Cureus
Part of SPRINGER NATURE

Open Access Original Article

# Improving Documentation of Surgical Site Infection Prevention Measures Through a Digital Quality Improvement Intervention: A Two-Cycle Clinical Audit at Al Managil Teaching Hospital, Sudan

**Review began** 10/05/2026
**Review ended** 10/18/2026
**Published** 10/22/2026

© **Copyright** 2026
ShmsEldeen Abozaid Alshafiea et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

**DOI:** 10.7759/cureus.118402

Wafa ShmsEldeen Abozaid Alshafiea [1], Abdulwahab Mustafa Abdulgader Mustafa [2], Mohamed Khalid Hassan Abdelkarim [3], Fatmah Abdulkadir Nur Hassan [4], Razan Imad Mohamedtahir Fadlalla [5], Nada Abdelnaser Ahmed Alshorbagy [6], Mahdi Hamdan Salih Elnemair [7], Razan Mutasim Mahgoub Idris [8], Eman Abubakeralsideeg Diaaldeen Mohamed [3], Gesaim Mohammed [9], Abdelhameed Mohamed Ibrahim Yousif [4], Mohamed Mahmoud Mohamed Ali [4], Mohamed Elsayed Abdelhalim Hassan [10], Muayad Mubarak Mohamed Ali [11], Alaa Kamal Hassan Hamedelnile [12], Mustafa Mohamed [13], Mawia Ahmed [10], Albushra Altayeb Adam Osman [4], Abdelgalil Esameldin Omer Eldaw [10], Abdalmahmoud Asadig Kanan Ahmed [14], Ahmed Zainalbden Ibrahim Mohammed [4]

1. Otorhinolaryngology, Atbara Police Hospital, Atbara, SDN 2. General Surgery, Port Sudan Doctors Hospital, Port Sudan, SDN 3. General Surgery, Al Managil Teaching Hospital, Al Managil, SDN 4. Surgery, Al Managil Teaching Hospital, Al Managil, SDN 5. General Surgery, Nile University, Khartoum, SDN 6. General Practice, University of Sharjah, Sharjah, ARE 7. Orthopedic Surgery, Sudan Medical Specialization Board, Khartoum, SDN 8. Pediatric Surgery, Ibn Sina University, Khartoum, SDN 9. Surgery, Via Medica International Healthcare, Abu Dhabi, ARE 10. Emergency Medicine, Al Managil Teaching Hospital, Al Managil, SDN 11. General Surgery, Atbara Teaching Hospital, Atbara, SDN 12. Surgery, University of Khartoum, Khartoum, SDN 13. Internal Medicine, Al Neelain University, Khartoum, SDN 14. Internal Medicine and General Surgery, Al Managil Teaching Hospital, Al Managil, SDN

**Corresponding author:** Wafa ShmsEldeen Abozaid Alshafiea, wafaashams733@gmail.com

## Abstract

### Background

Surgical site infections (SSIs) remain an important cause of postoperative morbidity, particularly in resource-limited healthcare settings. Reliable implementation and documentation of evidence-based perioperative preventive measures are essential for reducing SSI risk. This quality improvement project assessed changes in documented perioperative SSI prevention measures following implementation of a structured digital documentation system supported by targeted staff education in a Sudanese teaching hospital.

### Methods

A two-cycle clinical audit was conducted in the Surgical Department of Al Managil Teaching Hospital, Sudan, between 1 June and 31 August 2026. Cycle 1 comprised a two-week retrospective audit of 51 surgical patients, followed by a one-month intervention incorporating the Clinical Audit System for Surgical Site Infection Prevention (CASSSI), targeted staff education, and reinforcement of evidence-based SSI prevention and documentation practices. Cycle 2 was conducted prospectively over approximately six weeks and included 48 patients, with data obtained from clinical records and direct observation using CASSSI. Audit items were informed primarily by the World Health Organization SSI prevention recommendations. Whole-cohort proportions of documented affirmative responses were compared using Pearson's chi-square or Fisher's exact test, as appropriate. A two-sided $p < 0.05$ was considered statistically significant, without adjustment for multiple comparisons.

### Results

Substantial increases in documented affirmative responses were observed across several perioperative measures. Surgical antibiotic prophylaxis recorded as appropriately timed increased from 2/51 (3.9%) to 37/48 (77.1%; $p < 0.001$). Recorded surgical-site preparation with chlorhexidine increased from 2/51 (3.9%) to 47/48 (97.9%; $p < 0.001$), and surgical hand preparation from 12/51 (23.5%) to 47/48 (97.9%; $p < 0.001$). Affirmative recording of adequate circulating volume increased from 3/51 (5.9%) to 48/48 (100%; $p < 0.001$), incisional wound irrigation from 4/51 (7.8%) to 47/48 (97.9%; $p < 0.001$), and sterile drape and gown use from 13/51 (25.5%) to 43/48 (89.6%; $p < 0.001$). Documentation of postoperative wound dressing increased from 1/51 (2.0%) to 44/48 (91.7%; $p < 0.001$). Recorded postoperative antimicrobial prophylaxis increased from 19/51 (37.3%) to 47/48 (97.9%; $p < 0.001$), highlighting an antimicrobial-stewardship concern. Post-discharge SSI surveillance remained limited, with Day 7, 14, and 30 follow-up documented in only 4/48 (8.3%), 2/48 (4.2%), and 1/48 (2.1%) of Cycle 2 patients, respectively.

**How to cite this article**
ShmsEldeen Abozaid Alshafiea W, Mustafa A, Abdelkarim M, et al. (October 22, 2026) Improving Documentation of Surgical Site Infection Prevention Measures Through a Digital Quality Improvement Intervention: A Two-Cycle Clinical Audit at Al Managil Teaching Hospital, Sudan. Cureus 18(10): e118402. DOI 10.7759/cureus.118402

## Conclusions

Implementation of CASSSI alongside targeted education was associated with improved documentation completeness and increased recording of several perioperative SSI prevention measures. Differences in ascertainment between cycles and incomplete standardization of operational definitions limit attribution of these changes to improved clinical practice or guideline adherence. Increased recorded postoperative prophylaxis highlighted an antimicrobial-stewardship concern, while incomplete surveillance prevented reliable estimation of SSI incidence or conclusions about infection reduction. Further cycles should standardize measurement, strengthen antimicrobial stewardship, and establish systematic postoperative surveillance.

