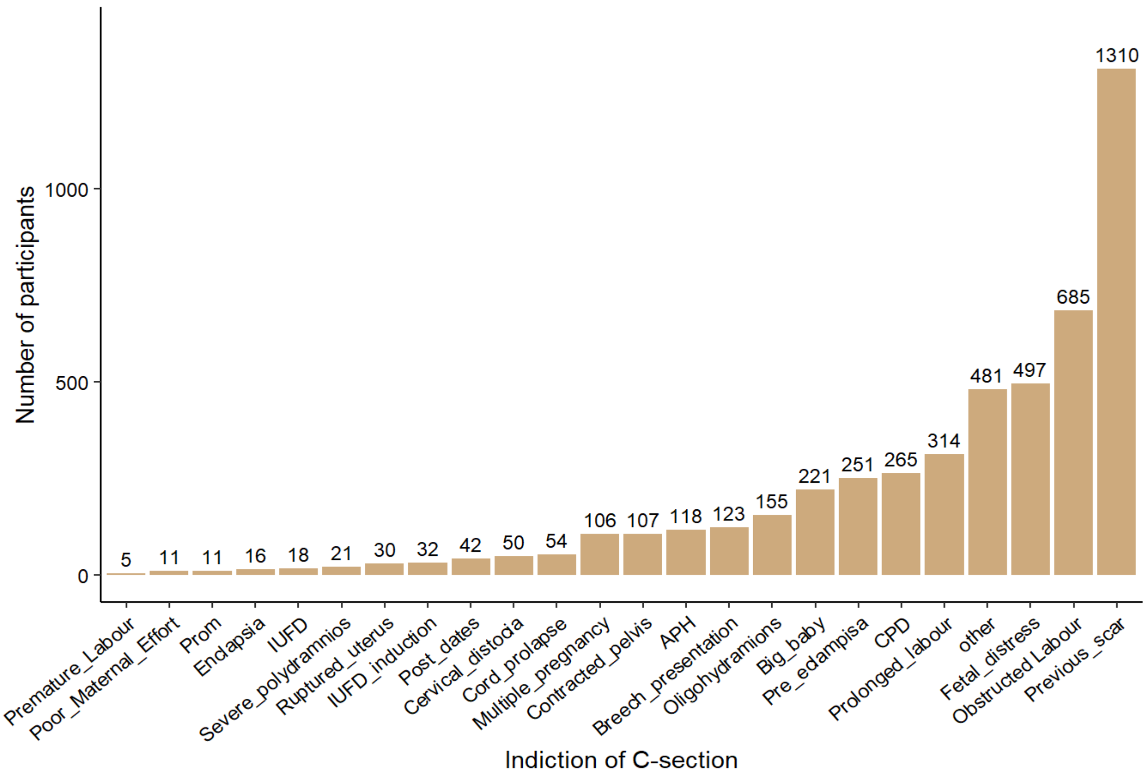


## Appendix II. REFERRALS AND INDICATIONS FOR C/S

### Number of Referrals from other facilities and non-referrals per RRH

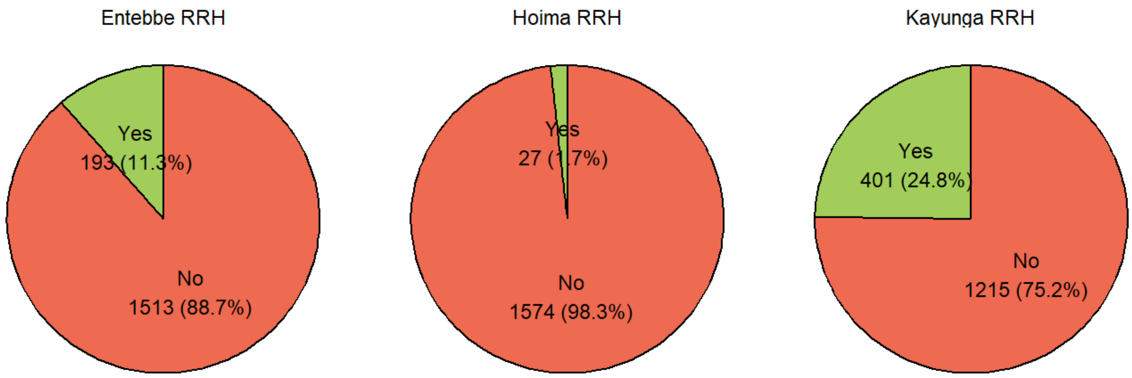



