*RESEARCH*

# Retrospective Study: Effectiveness of the Surgical Safety Checklist in Reducing Surgical Site Infections

Richa Noprianty[✉*], Aulia Senandung Nacita[*], Muhammad Dwi Satriyanto[**]

[*]Faculty of Health Sciences, Universitas Bhakti Kencana, Bandung, Indonesia
[**]Faculty of Medicine, Institut Kesehatan dan Teknologi Al Insyirah, Pekanbaru

[✉]Correspondence: richa.noprianty@bku.ac.id / richa.noprianty@gmail.com



**ABSTRACT**

**Background:** Surgical site infection (SSI) is one of the major challenges in healthcare, increasing patient morbidity and mortality. The global incidence of SSI has risen to 23.6 cases per 100 surgical procedures. Therefore, prevention and control of SSI are essential patient safety efforts.

**Objective:** This study aimed to analyze the association between surgical safety checklist (SSC) implementation and SSI occurrence among surgical patients at a hospital setting.

**Methods:** A quantitative retrospective case-control design was employed. The study included 63 medical records of surgical patients with documented SSI indications, collected from January 2024 to April 2025 using total sampling. SSC implementation was evaluated using a structured observation tool adapted from the WHO SSC, covering three phases: sign in, time out, and sign out. Each item was scored dichotomously (1 = performed, 0 = not performed) and categorized as good (≥80%) or poor (<80%) compliance. Data were analyzed using the chi-square ($\alpha = 0.05$), with odds ratio (OR) and 95% confidence interval (CI) calculated to quantify the strength of association.

**Results:** Data analysis using the independent t-test revealed a significance value of 0.000 ($p < 0.05$), indicating a statistically significant difference in the mean incidence of SSI between groups with good and poor SSC implementation. Among the 63 patients diagnosed with wound dehiscence, the average onset of infection was 9 days postoperatively, with a mean surgical duration of 142 minutes.

**Conclusion:** The findings suggest that enhancing the quality of SSC implementation may serve as an effective strategy to reduce the incidence of healthcare-associated infections (HAIs) in hospitals, particularly within central surgical installations. The results also underscore the importance of strengthening supervision, implementing preventive measures, and integrating the use of electronic medical records (EMR) to improve infection control and patient safety.

**Keywords:** central surgical installation; healthcare-associated infections; medical records; surgical safety checklist; surgical site infection

## INTRODUCTION

Surgical site infection (SSI) remains one of the major challenges worldwide. This infection not only increases patient morbidity and mortality, but also makes the prevention and control of healthcare-associated infections (HAIs) a top priority to improve service quality and patient safety. Patient safety is a cultural aspect that must be implemented in hospitals. According to the International Patient Safety Goals (IPSG), key safety targets include the correct surgical site, the correct patient, and the correct surgical procedure.[1,2,3]

The global incidence of HAIs reaches 9 % or fewer than 1.40 million patients.[4,5] In Indonesia, surveillance data from the Ministry of Health in 2022 showed an HAIS prevalence of 15.74 %, far above that of developed countries (4.8–15.5 %). In Bandung Regency, West Java, the HAIS rate is 57.6 %.[6,7,8]

The most common HAIs in health-care facilities are ventilator-associated pneumonia (VAP), bloodstream infection (BSI), urinary tract infection (UTI), and SSI. SSI is a leading cause of the high HAI burden in hospitals.[9,10,11] Prevention of SSI has attracted particular attention from surgeons, infection-control specialists, and health authorities.[12,13]

Worldwide, SSI incidence has risen from 1.2 to 23.6 cases per 100 surgeries. In Indonesia, SSI rates vary between 2 % and 18 % of all procedures.[2,14]

The SSC is seen as a remedy for socio-technical challenges in operating rooms, with most studies examining its clinical/economic impact, staff perceptions, and implementation barriers. Poor outcomes occur when context is ignored. Ethnographic data from an urban teaching hospital frames the SSC as a ritual comprising two versions: an improvised one and a scripted one.[15] Consistent and proper use of the SSC is an important strategy for SSI prevention in operating rooms. Nevertheless, compliance and effectiveness differ across hospitals, influenced by resource availability and the prevailing safety culture.[16]

Numerous studies have shown that comprehensive, integrated SSC implementation lowers SSI rates and enhances patient safety quality.[17] Success, however, depends on factors such as training availability, safety culture, and robust documentation systems.