**Categories:** General Surgery, Medical Education, Quality Improvement
**Keywords:** audit, quality improvement project, surgical incision, surgical site infections, world health organization

# Introduction

Surgical site infections (SSIs) are an important cause of healthcare-associated morbidity and remain a major patient-safety concern worldwide. They may occur following surgical procedures when microorganisms contaminate the surgical incision or deeper operative tissues, resulting in infections ranging from superficial incisional disease to deep or organ-space infection. SSIs can adversely affect postoperative recovery and are associated with prolonged hospitalization, additional antimicrobial therapy and procedures, increased healthcare utilization, and substantial clinical and economic burden. The World Health Organization (WHO) identifies SSI as one of the most frequently reported healthcare-associated infections, particularly in low- and middle-income countries, where the burden is disproportionately high [1,2].

The burden of SSI is particularly relevant in resource-limited healthcare settings. WHO data indicate that approximately 11% of patients undergoing surgery in low- and middle-income countries develop an infection during the surgical process, while rates following some procedures may be considerably higher; for example, wound infection has been reported in up to 20% of women undergoing caesarean section in Africa [2]. Although SSI also remains an important healthcare-associated infection in high-income settings, limitations in infection-prevention infrastructure, surveillance systems, staffing, and resources can create additional challenges in lower-resource environments. Consequently, prevention of SSI represents an important opportunity to improve surgical outcomes and patient safety [2,3].

A substantial proportion of SSIs can be prevented through consistent implementation of evidence-based measures throughout the perioperative pathway. International guidelines recommend a multimodal approach encompassing appropriate preoperative preparation, timely surgical antimicrobial prophylaxis, appropriate hair removal when necessary, effective antiseptic skin preparation, maintenance of intraoperative physiological parameters, appropriate wound management, and other measures according to the procedure and individual patient risk [1,4,5]. The WHO Global Guidelines for the Prevention of Surgical Site Infection provide evidence-based recommendations spanning the preoperative, intraoperative, and postoperative periods, while NICE and CDC guidance similarly emphasize systematic implementation of established infection-prevention practices [1,3,5].

Effective SSI prevention, however, depends not only on the delivery of appropriate clinical interventions but also on reliable documentation and postoperative surveillance. Accurate perioperative records enable clinical teams to demonstrate whether recommended preventive measures have been undertaken, support communication and continuity of care, and permit meaningful assessment of adherence to agreed standards. Structured surveillance is similarly important because an SSI may become apparent after discharge; established surveillance frameworks therefore assess infections occurring during defined postoperative surveillance periods [5,6]. Inadequate documentation or follow-up can consequently make it difficult to distinguish between failure to implement an intervention and failure to record it, limiting the ability of healthcare organizations to evaluate practice and identify opportunities for improvement.

This quality improvement project (QIP) was undertaken in the Surgical Department of Al Managil Teaching Hospital, Sudan. Its primary objective was to assess changes in documented perioperative SSI prevention measures between a baseline audit and a reaudit following implementation of the Clinical Audit System for Surgical Site Infection Prevention (CASSSI), supported by targeted staff education. The project also sought to identify persistent documentation and surveillance gaps to guide subsequent improvement cycles. The primary focus was documentation of preventive processes rather than changes in SSI incidence. Although Cycle 2 entries were checked against clinical records or direct observation, differences in ascertainment between cycles prevented recorded changes from establishing equivalent improvements in clinical practice.

# Materials And Methods

## Study design and setting

This QIP was conducted in the Surgical Department of Al Managil Teaching Hospital, Sudan, using a two-

cycle clinical audit design. The project evaluated documented SSI prevention practices and the completeness of perioperative documentation. Cycle 1 established baseline documentation through retrospective review of clinical records. Following identification of priority gaps, a structured quality improvement intervention was implemented, after which Cycle 2 was conducted prospectively.

## Audit standards

The audit checklist was developed primarily from the WHO Global Guidelines for the Prevention of Surgical Site Infection [1]. It covered preoperative preparation, surgical antibiotic prophylaxis (SAP), surgical-site and hand preparation, intraoperative preventive measures, and postoperative care. Background clinical documentation and postoperative SSI surveillance were also assessed.

The same core checklist items were maintained across both cycles. However, detailed operational definitions were not standardized for every item. Affirmative responses therefore reflected the data collectors' assessment of the available information against the checklist rather than uniform verification of every WHO recommendation.

For interpretation, recording that an intervention had been performed was distinguished from establishing concordance with the relevant recommendation. This distinction was particularly important for interventions applicable only to selected patients or procedures and for practices whose routine use was not recommended. An increase in affirmative responses was therefore not automatically interpreted as improved guideline adherence.

## Study population and audit timeline

The QIP was conducted in three sequential phases between 1 June and 31 August 2026. Cycle 1 was undertaken from 1 to 14 June 2026 and included 51 patients undergoing primary open surgical procedures. Baseline data were collected retrospectively from existing clinical records.

A one-month intervention period followed, from 15 June to 14 July 2026. Identified gaps were addressed through implementation of the CASSSI, targeted staff education, and reinforcement of evidence-based SSI prevention and documentation practices.

Cycle 2 was conducted prospectively from 15 July to 31 August 2026 and included 48 surgical patients. The same core checklist items were assessed during reaudit.

Patients of all ages and both sexes undergoing primary open surgical procedures classified as Class I (clean), Class II (clean-contaminated), or Class III (contaminated) wounds were eligible. Patients with a preexisting SSI or Class IV (dirty/infected) wounds at the time of surgery were excluded. Purely endoscopic, closed-reduction, and other non-incisional procedures were also excluded. Patients who died or were transferred to another healthcare facility within 48 hours of surgery were excluded if this prevented adequate postoperative assessment.

Where wound classification was not explicitly recorded, eligibility was assessed by reviewing the available operative details. For the documentation outcome, wound classification was counted as documented only when the classification itself was explicitly recorded. The absence of an explicitly recorded wound class therefore did not necessarily prevent assessment of eligibility.

No formal sample size calculation was performed. A total-coverage approach was adopted, whereby all patients meeting the eligibility criteria within each predefined audit period were included. Sample sizes were therefore determined by the number of eligible patients during these periods, yielding 51 patients in Cycle 1 and 48 patients in Cycle 2.