### Number of participants by indication of C-section

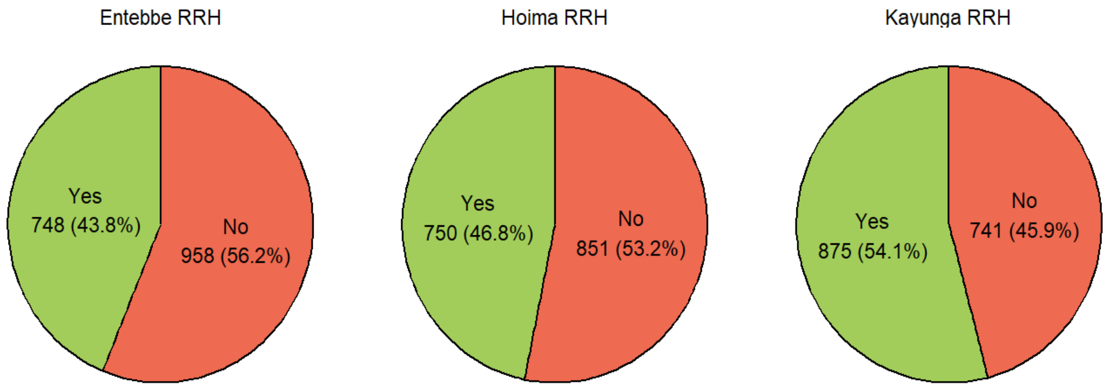


## Appendix III. ADHERENCE TO SURGICAL CARE BUNDLES

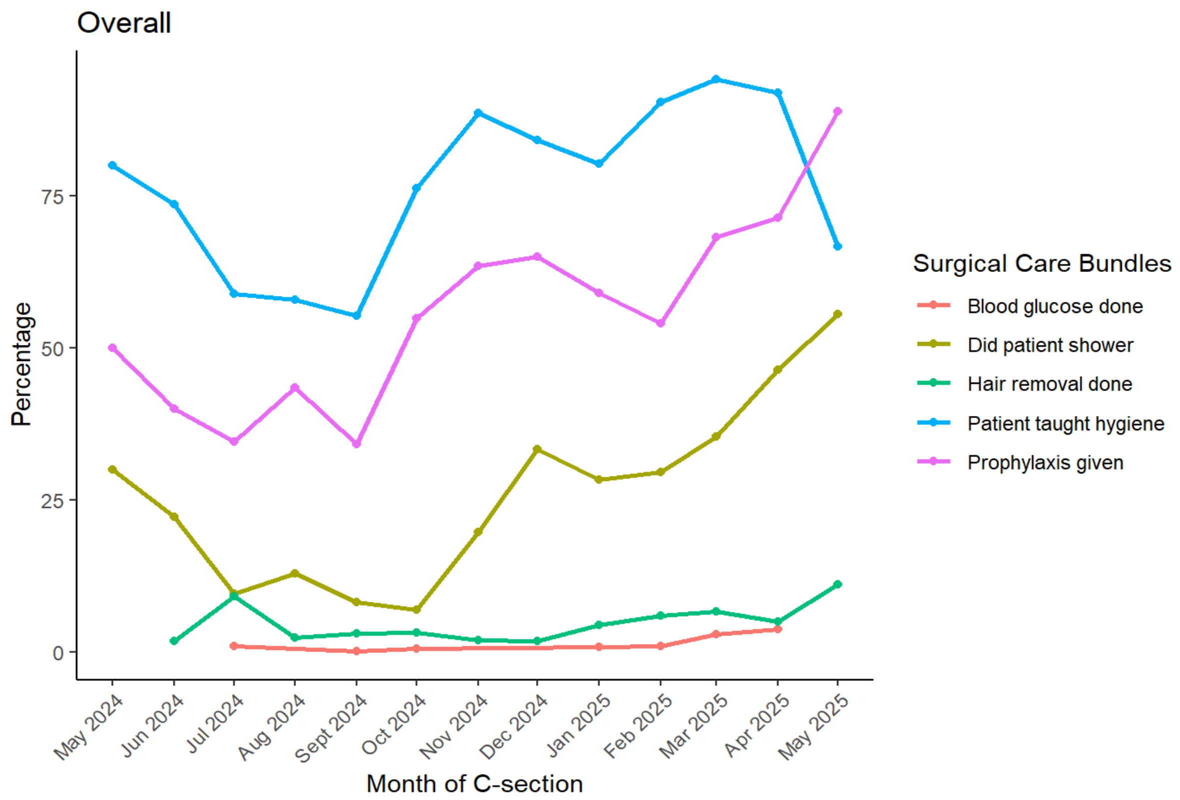
### Adherence to surgical care bundles for all bundles