In the past five years, further evidence supports SSC effectiveness in decreasing infections and improving safety. A recent meta-analysis[18,19] reported a global SSC compliance of only 73 %. SSC use significantly reduces SSI, pneumonia, and other perioperative complications, especially when integrated into adaptive hospital quality systems.[20] Similar findings were observed in sub-Saharan African hospitals, where multimodal interventions combining SSC with infection-prevention protocols effectively lowered SSI rates.[21]

Proper SSC implementation can reduce near-miss events, ensure equipment and medication readiness before procedures, and confirm patient identity and the correct surgical site. SSC use is high worldwide, but implementation varies significantly. Tailored strategies are needed to address this variability.[22] Consequently, repeated training and periodic audits are essential so that the checklist becomes fully internalised in the clinical work culture. Effective SSC implementation should target micro, meso, and macro levels. Future research must address barriers and use professional organisations to standardise SSC practices, thereby enhancing patient safety.[23,24]

## METHOD

This study employed a quantitative analytic observational design using a case-control approach to examine the relationship between SSC implementation and the incidence of SSI. The study involved no intervention and relied solely on observation of existing practices and outcomes.

Cases were defined as patients who developed SSI (including wound dehiscence) within the postoperative period, while controls were patients who did not develop SSI during the same period. Cases and controls were selected from the same population and time frame to ensure comparability. The research is conducted retrospectively.[25, 26]

SSC implementation was assessed using a structured observation tool adapted from the WHO SSC, covering the sign-in, time-out, and sign-out phases. Each item was scored dichotomously (1 = performed, 0 = not performed), and total scores were converted into percentages. Implementation was categorized as good (≥80% compliance) or poor (<80%).

The population in this study comprises all patients who underwent surgery with an indication of SSI, numbering 63 patients over the period from January 2024 to April 2025. Sampling was performed by total sampling. This approach is appropriate when the population size is relatively small; in this study, the sample consists of medical records of patients who underwent surgery at the Central Surgical Installation of X Hospital.

The instrument used was an observation sheet containing three phases: sign-in (7 statements), time-out (9 statements), and sign-out (5 statements), for a total of 21 statements. Observation was based on patients' medical records matched with SSI surveillance data for patients diagnosed with wound dehiscence by the infection prevention and control (IPC).

Data were analyzed using the Chi-Square Test of Independence ($\alpha = 0.05$), with Odds Ratio (OR) and 95% confidence interval (CI) calculated to determine the strength of association between SSC compliance category and SSI occurrence. Ethical approval was granted by Universitas Bhakti Kencana (Approval No. 152/09. KEPK/UBK/VI/2025).

## RESULTS

It was found that among the 63 patients with HAIs, specifically those with SSI at X Hospital, the majority (52.4%) were aged 26–35 years (33 patients). Most also had a BMI of 25–29.9 (33 patients, 52.4%). Almost all (98.4%) were American Society of Anesthesiologists (ASA) class II (62 patients). Most had no comorbidities (45 patients, 71.4%), while 12 patients (19%) had hypertension. The majority had no prior surgery (38 patients, 60.3%) and did not use medication (40 patients, 63.5%). Most underwent cesarean section (45 patients, 69.8%). All patients (100%) had major surgery. The most common operation duration was 1–2 hours (29 patients, 46%). Elective surgeries accounted for 33 patients (52.4%). Most received general anesthesia (44 patients, 69.8%) and did not experience postoperative anesthetic complications (43 patients, 68.3%). (Table 1)

In all SSC phases, the number of checklist items with the highest implementation is observed in the sign-in phase (100%). Meanwhile, the time-out phase (88%) has the lowest implementation of checklist items. (Chart 1)