## Quality improvement intervention

Following completion of Cycle 1, identified gaps in documented SSI prevention practices were addressed through a targeted quality improvement strategy. The principal intervention was implementation of CASSSI, a digital application developed by the authors to provide a structured perioperative pathway for recording and monitoring SSI prevention measures. This was accompanied by targeted staff education and reinforcement of evidence-based SSI prevention and documentation practices.

Staff education was delivered during the intervention period through two sessions per week, each lasting approximately two hours. The program targeted theatre team members across different professional levels and was supervised by two consultant surgeons. Educational content addressed baseline audit findings and perioperative SSI prevention measures, including preoperative preparation, SAP timing, surgical-site and hand preparation, intraoperative preventive measures, postoperative wound care, and follow-up documentation. Supporting materials included the first-cycle audit presentation and the CASSSI user guide, which described case creation, completion of the staged audit questions, recording of response status and relevant measurements, and case submission.

CASSSI comprised an Android application for point-of-care data collection and a web dashboard for administrative review and data export, connected to a shared Firebase Firestore database. The application organized 29 audit questions mapped to WHO recommendations [1] into four stages: preoperative care; perioperative preparation and antibiotic prophylaxis; intraoperative care; and postoperative care and outcomes. Each item allowed users to record whether a practice was followed, not followed, or not applicable, together with relevant measurements, timings, and explanatory notes.

The application supported offline data entry and automatic synchronization when connectivity became available. Before case submission, completeness checks identified unanswered audit questions. These checks required completion of responses rather than affirmative answers and did not themselves verify whether a clinical measure had been performed.

The web dashboard enabled authorized administrators to review submitted cases and export completed records to Google Sheets (Google LLC, Mountain View, CA, USA) for subsequent processing. It also displayed case status, auditor identity, and timestamps to support administrative oversight. The application provided access to the WHO guideline and a guideline-based chatbot intended for educational and audit support. Patient names were retained in encrypted local storage on the auditor's device, while hospital file numbers and audit responses were synchronized to the central database.

Implementation was monitored through staff attendance tracking during the educational sessions and periodic review of CASSSI records during Cycle 2. Reviews assessed application use, case-submission status, and completeness of recorded responses. Recorded entries were also checked against clinical records or direct observation, as appropriate to the variable, to verify their accuracy.

## Data collection

Data collection was undertaken by four medical officers working in the surgical unit. Two weeks before the project began, the data collectors received practical training involving the collection of 10 complete practice datasets, each covering all audit variables, to familiarize them with the audit checklist and recording procedures. Education and data-collection activities were supervised by two consultant surgeons.

Cycle 1 data were collected retrospectively through manual review of eligible clinical records using the structured SSI prevention checklist. Cycle 2 data were collected prospectively using CASSSI, retaining the same core checklist items. During Cycle 2, information was obtained from clinical records or direct observation, depending on the variable assessed, and entered into the application. CASSSI enabled recording of response status, relevant measurements and timings, and explanatory notes.

For the comparative analysis, affirmative ("Yes") responses were counted for each audit item. For background documentation variables, an affirmative response indicated that the relevant information had been recorded. For clinical process variables, it indicated that the measure was recorded as performed according to the collector's assessment. Surveillance and SSI outcome variables represented recorded follow-up and recorded diagnoses, respectively.

Frequencies and percentages of affirmative responses were calculated separately for each cycle, using the total number of included patients as the denominator. These whole-cohort percentages represented the frequency of documented affirmative responses. For measures applicable only to selected patients or procedures, they did not represent adherence among eligible patients alone. The absence of an affirmative response did not, by itself, establish that a clinically indicated measure had not been performed.

For presentation and analysis, items were grouped into four domains: background clinical documentation; preoperative and pre-incision measures; intraoperative measures; and postoperative care and outcome surveillance.

Although the same core checklist items were retained, ascertainment changed from retrospective clinical-record review to prospective collection incorporating clinical records and direct observation with digital recording. Consequently, observed differences could reflect changes in ascertainment and recording as well as changes in care delivery. Verification of Cycle 2 entries did not eliminate this difference between cycles, and the comparison could not distinguish the contribution of improved documentation from that of changes in actual clinical practice.

## Data analysis

Data from both audit cycles were entered into Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analyzed using JASP version 0.96.0.0 (JASP Team, University of Amsterdam, Amsterdam, The Netherlands). Categorical variables were summarized as frequencies and percentages and reported as n (%). For each audit item, the proportion of documented affirmative responses in Cycle 1 was compared with that in Cycle 2. Absolute change was expressed as the percentage point (pp) difference between Cycle 2 and Cycle 1.

As the two audit cycles comprised independent patient samples, differences in proportions were assessed using Pearson's chi-square ($\chi^2$) test, where its assumptions were satisfied. Fisher's exact test was used where expected cell counts were small. All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant. No adjustment was made for multiple comparisons; individual p-values were therefore interpreted cautiously alongside the magnitude of observed changes.

### Ethical and governance considerations

The project was conducted as a clinical audit and quality improvement initiative within the Surgical Department of Al Managil Teaching Hospital. Formal institutional approval was obtained from Al Managil Teaching Hospital under IRB reference number 45-07-N1000.

The project was conducted in accordance with institutional ethical standards and recognized clinical-governance principles. Patient information was handled confidentially throughout both audit cycles. Patient-identifiable information was excluded from the analysis and reporting of results, and findings were reported at an aggregate level for quality improvement purposes.

## Results

### Background clinical documentation characteristics

Baseline documentation varied considerably across the assessed characteristics. Patient name and procedure name were already well documented in Cycle 1, in 50/51 (98.0%) and 42/51 (82.4%) cases, respectively. In contrast, documentation was substantially lower for file number 13/51 (25.5%), date of birth 14/51 (27.5%), procedure category 7/51 (13.7%), surgical site and laterality 26/51 (51.0%), and American Society of Anesthesiologists (ASA) grade 5/51 (9.8%). Wound classification and emergency/elective status were not documented in any Cycle 1 cases.