### Adherence to surgical care bundles for 3/4 bundles

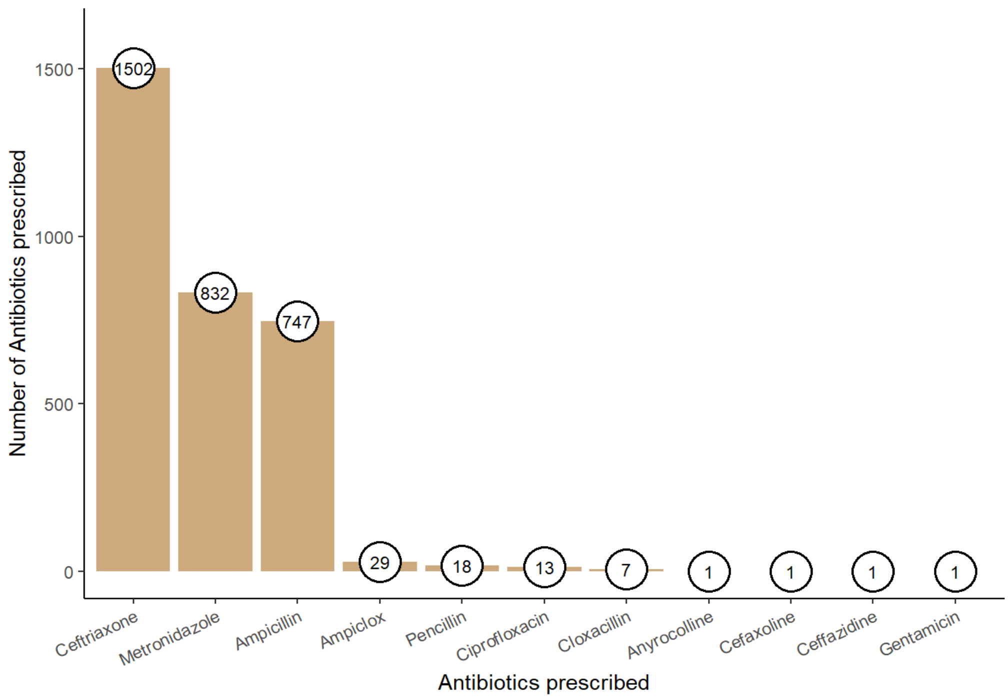


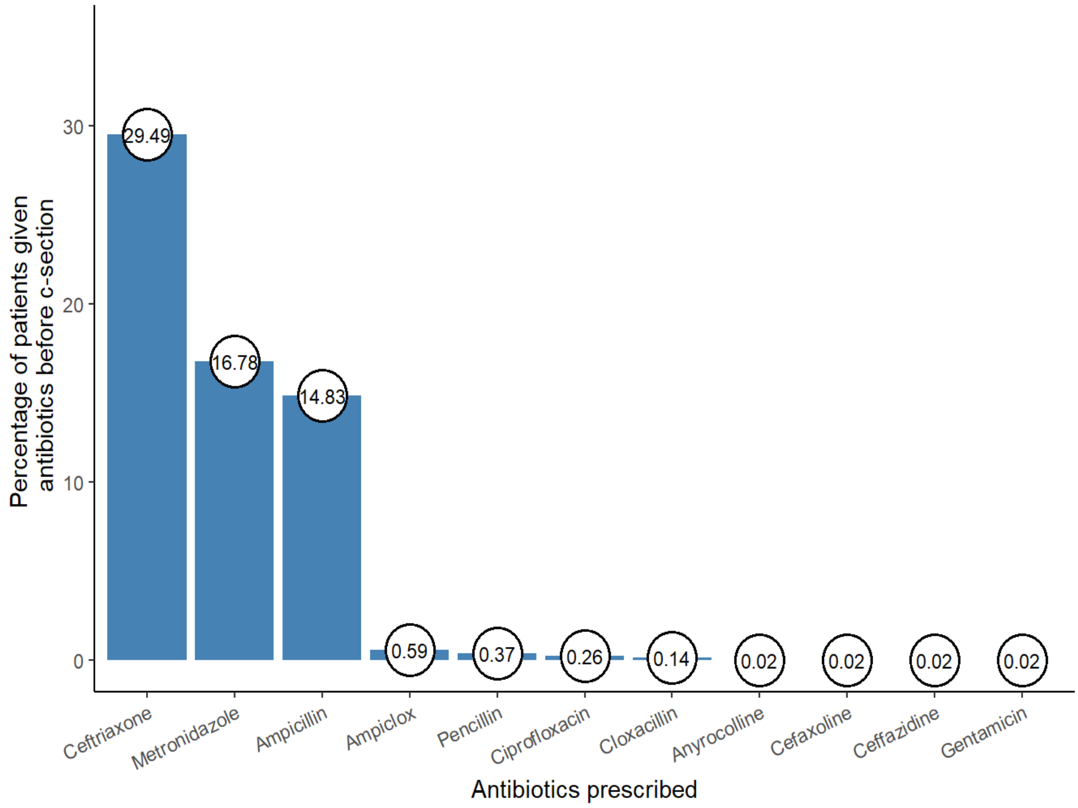
### Trends of the surgical care bundles



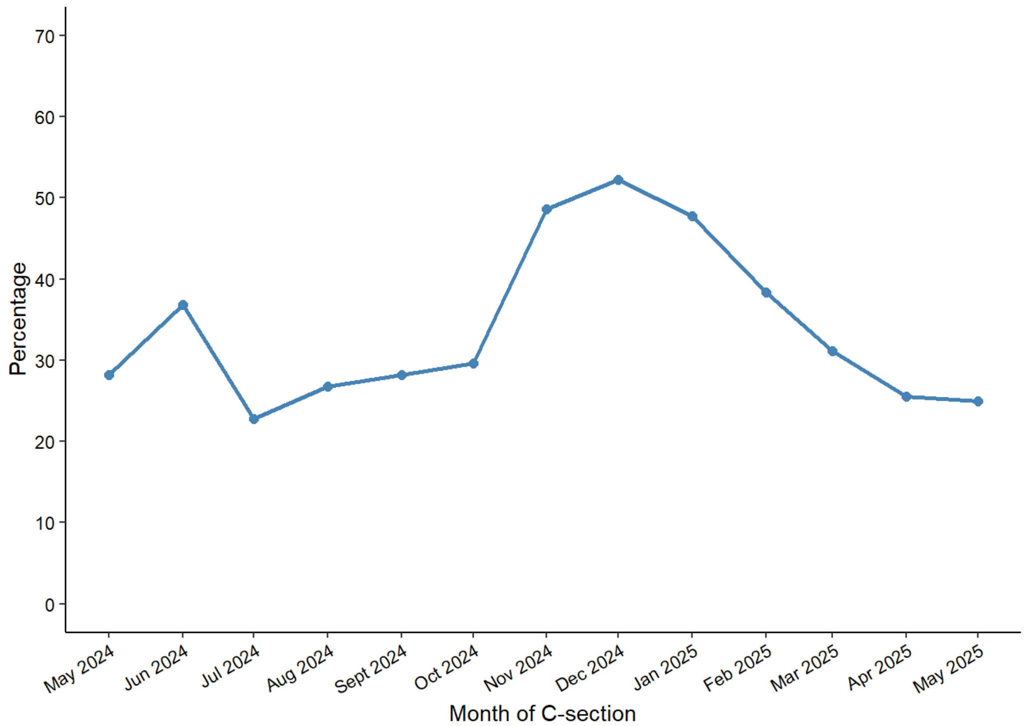

## Appendix IV. ANTIBIOTICS PRESCRIBED

### Antibiotics prescribed






**Trends of correct Antibiotic duration before C-section (Among those who received antibiotics)**



## Appendix V. SSI OUTCOMES

### SSIs at each follow-up period by HIV status

| Variable | HIV Positive | HIV Negative | Unknown | Total |
|---|---|---|---|---|
| **Surveillance site** | | | | |
| Entebbe RRH | 1,607 (34.89%) | 94 (31.33%) | 5 (29.41%) | 1,706 (34.65%) |
| Hoima RRH | 1,481 (32.15%) | 112 (37.33%) | 8 (47.06%) | 1,601 (32.52%) |
| Kayunga RRH | 1,518 (32.96%) | 94 (31.33%) | 4 (23.53%) | 1,616 (32.83%) |