The distribution of complete and incomplete SSC implementation across the three mandatory phases among 63 patients in the complete SSC group. All 63 patients (100%) completed the Sign In phase, indicating strong adherence at the pre-incision stage. In contrast, the Time Out phase showed the most substantial gap, with only 25 patients (39.7%) completing it fully while 38 patients (60.3%) did not — making it the most critical point of non-adherence in the SSC workflow. The Sign Out phase was largely completed, with 59 patients (93.7%) adhering fully and only 4 patients (6.3%) failing to complete it. (Chart 2)

The majority of respondents (14 %, 9 respondents) experienced infection within 7 days postoperatively. (Chart 3)

The majority of respondents (46.0 %, 29 respondents) underwent surgery lasting 1–2 hours, followed by 33.3 % (21 respondents) with a duration of less than 1 hour, and 20.6 % (13 respondents) with a duration longer than 2 hours. (Chart 4)

Based on the Chi-Square Test of Independence, a statistically significant association was found between SSC implementation and SSI occurrence ($\chi^2 = 16.831$; df = 1; $p = 0.000$). Among patients with good SSC compliance (≥80%), only 8 of 35 (22.9%) developed SSI, compared to 21 of 28 (75.0%) in the poor compliance group (<80%). The Odds Ratio of 9.964 (95% CI: 3.191–31.103) indicates that patients with poor SSC compliance were approximately 10 times more likely to develop SSI. As the 95% CI does not cross 1.0, the null hypothesis ($H_0$) is rejected, and the alternative hypothesis ($H_a$) is accepted. (Table 2)

**Table 1**. Respondent's characteristics (n=63)

| Characteristics | N | % |
|---|---|---|
| Age | | |
| 17-25 years | 11 | 17.5 |
| 26-35 years | 33 | 52.4 |
| 36-45 years | 11 | 17.5 |
| 46-55 years | 4 | 6.3 |
| 56-65 years | 1 | 1.6 |
| >65 years | 3 | 4.8 |
| Body mass index (BMI) | | |
| 18,5 – 22,9 (Normal) | 3 | 4.8 |
| 23 – 24,9 (Overweight) | 14 | 22.2 |
| 25 – 29,9 (Obesity I) | 33 | 52.4 |
| ≥ 30 (Obesity II) | 3 | 20.6 |
| ASA Physical Status | | |
| II | 62 | 98.4 |
| III | 1 | 1.6 |
| Comorbidities | | |
| Hypertension | 12 | 19 |
| Diabetes Mellitus | 11 | 17.5 |
| Asthma | 2 | 3.2 |
| Hypertension and pneumonia | 1 | 1.6 |
| None | 37 | 58.7 |
| Previous surgery | | |
| Yes | 25 | 39.7 |
| No | 38 | 60.3 |
| Medication use | | |
| Yes | 23 | 36.5 |
| No | 40 | 63.5 |
| Surgical procedure | | |
| Sectio caesarea (SC) | 45 | 71.4 |
| Hysterectomy | 2 | 3.2 |
| Extirpation | 1 | 1.6 |
| Cystectomy | 2 | 3.2 |
| Laparotomy | 13 | 20.6 |
| Surgery Type | | |
| Minor | 21 | 33.3 |
| Moderate | 29 | 46.3 |
| Major | 13 | 20.6 |
| Duration of surgery | | |
| < 1 hour | 21 | 33.3 |
| 1-2 hours | 29 | 46.0 |
| >2 hours | 13 | 20.6 |
| Classification of surgical procedure | | |
| Elective | 34 | 54.0 |
| Emergency (cito) | 29 | 46.0 |
| Anesthesia Type | | |
| General anesthesia (GA) | 44 | 69.8 |
| Spinal anesthesia (SA) | 19 | 30.2 |
| Postoperative complications | | |
| PONV (postoperative nausea & vomiting) | 7 | 11.1 |
| Shivering | 11 | 17.5 |
| PDPH (post-dural puncture headache) | 2 | 3.2 |
| None | 43 | 68.3 |
| Total | 63 respondents | 100% |