Cycle 2 demonstrated substantial improvement across most background documentation measures. Complete documentation was achieved for file number, patient name, date of birth, procedure name, and ASA grade (48/48 (100%)). Documentation of procedure category increased to 43/48 (89.6%), surgical site and laterality to 46/48 (95.8%), wound classification to 44/48 (91.7%), and emergency/elective status to 46/48 (95.8%). Most improvements were statistically significant, with the largest absolute increases observed for emergency/elective status (+95.8 pp; $p < 0.001$), wound classification (+91.7 pp; $p < 0.001$), and ASA grade (+90.2 pp; $p < 0.001$). Patient-name documentation showed no significant change because baseline performance was already high (98.0% vs 100%; $p = 1.000$). In contrast, documentation of colorectal surgery status decreased from 8/51 (15.7%) to 0/48 (0%) ($p = 0.006$) (Table *1*).

| Clinical metric | Cycle 1 (N = 51), n (%) | Cycle 2 (N = 48), n (%) | Change (pp) | $\chi^2$ | p-value |
|---|---|---|---|---|---|
| File number documented | 13 (25.5%) | 48 (100.0%) | 74.5 | 58.04 | <0.001 |
| Patient name documented | 50 (98.0%) | 48 (100.0%) | 2 | - † | 1.000 |
| Date of birth documented | 14 (27.5%) | 48 (100.0%) | 72.5 | 55.61 | <0.001 |
| Procedure name documented | 42 (82.4%) | 48 (100.0%) | 17.6 | - † | 0.003 |
| Procedure category documented | 7 (13.7%) | 43 (89.6%) | 75.9 | 56.92 | <0.001 |
| Surgical site and laterality documented | 26 (51.0%) | 46 (95.8%) | 44.8 | 25.08 | <0.001 |
| Wound class documented | 0 (0.0%) | 44 (91.7%) | 91.7 | 84.15 | <0.001 |
| ASA grade documented | 5 (9.8%) | 48 (100.0%) | 90.2 | 80.87 | <0.001 |
| Emergency/elective status documented | 0 (0.0%) | 46 (95.8%) | 95.8 | 91.29 | <0.001 |
| Colorectal surgery status documented | 8 (15.7%) | 0 (0.0%) | −15.7 | - † | 0.006 |

**TABLE 1: Comparison of background clinical documentation between Cycle 1 and Cycle 2.**

Data are presented as n (%). Absolute change represents the pp difference between Cycle 2 and Cycle 1. Pearson's chi-square ($\chi^2$) test was used to compare proportions where assumptions were satisfied; Fisher's exact test was used where expected cell counts were small. A two-sided p-value <0.05 was considered statistically significant.

† Indicates that Fisher's exact test was used to calculate the reported p-value; no chi-square statistic is presented for these comparisons.

ASA, American Society of Anesthesiologists; pp, percentage points

## Preoperative and pre-incision SSI prevention measures

The frequency of documented affirmative responses increased for several preoperative and pre-incision SSI prevention measures. Recorded surgical-site preparation with chlorhexidine increased from 2/51 (3.9%) in Cycle 1 to 47/48 (97.9%) in Cycle 2 (+94.0 pp; $\chi^2 = 87.40$, $p < 0.001$). Recorded surgical hand preparation increased from 12/51 (23.5%) to 47/48 (97.9%) (+74.4 pp; $\chi^2 = 56.82$, $p < 0.001$), while SAP recorded as appropriately timed increased from 2/51 (3.9%) to 37/48 (77.1%) (+73.2 pp; $\chi^2 = 55.44$, $p < 0.001$). Recorded preoperative bathing also increased from 6/51 (11.8%) to 16/48 (33.3%) ($p = 0.010$).

In contrast, changes in decolonization with mupirocin (0% vs 2.1%; $p = 0.485$), bowel preparation with oral antibiotics (0% vs 8.3%; $p = 0.052$), appropriate hair removal (0% vs 4.2%; $p = 0.233$), enhanced nutritional support (0% vs 2.1%; $p = 0.485$), and perioperative oxygenation (2.0% vs 0%; $p = 1.000$) were not statistically significant. Antimicrobial skin sealant use decreased from 8/51 (15.7%) to 2/48 (4.2%), although this difference was also not statistically significant ($p = 0.093$). Overall, the largest increases in documented affirmative responses during this phase were observed for surgical-site preparation, surgical hand preparation, and SAP recorded as appropriately timed (Table *2*).

| SSI prevention measure | Cycle 1 (N = 51), n (%) | Cycle 2 (N = 48), n (%) | Change (pp) | $\chi^2$ | p-value |
|---|---|---|---|---|---|
| Preoperative bathing (soap/antiseptic) | 6 (11.8%) | 16 (33.3%) | 21.5 | 6.66 | 0.010 |
| Decolonization (mupirocin) | 0 (0.0%) | 1 (2.1%) | 2.1 | - † | 0.485 |
| Bowel preparation + oral antibiotics | 0 (0.0%) | 4 (8.3%) | 8.3 | - † | 0.052 |
| Correct SAP administration timing | 2 (3.9%) | 37 (77.1%) | 73.2 | 55.44 | <0.001 |
| Appropriate hair-removal method | 0 (0.0%) | 2 (4.2%) | 4.2 | - † | 0.233 |
| Surgical-site preparation (CHG) | 2 (3.9%) | 47 (97.9%) | 94 | 87.4 | <0.001 |
| Antimicrobial skin sealants | 8 (15.7%) | 2 (4.2%) | −11.5 | - † | 0.093 |
| Surgical hand preparation (scrubbing) | 12 (23.5%) | 47 (97.9%) | 74.4 | 56.82 | <0.001 |
| Enhanced nutritional support | 0 (0.0%) | 1 (2.1%) | 2.1 | - † | 0.485 |
| Perioperative oxygenation | 1 (2.0%) | 0 (0.0%) | −2.0 | - † | 1.000 |

**TABLE 2: Comparison of preoperative and pre-incision SSI prevention measures between audit cycles.**

Data are presented as n (%). Absolute change represents the pp difference between Cycle 2 and Cycle 1. Pearson's chi-square ($\chi^2$) test was used to compare proportions where assumptions were satisfied; Fisher's exact test was used where expected cell counts were small. A two-sided p-value <0.05 was considered statistically significant.

† Indicates that Fisher's exact test was used to calculate the reported p-value; no chi-square statistic is presented for these comparisons.