| **Baseline** | | | | |
| No | 4,480 (99.76%) | 294 (99.66%) | 17 (100.00%) | 4,791 (99.75%) |
| Yes | 11 (0.24%) | 1 (0.34%) | 0 (0.00%) | 12 (0.25%) |
| **Day 6 infections** | | | | |
| No | 3,789 (95.80%) | 238 (95.58%) | 15 (93.75%) | 4,042 (95.78%) |
| Yes | 166 (4.20%) | 11 (4.42%) | 1 (6.25%) | 178 (4.22%) |
| **Day 14 infections** | | | | |
| No | 3,760 (95.55%) | 243 (97.20%) | 15 (88.24%) | 4,018 (95.62%) |
| Yes | 175 (4.45%) | 7 (2.80%) | 2 (11.76%) | 184 (4.38%) |
| **Day 30 infections** | | | | |
| No | 4,236 (98.35%) | 274 (97.51%) | 17 (100.00%) | 4,527 (98.31%) |
| Yes | 71 (1.65%) | 7 (2.49%) | 0 (0.00%) | 78 (1.69%) |
| **Total SSIs** | | | | |
| No | 4,183 (90.82%) | 274 (91.33%) | 14 (82.35%) | 4,471 (90.82%) |
| Yes | 423 (9.18%) | 26 (8.67%) | 3 (17.65%) | 452 (9.18%) |