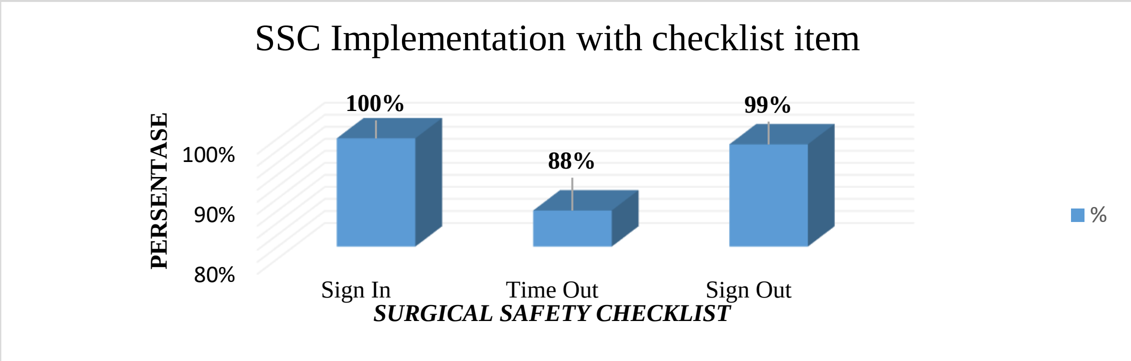


**Chart 1**. SSC Implementation with checklist item

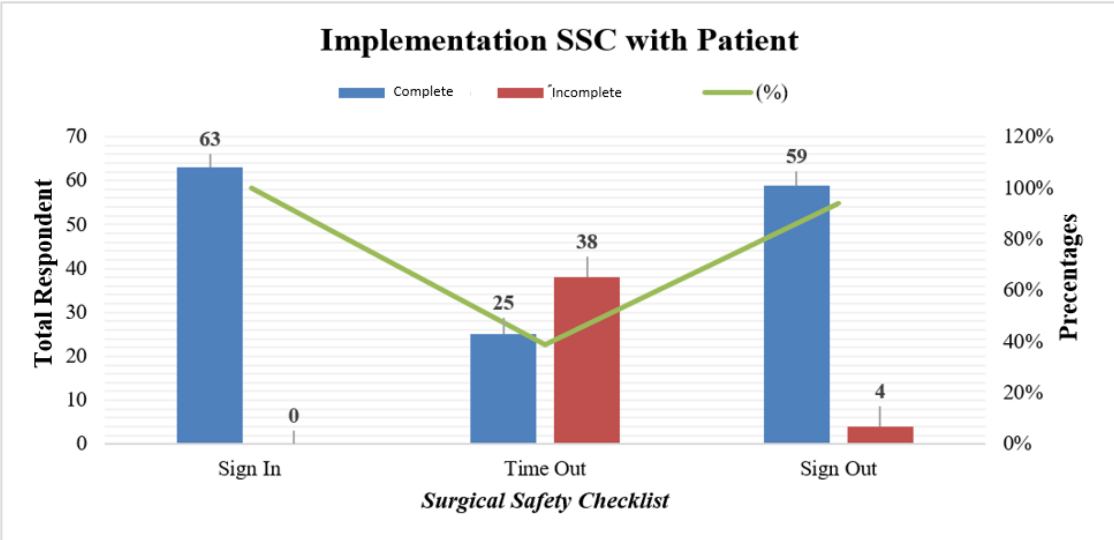


**Chart 2.** SSC implementation completeness by phase

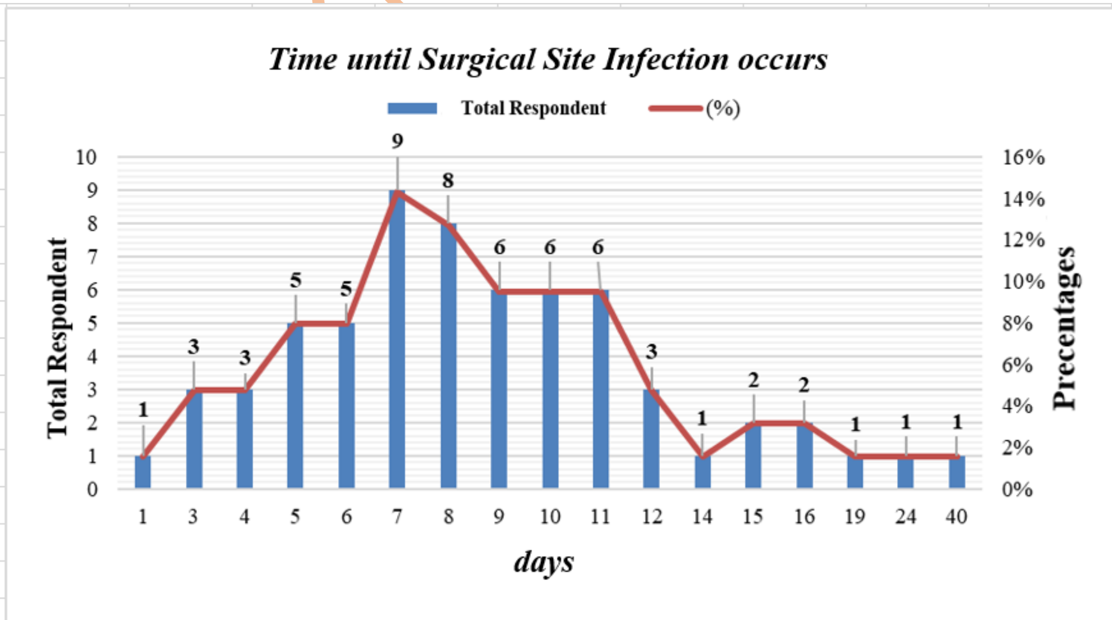


**Chart 3.** Surgical site infection occurrence by operation duration

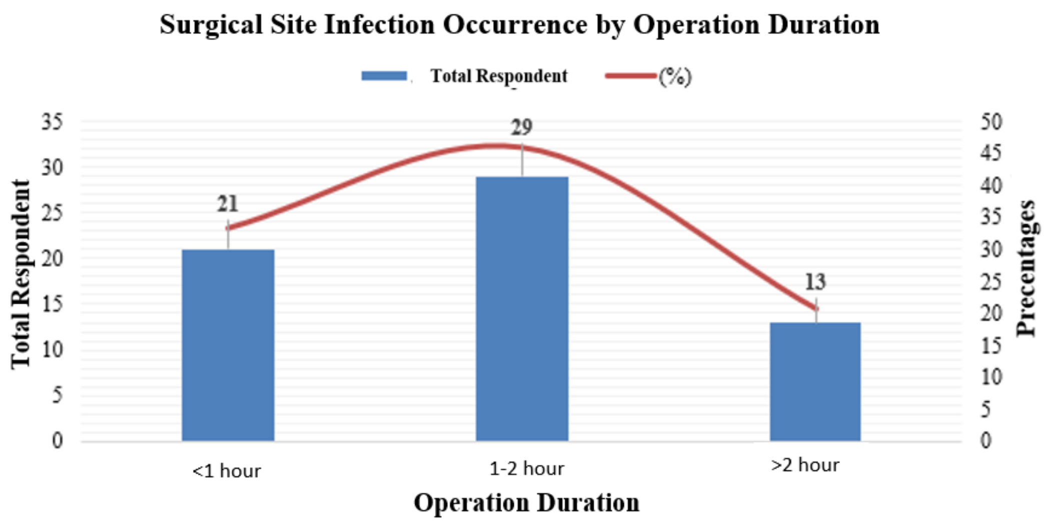


**Chart 4.** Surgical site infection occurrence by operation duration



**Table 2**. Cross tabulation SSC implementation and SSI occurance (n=63)

| SSC Implementation | SSI (+) | SSI (-) | Total N | Total % | $X^2$ | p-value | OR |
|---|---|---|---|---|---|---|---|
| Good (≥80%) | 8 | 27 | 35 | 55.6 | 16.831 | 0.000 | 9.964 |
| Poor (<80%) | 21 | 7 | 28 | 44.4 | | | |
| Total | 29 | 34 | 63 | 100 | | | |