CHG, chlorhexidine gluconate; pp, percentage points; SAP, surgical antibiotic prophylaxis

## Intraoperative SSI prevention measures

The frequency of documented affirmative responses increased substantially for several intraoperative measures. Affirmative recording of adequate circulating volume increased from 3/51 (5.9%) in Cycle 1 to 48/48 (100.0%) in Cycle 2 (+94.1 pp; $\chi^2 = 87.70$, $p < 0.001$). Recorded incisional wound irrigation increased from 4/51 (7.8%) to 47/48 (97.9%) (+90.1 pp; $\chi^2 = 80.32$, $p < 0.001$), while recorded sterile drape and gown use increased from 13/51 (25.5%) to 43/48 (89.6%) (+64.1 pp; $\chi^2 = 41.34$, $p < 0.001$).

Significant increases in documented affirmative responses were also observed for intraoperative antimicrobial irrigation (2.0-50.0%; $p < 0.001$), prophylactic negative-pressure wound therapy (0-29.2%; $p < 0.001$), laminar airflow ventilation (0-25.0%; $p < 0.001$), normothermia maintenance (0-18.8%; $p < 0.001$), wound protector use (0-18.8%; $p < 0.001$), and blood glucose control (5.9-31.2%; $p = 0.001$). These increases describe changes in recorded responses and do not uniformly indicate improved guideline adherence. Interpretation depends on the intervention, its clinical indication, and the population to which the recommendation applies.

No statistically significant changes were observed in triclosan-coated sutures, surgical glove management, instrument/drape change, antimicrobial sutures, optimal oxygenation, or intraoperative SAP redosing (all $p > 0.05$). Overall, Cycle 2 showed substantial increases in documented affirmative responses for several intraoperative measures, particularly circulating-volume management, incisional wound irrigation, and sterile drape and gown use (Table *3*).

| Intraoperative SSI prevention measure | Cycle 1 (N = 51), n (%) | Cycle 2 (N = 48), n (%) | Change (pp) | $\chi^2$ | p-value |
|---|---|---|---|---|---|
| Normothermia maintained | 0 (0.0%) | 9 (18.8%) | 18.8 | - † | <0.001 |
| Blood glucose control | 3 (5.9%) | 15 (31.2%) | 25.3 | 10.7 | 0.001 |
| Adequate circulating volume | 3 (5.9%) | 48 (100.0%) | 94.1 | 87.7 | <0.001 |
| Sterile drapes and gowns | 13 (25.5%) | 43 (89.6%) | 64.1 | 41.34 | <0.001 |
| Wound protector devices | 0 (0.0%) | 9 (18.8%) | 18.8 | - † | <0.001 |
| Incisional wound irrigation | 4 (7.8%) | 47 (97.9%) | 90.1 | 80.32 | <0.001 |
| Prophylactic NPWT | 0 (0.0%) | 14 (29.2%) | 29.2 | 17.32 | <0.001 |
| Triclosan-coated sutures | 0 (0.0%) | 1 (2.1%) | 2.1 | - † | 0.485 |
| Laminar airflow ventilation | 0 (0.0%) | 12 (25.0%) | 25 | 14.51 | <0.001 |
| Surgical glove management | 2 (3.9%) | 5 (10.4%) | 6.5 | - † | 0.259 |
| Instrument/drape change | 0 (0.0%) | 2 (4.2%) | 4.2 | - † | 0.233 |
| Antimicrobial sutures | 0 (0.0%) | 1 (2.1%) | 2.1 | - † | 0.485 |
| Optimal oxygenation | 1 (2.0%) | 0 (0.0%) | −2.0 | - † | 1.000 |
| Intraoperative SAP redosing | 0 (0.0%) | 2 (4.2%) | 4.2 | - † | 0.233 |
| Intraoperative antimicrobial irrigation | 1 (2.0%) | 24 (50.0%) | 48 | 30.23 | <0.001 |

**TABLE 3: Comparison of intraoperative SSI prevention measures between audit cycles.**

Data are presented as n (%). Absolute change represents the pp difference between Cycle 2 and Cycle 1. Pearson's chi-square ($\chi^2$) test was used to compare proportions where assumptions were satisfied; Fisher's exact test was used where expected cell counts were small. A two-sided p-value <0.05 was considered statistically significant.

† Indicates that Fisher's exact test was used to calculate the reported p-value; no chi-square statistic is presented for these comparisons.

NPWT, negative-pressure wound therapy; pp, percentage points; SAP, surgical antibiotic prophylaxis

## Postoperative SSI prevention and outcome surveillance

Recorded postoperative measures showed variable changes between cycles. Documentation of wound dressing increased from 1/51 (2.0%) in Cycle 1 to 44/48 (91.7%) in Cycle 2 (+89.7 pp; $\chi^2 = 80.26$, $p < 0.001$). Recorded postoperative SAP increased from 19/51 (37.3%) to 47/48 (97.9%) (+60.6 pp; $\chi^2 = 40.95$, $p < 0.001$), while recorded continuation of SAP in the presence of a drain increased from 7/51 (13.7%) to 20/48 (41.7%) (+28.0 pp; $\chi^2 = 9.73$, $p = 0.002$). Drain removal recorded as appropriately timed increased from 1/51 (2.0%) to 6/48 (12.5%) (+10.5 pp), although this difference did not reach statistical significance ($p = 0.055$).

Postoperative SSI surveillance remained limited. No Day 7, Day 14, or Day 30 surveillance was recorded in Cycle 1, compared with 4/48 (8.3%), 2/48 (4.2%), and 1/48 (2.1%), respectively, in Cycle 2; none of these changes reached statistical significance (all $p > 0.05$). One SSI was recorded in Cycle 2 (1/48 (2.1%)), compared with none in Cycle 1, with no statistically significant difference ($p = 0.485$). Overall, while wound-dressing documentation improved markedly, postoperative surveillance remained a major area of low adherence in Cycle 2 (Table *4*).

| Postoperative/surveillance measure | Cycle 1 (N = 51), n (%) | Cycle 2 (N = 48), n (%) | Change (pp) | $\chi^2$ | p-value |
|---|---|---|---|---|---|
| SAP continued with drain | 7 (13.7%) | 20 (41.7%) | 28 | 9.73 | 0.002 |
| Wound dressing | 1 (2.0%) | 44 (91.7%) | 89.7 | 80.26 | <0.001 |
| Drain removal timing | 1 (2.0%) | 6 (12.5%) | 10.5 | - † | 0.055 |
| Postoperative SAP | 19 (37.3%) | 47 (97.9%) | 60.6 | 40.95 | <0.001 |
| Day 7 surveillance | 0 (0.0%) | 4 (8.3%) | 8.3 | - † | 0.052 |
| Day 14 surveillance | 0 (0.0%) | 2 (4.2%) | 4.2 | - † | 0.233 |
| Day 30 surveillance | 0 (0.0%) | 1 (2.1%) | 2.1 | - † | 0.485 |
| SSI diagnosed | 0 (0.0%) | 1 (2.1%) | 2.1 | - † | 0.485 |