### C-Section associated Infections at each follow-up period across predictor variables

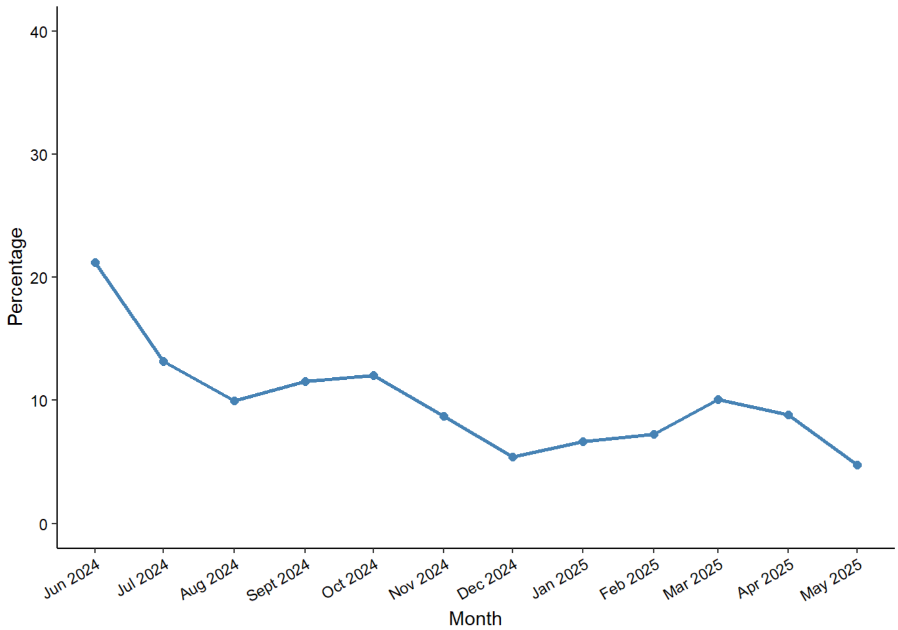
| Variable | No SSI | SSI | Total | P-value |
|---|---|---|---|---|
| **Age in years** | | | | |
| Median (IQR) | 25.00 (8.00) | 25.00 (9.00) | 25.00 (8.00) | - |
| Q1, Q3 | 22.00, 30.00 | 21.00, 30.00 | 22.00, 30.00 | |
| **C-section type** | | | | |
| Elective | 448 (10.02%) | 39 (8.63%) | 487 (9.89%) | 0.389 |
| Emergent | 4,023 (89.98%) | 413 (91.37%) | 4,436 (90.11%) | |
| **Surgery done by** | | | | |
| Intern doctor | 2,544 (56.90%) | 256 (56.64%) | 2,800 (56.88%) | 0.593 |
| Medical officer | 875 (19.57%) | 97 (21.46%) | 972 (19.74%) | |
| Other | 212 (4.74%) | 23 (5.09%) | 235 (4.77%) | |
| SHO | 603 (13.49%) | 59 (13.05%) | 662 (13.45%) | |
| Specialist obstetrician | 237 (5.30%) | 17 (3.76%) | 254 (5.16%) | |
| **Anesthesia by** | | | | |
| Anesthetist | 4,419 (98.84%) | 444 (98.23%) | 4,863 (98.78%) | 0.445 |
| Intern anesthetist | 21 (0.47%) | 4 (0.88%) | 25 (0.51%) | |
| Specialist anesthesiologist | 31 (0.69%) | 4 (0.88%) | 35 (0.71%) | |
| **ASA score** | | | | |
| 1 | 3,159 (70.66%) | 328 (72.57%) | 3,487 (70.83%) | 0.457 |
| 2 | 1,199 (26.82%) | 114 (25.22%) | 1,313 (26.67%) | |
| 3 | 93 (2.08%) | 7 (1.55%) | 100 (2.03%) | |
| 4 | 13 (0.29%) | 3 (0.66%) | 16 (0.33%) | |
| 5 | 7 (0.16%) | 0 (0.00%) | 7 (0.14%) | |

| | | | | |
|---|---|---|---|---|
| **HIV status** | | | | |
| Negative | 4,183 (93.56%) | 423 (93.58%) | 4,606 (93.56%) | 0.459 |
| Positive | 274 (6.13%) | 26 (5.75%) | 300 (6.09%) | |
| Unknown | 14 (0.31%) | 3 (0.66%) | 17 (0.35%) | |
| **Blood glucose done** | | | | |
| No | 4,433 (99.15%) | 446 (98.67%) | 4,879 (99.11%) | 0.444 |
| Yes | 38 (0.85%) | 6 (1.33%) | 44 (0.89%) | |
| **Prophylaxis given** | | | | |
| No | 1,963 (45.26%) | 235 (53.29%) | 2,198 (46.00%) | 0.002 |
| Yes | 2,374 (54.74%) | 206 (46.71%) | 2,580 (54.00%) | |
| Missing | 134 | 11 | 145 | |
| **Did patient shower** | | | | |
| No | 3,329 (76.76%) | 367 (83.22%) | 3,696 (77.35%) | 0.002 |
| Yes | 1,008 (23.24%) | 74 (16.78%) | 1,082 (22.65%) | |
| Missing | 134 | 11 | 145 | |
| **Hair removal done** | | | | |
| No | 4,282 (95.77%) | 436 (96.46%) | 4,718 (95.84%) | 0.566 |
| Yes | 189 (4.23%) | 16 (3.54%) | 205 (4.16%) | |
| **Patient skin preparation** | | | | |
| Alcohol | 87 (1.95%) | 7 (1.55%) | 94 (1.91%) | 0.023 |
| Betadine | 1,457 (32.59%) | 120 (26.55%) | 1,577 (32.03%) | |
| Chlorhexidine | 2,927 (65.47%) | 325 (71.90%) | 3,252 (66.06%) | |
| **Skin dry before incision** | | | | |
| No | 1,361 (31.38%) | 120 (27.21%) | 1,481 (31.00%) | 0.080 |
| Yes | 2,976 (68.62%) | 321 (72.79%) | 3,297 (69.00%) | |
| Missing | 134 | 11 | 145 | |
| **Patient taught hygiene** | | | | |
| No | 967 (22.30%) | 117 (26.53%) | 1,084 (22.69%) | 0.05 |
| Yes | 3,370 (77.70%) | 324 (73.47%) | 3,694 (77.31%) | |
| Missing | 134 | 11 | 145 | |
| **Antibiotics post-surgery** | | | | |
| No | 59 (1.36%) | 4 (0.91%) | 63 (1.32%) | 0.565 |
| Yes | 4,278 (98.64%) | 437 (99.09%) | 4,715 (98.68%) | |
| Missing | 134 | 11 | 145 | |
| **Adherence to all surgical care bundles** | | | | |
| No | 3,890 (87.01%) | 412 (91.15%) | 4,302 (87.39%) | 0.014 |
| Yes | 581 (12.99%) | 40 (8.85%) | 621 (12.61%) | |