**DISCUSSION**

Effective implementation of the surgical safety checklist (SSC) has been proven to reduce Healthcare-Associated Infections (HAIs) in surgical patients, where consistent SSC application significantly reduced postoperative complications and infections. The SSC serves as a tool to ensure key patient safety steps are followed from preoperative preparation, team communication during surgery, to postoperative evaluation. As a result, the risk of hospital-acquired infections can be significantly minimized.[27,28]

According to findings from expert interviews in the study [23,] the implementation of SSC directly contributes to patient safety. Respondents reported that without strict adherence to the SSC, critical preventive actions such as counting surgical instruments and dressings are not systematically performed, thereby increasing the risk of postoperative complications. This indicates that without comprehensive SSC implementation, patients are exposed to risks arising from incomplete instrument or dressing verification, which significantly impacts patient safety.[29,1]

Low readiness for electronic anesthesia record completion, especially in human resources, organizational support, and technology, was found, alongside variability in electronic health record (EHR) safety implementation: strong technically, weak clinically. The study provides a foundational understanding of EHR safety in public healthcare.[29,30,31]

Integrating SSC with the Hospital Management Information System enables real-time monitoring of checklists, reduces documentation errors, and ensures all safety steps are fulfilled.[27]

Additionally, structured training, such as in-house training through SSC socialization and simulation sessions, exemplifies efforts to enhance team awareness and competence in SSC implementation. These training activities involve all surgical team members, including specialists, nurses, and ward supervisors, strengthening commitment to patient safety standards.[23,15]

This approach aligns with recommendations from recent studies emphasizing that SSC success heavily depends on active team involvement, coordination, and hospital management support.[24,32] With such measures, it is hoped that a culture of patient safety through SSC will take root in Indonesian healthcare settings, reducing surgical complications and mortality rates.[17,29]

This finding is consistent with literature reviews stating that compliance with SSC implementation has a positive impact on surgical patient safety across hospitals, where high compliance directly correlates with reduced complications and infection risks.[33]

In summary, this study underscores the importance of SSC implementation as a strategy to prevent HAIs and improve surgical quality. Hospitals should continue strengthening SSC implementation through periodic training, structured monitoring and evaluation, and integration of information technology to maximize the benefits of SSC in reducing infection risks and enhancing patient safety.[12,16]

Based on research involving 63 surgical patients at the Central Surgery Installation of X Hospital, the majority of respondents were in the 26–35 years age group, classified as early adults. The majority of respondents had a body mass index (BMI) in the obesity I category, which has been identified as a major risk factor for SSI.[34,35,36]

This aligns with numerous studies indicating that key SSI risk factors originate from patient characteristics and surgical procedures. Although the 26–35 age group represents young adults with relatively strong immunity compared to older individuals, they remain at high risk when combined with factors such as obesity/overweight, which impair wound healing due to poor tissue vascularization.[37,38]

In terms of physical status based on the ASA Score classification, most respondents fell into the ASA II category, indicating patients generally have mild systemic disease without activity limitations. The ASA II status correlates with increased SSI risk due to organ dysfunction and compromised immune function.[39,40]

Regarding surgical procedures, caesarean procedures are classified as major surgeries with high SSI risk due to abdominal and uterine incisions, which are vulnerable to microbial contamination. The relatively long procedure duration of 1–2 hours also increases wound exposure to ambient operating room microbes, thereby potentially increasing SSI incidence.[36,38]

Data analysis revealed that the t-test yielded a significance value of 0.00 ($p < 0.05$), leading to the rejection of the null hypothesis ($H_0$) and acceptance of the alternative hypothesis ($H_a$). This indicates a statistically significant difference in the mean incidence of SSI between groups with good and poor SSC implementation. This evidence confirms that the quality of SSC implementation is closely linked to patient safety outcomes after surgery.

## CONCLUSION

Good and standardized implementation of the SSC significantly reduces the occurrence of HAIs, particularly SSI. The main challenges lie in low awareness and inadequate documentation systems, which need to be addressed. Healthcare professionals are urged to improve compliance through training, hospitals must strengthen supervision and documentation using EMR, and future research is recommended to use a cohort approach for deeper analysis.

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