**TABLE 4: Comparison of postoperative SSI prevention and outcome surveillance measures between audit cycles.**

Data are presented as n (%), using the total cohort in each cycle as the denominator. Percentages represent documented affirmative responses, not necessarily adherence among eligible patients. Change represents the pp difference between cycles, calculated from unrounded proportions. Pearson's chi-square test or Fisher's exact test was used, as appropriate. All p-values are two-sided and unadjusted for multiple comparisons.

† Fisher's exact test; no chi-square statistic is presented.

pp, percentage points; SAP, surgical antibiotic prophylaxis; SSI, surgical site infection

## Discussion

This two-cycle QIP identified substantial increases in recorded perioperative SSI prevention measures and improvements in documentation completeness following implementation of CASSSI and targeted staff education. The largest changes included recorded surgical-site preparation, surgical hand preparation, SAP timing, circulating-volume management, sterile drape and gown use, wound irrigation, and postoperative wound dressing. Background clinical documentation also improved, with several previously poorly recorded variables reaching complete documentation during Cycle 2. However, low recorded frequencies persisted for selected perioperative measures and postoperative surveillance, while recorded postoperative antibiotic prophylaxis increased. Differences in ascertainment between cycles and incomplete standardization of operational definitions prevent these increases from being equated with equivalent improvements in clinical practice or guideline adherence.

The findings can be considered alongside evidence from multimodal surgical quality improvement programs in resource-constrained settings. In the prospective Clean Cut program across five Ethiopian hospitals, mean compliance increased from 2.9 to 4.5 of six perioperative infection-prevention standards, accompanied by a reduction in surgical infections [7]. A systematic review and meta-analysis also reported benefits from perioperative quality improvement interventions in low- and middle-income countries [8]. These studies support combining measurement with locally adapted improvement activities. However, their clinical outcome findings cannot be extrapolated to the present audit, in which postoperative surveillance was insufficient to evaluate infection reduction. Evidence concerning electronic surgical checklists and documentation completeness provides a more relevant comparison for the recording gains observed here [9].

Several large increases occurred in recorded pre-incision measures. Recorded surgical-site preparation increased from 3.9% to 97.9%, surgical hand preparation from 23.5% to 97.9%, and SAP recorded as appropriately timed from 3.9% to 77.1%. These measures concern clinically important components of perioperative infection prevention and overlap with domains addressed by the Clean Cut program [7]. Nevertheless, baseline assessment relied on retrospective clinical records, whereas Cycle 2 incorporated clinical-record review and direct observation with digital recording. Some of the observed increase may therefore represent improved ascertainment of care that previously went unrecorded. The comparison cannot establish the magnitude of any underlying change in clinical performance.

Recorded intraoperative measures also increased. The circulating-volume item received an affirmative response in 100% of Cycle 2 cases, incisional wound irrigation in 97.9%, and sterile drape and gown use in 89.6%. Recorded normothermia increased from 0% to 18.8%, and blood glucose control from 5.9% to 31.2%. These findings identify priorities for further assessment, although incomplete standardization of operational definitions limits interpretation of the percentages as verified attainment of physiological

targets. The clinical importance of temperature management is supported by the trial by Kurz et al., which found fewer surgical wound infections among colorectal surgical patients maintained near normothermia [10]. Subsequent audit cycles should define the relevant measurements and assessment criteria explicitly and examine barriers to recording and delivering temperature and glucose management.

The increases in recorded antimicrobial irrigation and laminar airflow use require separate interpretation. WHO advises against antibiotic incisional irrigation for SSI prevention and suggests that laminar airflow should not be used to reduce SSI in total arthroplasty [1]. Increased recording of these interventions should therefore not automatically be regarded as improvement. Interpretation of the antimicrobial irrigation finding requires identification of the agent and site of irrigation, while interpretation of laminar airflow requires the relevant procedure type. Similarly, the broad incisional wound irrigation item does not establish whether the solution and indication were consistent with the relevant recommendation. These examples illustrate why an affirmative checklist response must be distinguished from guideline-concordant care.

Recorded instrument/drape change increased from 0% to 4.2%, while surgical glove management increased from 3.9% to 10.4%; neither difference reached statistical significance. These findings warrant further assessment in procedures for which glove and instrument changes are relevant. The ChEETAh cluster-randomized trial found that routine sterile glove and instrument change before abdominal wound closure reduced SSI [11]. However, the present audit's broader checklist labels and whole-cohort denominators do not permit direct comparison with that trial's intervention or eligible population. Future evaluation should distinguish glove changes, instrument changes, and drape changes and specify the procedures to which each criterion applies.

An important finding alongside the documentation gains was the increase in recorded postoperative antimicrobial prophylaxis. Recorded postoperative SAP increased from 37.3% to 97.9%, while recorded continuation in the presence of drains increased from 13.7% to 41.7%. These increases should not be interpreted as improvements in SSI prevention; they identify an important antimicrobial-stewardship concern. Evidence indicates no additional SSI prevention benefit from postoperative continuation when established best-practice standards for SAP are followed [12] and does not support continuation solely because a drain remains in situ [13]. The drain-related percentages used the entire cohort as the denominator and therefore do not represent prescribing rates specifically among patients with drains.

The increased recording of both appropriately timed pre-incision SAP and postoperative continuation highlights the need to address initiation and discontinuation separately. One possible unintended effect is that prompts recording antibiotic administration may have reinforced attention to administration without equivalent emphasis on appropriate discontinuation. However, the uncontrolled design and change in ascertainment cannot establish that the digital system caused inappropriate prescribing. Improved documentation of existing practice and differences in clinical indications remain alternative explanations. Moreover, the reported comparisons do not establish the indication or duration of individual antibiotic courses. Future interventions should incorporate explicit guideline-based prophylaxis stop criteria, distinguish prophylactic from therapeutic antibiotic use, and review postoperative prescribing indications and duration. Unnecessary continuation of prophylaxis should also be assessed as a balancing measure in subsequent audit cycles.