**Logistic regression of factors associated with SSI**

| | **Categories** | **OR** | **95% CI** | **P-value** |
|---|---|---|---|---|
| Referral in | No (ref) | — | — | — |
| | Yes | 1.08 | 0.87–1.33 | 0.4860 |
| C-section type | Elective (ref) | — | — | — |
| | Emergent | 1.07 | 0.76–1.54 | 0.7100 |
| HIV status | Negative (ref) | — | — | — |
| | Positive | 1.00 | 0.65–1.50 | 0.9880 |
| | Unknown | 2.60 | 0.59–8.13 | 0.1390 |
| Patient skin preparation | Alcohol (ref) | — | — | — |
| | Betadine | 1.22 | 0.56–3.22 | 0.6480 |
| | Chlorhexidine | 1.57 | 0.73–4.08 | 0.2980 |
| Age categories | 10–19 (ref) | — | — | — |
| | 19–35 | 0.78 | 0.57–1.09 | 0.1350 |
| | 35–50 | 0.65 | 0.40–1.04 | 0.0730 |
| Surgery done by | Intern doctor (ref) | — | — | — |
| | Medical officer | 1.13 | 0.87–1.45 | 0.3620 |
| | Other surgery cadre | 0.93 | 0.56–1.47 | 0.7600 |
| | SHO | 1.03 | 0.75–1.38 | 0.8570 |
| | Specialist obstetrician | 0.71 | 0.40–1.16 | 0.1990 |
| Anesthesia by | Anesthetist (ref) | — | — | — |
| | Intern anesthetist | 2.16 | 0.62–5.75 | 0.1640 |
| | Specialist anesthesiologist | 1.31 | 0.39–3.38 | 0.6120 |
| Prophylaxis given | No (ref) | — | — | — |
| | Yes | 1.01 | 0.76–1.34 | 0.9460 |
| Adherence to surgical care bundles | No (ref) | — | — | — |
| | Yes | 0.63 | 0.47–0.85 | 0.0024 |
| Antibiotics post-surgery | No (ref) | — | — | — |
| | Yes | 1.38 | 0.55–4.62 | 0.5420 |

## Overall Trends of SSI infections

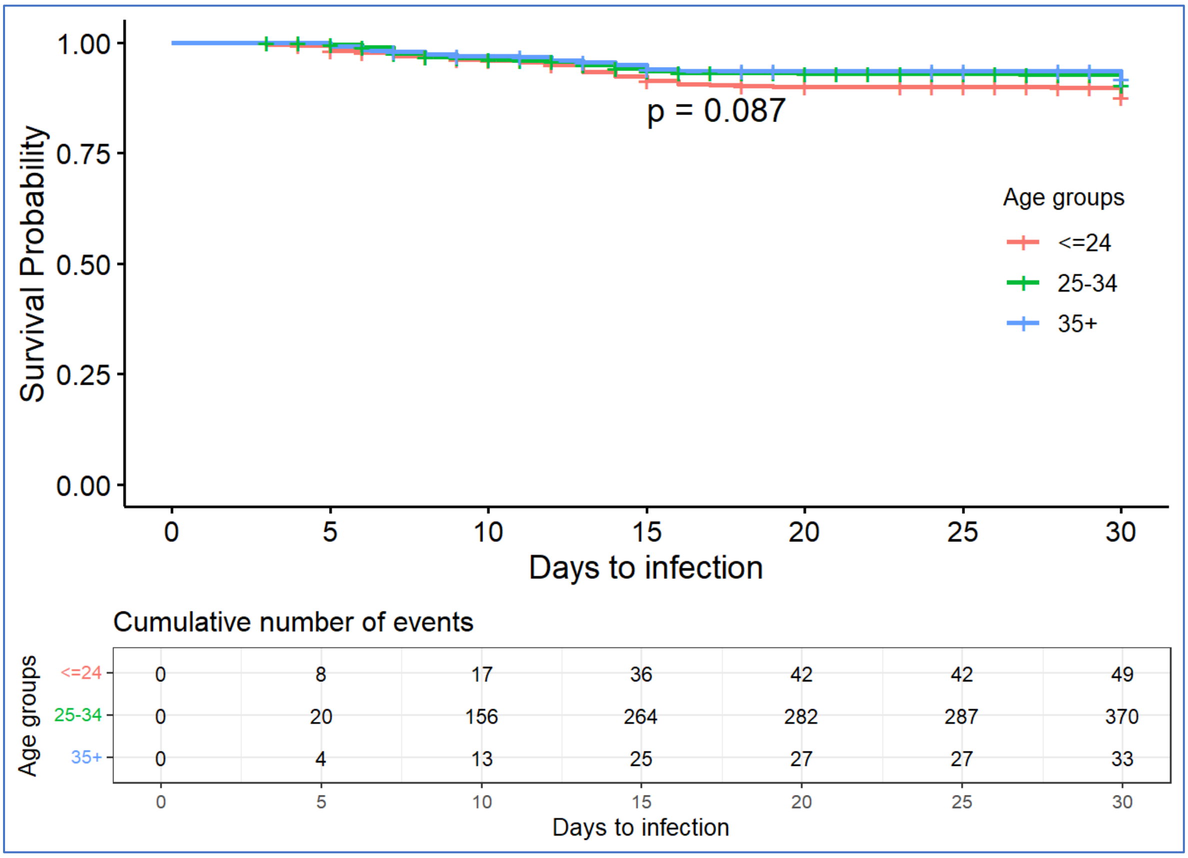


<u>**Appendix V. SSI TIME-EVENT ANALYSIS**</u>

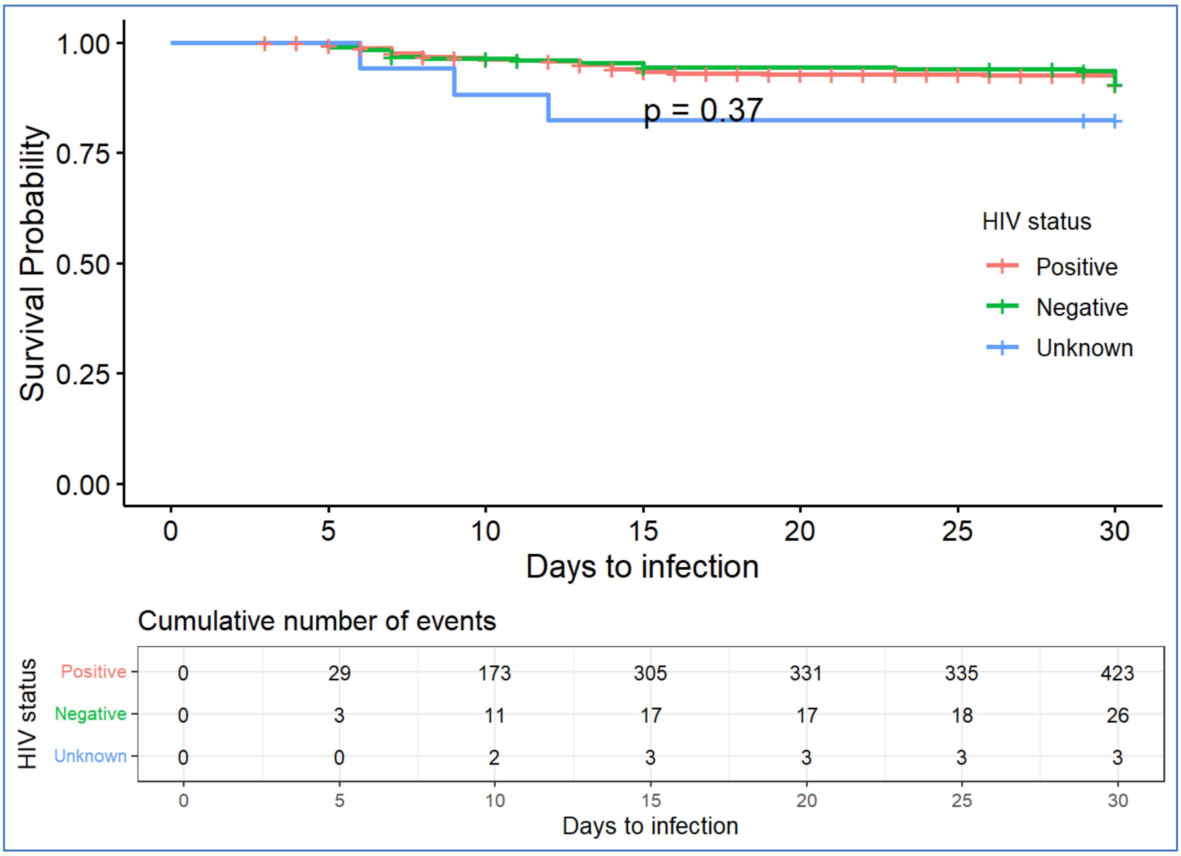
## Kaplan–Meier Survival probabilities for SSI 30 days follow-up