Post-discharge SSI surveillance remained a major limitation. Although wound-dressing documentation increased from 2.0% to 91.7%, follow-up was recorded for only 8.3%, 4.2%, and 2.1% of Cycle 2 patients at Days 7, 14, and 30, respectively. Consequently, the single recorded SSI cannot be interpreted as evidence of a low true infection incidence. A multicenter surveillance study identified a substantial proportion of SSIs after discharge [14], while a study in Cambodia demonstrated the value of active post-discharge surveillance for improving case ascertainment [15]. In the present audit, incomplete recorded follow-up prevents reliable estimation of SSI incidence or assessment of whether changes in preventive measures were associated with fewer infections. Subsequent cycles should establish a feasible, systematic postoperative surveillance pathway, with clearly recorded follow-up completion and infection assessments.

The findings identify priorities for further assessment, including temperature and glucose management, postoperative antibiotic prescribing, and post-discharge surveillance. The audit did not establish the reasons for persistent gaps; equipment availability, staff workload, and prescribing practices should therefore be investigated rather than assumed to explain them. Subsequent cycles should standardize operational definitions, use eligible-patient denominators where appropriate, incorporate explicit prophylaxis stop criteria, and establish reliable postoperative surveillance. These refinements would support more consistent assessment of guideline adherence and future evaluation of SSI outcomes.

## Strengths and limitations

A principal strength of this QIP is its two-cycle design, with baseline assessment followed by an intervention and reaudit using the same core checklist items. The project assessed documentation and preventive measures across the perioperative pathway and identified both increases in recording and areas requiring further attention. Implementation of prospective digital data collection within a resource-constrained teaching hospital provides a practical example of its use in this setting, although long-term

feasibility and sustainability were not established.

Several limitations should be considered. This was a single-center QIP with small independent samples of 51 and 48 patients, limiting generalizability and precision. Cycle 1 relied on retrospective clinical records, whereas Cycle 2 combined clinical-record review and direct observation with digital recording. Differences in ascertainment therefore prevent separation of improved recording from changes in actual care delivery. Checking Cycle 2 entries against records or observations did not remove this difference between cycles. Prospective observation may also have influenced staff behavior during reaudit.

Detailed operational definitions were not standardized for every item, limiting measurement consistency and interpretation of affirmative responses as guideline-concordant care. Differences in case mix could have contributed to the observed changes. The absence of a concurrent control group limits causal attribution, while the combined intervention prevents separation of the contributions of CASSSI and staff education. Multiple comparisons were performed without adjustment, increasing the possibility of false-positive findings; individual p-values therefore require cautious interpretation alongside the magnitude of the observed changes.

Whole-cohort denominators further limit interpretation of measures applicable only to selected patients or procedures. The absence of an affirmative response did not establish that a clinically indicated measure had not been performed, and an affirmative response did not necessarily establish that the intervention was appropriate. Increased recorded postoperative prophylaxis warrants investigation as a possible unintended effect, but the reported comparisons do not establish its cause or the appropriateness of individual prescriptions. Finally, incomplete post-discharge surveillance precludes reliable estimation of SSI incidence or conclusions about infection reduction.

## Conclusions

Implementation of CASSSI alongside targeted staff education was associated with improved completeness of perioperative documentation and increased recording of several SSI prevention measures in this two-cycle clinical audit. However, the transition from retrospective record review to prospective collection incorporating clinical records and direct observation limits attribution of these changes to improved care delivery. The findings therefore do not establish equivalent improvements in clinical practice or uniform adherence to guideline recommendations.

Low recorded frequencies persisted for selected measures, including normothermia and glove and instrument/drape changes, while increased recorded postoperative antibiotic prophylaxis highlighted an antimicrobial-stewardship concern. The audit did not determine the reasons for these findings. Incomplete postoperative surveillance also prevented reliable estimation of SSI incidence or conclusions about infection reduction; the small number of recorded infections should not be interpreted as evidence of a low true infection rate. Further audit cycles should standardize measurement criteria, assess barriers to the delivery and documentation of preventive measures, strengthen antimicrobial stewardship, and establish systematic postoperative surveillance. Longer-term evaluation is needed to assess sustainability and patient outcomes.

## Additional Information

### Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

**Concept and design:** Wafa ShmsEldeen Abozaid Alshafiea, Abdulwahab Mustafa Abdulgader Mustafa, Mohamed Khalid Hassan Abdelkarim, Fatmah Abdulkadir Nur Hassan, Razan Imad Mohamedtahir Fadlalla, Nada Abdelnaser Ahmed Alshorbagy, Mahdi Hamdan Salih Elnemair , Razan Mutasim Mahgoub Idris, Eman Abubakeralsideeg Diaaldeen Mohamed, Gesaim Mohammed, Abdelhameed Mohamed Ibrahim Yousif, Mohamed Mahmoud Mohamed Ali, Mohamed Elsayed Abdelhalim Hassan, Muayad Mubarak Mohamed Ali, Alaa Kamal Hassan Hamedelnile, Mawia Ahmed, Albushra Altayeb Adam Osman, Abdelgalil Esameldin Omer Eldaw, Abdalmahmoud Asadig Kanan Ahmed, Ahmed Zainalbden Ibrahim Mohammed, Mustafa Mohamed

**Acquisition, analysis, or interpretation of data:** Wafa ShmsEldeen Abozaid Alshafiea, Abdulwahab Mustafa Abdulgader Mustafa, Mohamed Khalid Hassan Abdelkarim, Fatmah Abdulkadir Nur Hassan, Razan Imad Mohamedtahir Fadlalla, Nada Abdelnaser Ahmed Alshorbagy, Mahdi Hamdan Salih Elnemair , Razan Mutasim Mahgoub Idris, Eman Abubakeralsideeg Diaaldeen Mohamed, Gesaim Mohammed, Abdelhameed Mohamed Ibrahim Yousif, Mohamed Mahmoud Mohamed Ali, Mohamed Elsayed Abdelhalim Hassan, Muayad Mubarak Mohamed Ali, Alaa Kamal Hassan Hamedelnile, Mawia Ahmed, Albushra Altayeb Adam Osman, Abdelgalil Esameldin Omer Eldaw, Abdalmahmoud Asadig Kanan Ahmed, Ahmed Zainalbden Ibrahim Mohammed, Mustafa Mohamed

**Drafting of the manuscript:** Wafa ShmsEldeen Abozaid Alshafiea, Abdulwahab Mustafa Abdulgader

Mustafa, Mohamed Khalid Hassan Abdelkarim, Fatmah Abdulkadir Nur Hassan, Razan Imad Mohamedtahir Fadlalla, Nada Abdelnaser Ahmed Alshorbagy, Mahdi Hamdan Salih Elnemair , Razan Mutasim Mahgoub Idris, Eman Abubakeralsideeg Diaaldeen Mohamed, Gesaim Mohammed, Abdelhameed Mohamed Ibrahim Yousif, Mohamed Mahmoud Mohamed Ali, Mohamed Elsayed Abdelhalim Hassan, Muayad Mubarak Mohamed Ali, Alaa Kamal Hassan Hamedelnile, Mawia Ahmed, Albushra Altayeb Adam Osman, Abdelgalil Esameldin Omer Eldaw, Abdalmahmoud Asadig Kanan Ahmed, Ahmed Zainalbden Ibrahim Mohammed, Mustafa Mohamed

**Critical review of the manuscript for important intellectual content:** Wafa ShmsEldeen Abozaid Alshafiea, Abdulwahab Mustafa Abdulgader Mustafa, Mohamed Khalid Hassan Abdelkarim, Fatmah Abdulkadir Nur Hassan, Razan Imad Mohamedtahir Fadlalla, Nada Abdelnaser Ahmed Alshorbagy, Mahdi Hamdan Salih Elnemair , Razan Mutasim Mahgoub Idris, Eman Abubakeralsideeg Diaaldeen Mohamed, Gesaim Mohammed, Abdelhameed Mohamed Ibrahim Yousif, Mohamed Mahmoud Mohamed Ali, Mohamed Elsayed Abdelhalim Hassan, Muayad Mubarak Mohamed Ali, Alaa Kamal Hassan Hamedelnile, Mawia Ahmed, Albushra Altayeb Adam Osman, Abdelgalil Esameldin Omer Eldaw, Abdalmahmoud Asadig Kanan Ahmed, Ahmed Zainalbden Ibrahim Mohammed, Mustafa Mohamed

**Supervision:** Mohamed Khalid Hassan Abdelkarim, Ahmed Zainalbden Ibrahim Mohammed, Mustafa Mohamed

## Disclosures

**Human subjects:** Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Review Board, Al Managil Teaching Hospital issued approval 45-07-N1000. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

## Acknowledgements

All authors contributed equally to this work and should be considered co-first authors. During manuscript preparation, the authors used ChatGPT (OpenAI, Inc., San Francisco, CA, USA) solely for grammatical correction and language refinement. The tool was not used to generate scientific content, analyze data, or interpret findings. All revisions were reviewed by the authors, who retain full responsibility for the accuracy and integrity of the manuscript.

# References

1. Global guidelines for the prevention of surgical site infection . (2018). https://www.who.int/publications/i/item/9789241550475?utm.
2. Allegranzi B, Bagheri Nejad S, Combescure C, et al.: Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011, 377:228-41. 10.1016/S0140-6736(10)61458-4
3. Surgical site infections: prevention and treatment . (2019). https://www.nice.org.uk/guidance/ng125.
4. Preventing surgical site infections: implementation approaches for evidence-based recommendations . (2018). https://www.who.int/publications/i/item/preventing-surgical-site-infections?utm.
5. Berríos-Torres SI, Umscheid CA, Bratzler DW, et al.: Centers for Disease Control and Prevention Guideline for the prevention of surgical site infection, 2017. JAMA Surg. 2017, 152:784-91. 10.1001/jamasurg.2017.0904
6. Protocol for the surveillance of surgical site infections and prevention indicators in European hospitals, version 2.3. (2025). https://www.ecdc.europa.eu/en/publications-data/protocol-surveillance-surgical-site-infections-and-prevention-indicat....
7. Forrester JA, Starr N, Negussie T, et al.: Clean Cut (adaptive, multimodal surgical infection prevention programme) for low-resource settings: a prospective quality improvement study. Br J Surg. 2021, 108:727-34. 10.1002/bjs.11997
8. Jin J, Akau Ola S, Yip CH, et al.: The impact of quality improvement interventions in improving surgical infections and mortality in low and middle-income countries: a systematic review and meta-analysis. World J Surg. 2021, 45:2993-3006. 10.1007/s00268-021-06208-y
9. Pati AB, Mishra TS, Chappity P, Venkateshan M, Pillai JS: Use of technology to improve the adherence to surgical safety checklists in the operating room. Jt Comm J Qual Patient Saf. 2023, 49:572-6. 10.1016/j.jcjq.2023.04.005
10. Kurz A, Sessler DI, Lenhardt R: Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. N Engl J Med. 1996, 334:1209-15. 10.1056/NEJM199605093341901
11. Routine sterile glove and instrument change at the time of abdominal wound closure to prevent surgical site infection (ChEETAh): a pragmatic, cluster-randomised trial in seven low-income and middle-income countries. Lancet. 2022, 400:1767-76. 10.1016/S0140-6736(22)01884-0
12. de Jonge SW, Boldingh QJJ, Solomkin JS, et al.: Effect of postoperative continuation of antibiotic prophylaxis

on the incidence of surgical site infection: a systematic review and meta-analysis. Lancet Infect Dis. 2020, 20:1182-92. 10.1016/S1473-3099(20)30084-0

13. Summary of a systematic review on antimicrobial prophylaxis in the presence of a drain and wound drain removal. Global Guidelines for the Prevention of Surgical Site Infection. Geneva, World Health Organization; 2018.
14. Srivastav S, Khurana S, Mukhopadhyay C, et al.: Surveillance for surgical site infections developed during hospital stay & after discharge: a multicentric study. Indian J Med Res. 2024, 160:428-37. 10.25259/IJMR_369_2024
15. Guerra J, Guichon C, Isnard M, So S, Chan S, Couraud S, Duong B: Active prospective surveillance study with post-discharge surveillance of surgical site infections in Cambodia. J Infect Public Health. 2015, 8:298-301. 10.1016/j.jiph.2014.09.007