| Time (Days) | Number at Risk | Number of Events | Survival Probability | Standard Error | Lower 95% CI | Upper 95% CI |
|---|---|---|---|---|---|---|
| 3 | 4,923 | 2 | 0.99959 | 0.00029 | 0.999 | 1.000 |
| 4 | 4,919 | 6 | 0.99837 | 0.00057 | 0.997 | 1.000 |
| 5 | 4,911 | 24 | 0.99350 | 0.00115 | 0.991 | 0.996 |
| 6 | 4,883 | 33 | 0.98678 | 0.00163 | 0.984 | 0.990 |
| 7 | 4,844 | 60 | 0.97456 | 0.00225 | 0.970 | 0.979 |
| 8 | 4,774 | 34 | 0.96762 | 0.00253 | 0.963 | 0.973 |
| 9 | 4,737 | 15 | 0.96455 | 0.00264 | 0.959 | 0.970 |
| 10 | 4,716 | 12 | 0.96210 | 0.00273 | 0.957 | 0.967 |
| 11 | 4,702 | 14 | 0.95923 | 0.00282 | 0.954 | 0.965 |
| 12 | 4,683 | 15 | 0.95616 | 0.00292 | 0.950 | 0.962 |
| 13 | 4,663 | 35 | 0.94899 | 0.00314 | 0.943 | 0.955 |
| 14 | 4,620 | 41 | 0.94056 | 0.00338 | 0.934 | 0.947 |
| 15 | 4,570 | 34 | 0.93357 | 0.00356 | 0.927 | 0.941 |
| 16 | 4,530 | 17 | 0.93006 | 0.00365 | 0.923 | 0.937 |
| 17 | 4,506 | 4 | 0.92924 | 0.00367 | 0.922 | 0.936 |
| 18 | 4,498 | 1 | 0.92903 | 0.00367 | 0.922 | 0.936 |
| 19 | 4,493 | 3 | 0.92841 | 0.00369 | 0.921 | 0.936 |
| 20 | 4,482 | 1 | 0.92820 | 0.00369 | 0.921 | 0.935 |
| 21 | 4,476 | 1 | 0.92800 | 0.00370 | 0.921 | 0.935 |
| 22 | 4,473 | 1 | 0.92779 | 0.00370 | 0.921 | 0.935 |
| 23 | 4,469 | 1 | 0.92758 | 0.00371 | 0.920 | 0.935 |
| 24 | 4,459 | 1 | 0.92737 | 0.00371 | 0.920 | 0.935 |
| 25 | 4,449 | 1 | 0.92716 | 0.00372 | 0.920 | 0.934 |
| 26 | 4,441 | 1 | 0.92696 | 0.00372 | 0.920 | 0.934 |
| 27 | 4,429 | 3 | 0.92633 | 0.00374 | 0.919 | 0.934 |
| 28 | 4,398 | 3 | 0.92570 | 0.00375 | 0.918 | 0.933 |
| 29 | 4,302 | 2 | 0.92527 | 0.00376 | 0.918 | 0.933 |
| 30 | 3,598 | 87 | 0.90289 | 0.00437 | 0.894 | 0.911 |

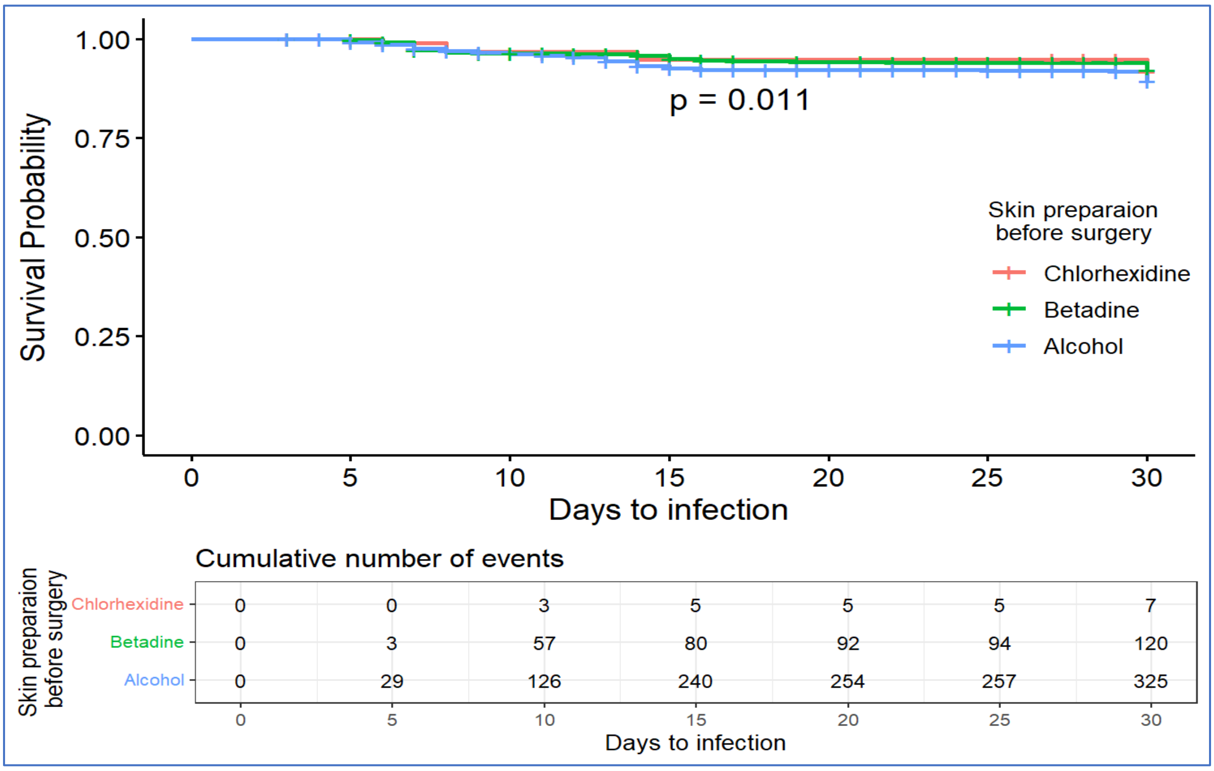
**Survival probabilities by age groups**




**Survival probabilities by HIV status**



**Survival probabilities by Skin preparation method**




**Survival probabilities by C-section type**