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# Adherence to The Surgical Safety Checklist And Patient Adverse Event: A Scoping Review

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**ABSTRACT**

*Daftar Periksa Keselamatan Bedah (SSC) vital untuk keselamatan pasien, namun kepatuhannya bervariasi secara global. Tinjauan scoping ini menyintesis bukti mengenai kepatuhan SSC dan dampaknya terhadap kejadian tidak diinginkan pada pasien. Mengikuti pedoman PRISMA-ScR, 30 studi (2020–2025) dari Scopus, PubMed, dan Springer Nature Link dianalisis. Analisis tematik mengidentifikasi dimensi kunci termasuk komunikasi tim, hambatan implementasi, dan inovasi teknologi. Hasil secara konsisten menunjukkan bahwa kepatuhan tinggi yang ditandai dengan keterlibatan tim aktif dan bukan sekadar penyelesaian administratif secara signifikan mengurangi komplikasi bedah dan mortalitas. Sebaliknya, kepatuhan rendah sering kali disebabkan oleh ritualisasi dan hambatan hierarkis. Tinjauan ini menyimpulkan bahwa peningkatan keselamatan berkelanjutan memerlukan pergeseran dari formalitas daftar periksa menuju budaya keselamatan matang yang didorong oleh kepemimpinan, adaptasi kontekstual, dan pelatihan antarprofesi.*

The Surgical Safety Checklist (SSC) is vital for patient safety, yet adherence varies globally. This scoping review synthesizes evidence on SSC compliance and its impact on adverse events. Following PRISMA-ScR guidelines, 30 studies (2020–2025) from Scopus, PubMed, and Springer Nature Link were analyzed. Thematic analysis identified key dimensions including team communication, barriers, and technological innovation. Results consistently show that high adherence defined by active team engagement rather than administrative completion significantly reduces surgical complications and mortality. Conversely, low compliance often stems from ritualization and hierarchical barriers. The review concludes that sustainable safety improvements require shifting from checklist formality to a mature safety culture driven by leadership, contextual adaptation, and interprofessional training.



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## Introduction

Surgical procedures are one of the most complex and high-risk medical interventions in healthcare systems worldwide. Despite advances in surgical techniques and anesthesia, adverse events during or after surgery remain a serious threat to patient safety. According to the latest estimates, approximately 310 million major

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surgical procedures are performed each year worldwide. Of these, it is estimated that 1–4% of patients die, and up to 15% experience serious postoperative complications. This means that approximately 8 million deaths and over 40 million complications occur each year as a result of surgical procedure (Dobson 2020). These data highlight the importance of implementing standardized safety protocols to minimize preventable injury risks. Despite advances in medical technology and clinical expertise, incidents of post-operative complications and preventable injuries remain a global issue in healthcare systems related to patient safety (Bergholz et al. 2022). The Surgical Safety Checklist (SSC) launched in 2008 by the World Health Organization (WHO) is one of the most important global efforts to reduce preventable surgical deaths and complications. This checklist is designed as a simple yet comprehensive tool covering the preoperative, intraoperative, and postoperative phases, and has been adopted by healthcare facilities in various countries (World Health Organization 2009). In addition, the SSC aims to improve patient safety by encouraging team communication and monitoring of critical steps during surgical procedures (Haugen et al. 2019). Although its implementation has become widespread, the effectiveness of the SSC remains variable and is highly dependent on the level of compliance of the surgical team in its application.

Over the past decade, the implementation of SSCs has been widely recognized in various countries as an effective intervention in reducing the rate of complications and deaths among surgical patients. Recent studies show that the use of SSCs can reduce the risk of surgical site infections, patient identification errors, and failures in the preparation of surgical instruments and equipment (Sun et al. 2022). However, compliance with the SSC still varies greatly between institutions and countries, so its effectiveness is not always reflected evenly in clinical practice (Gillespie et al. 2018). According to the results of the study Mahmood et al (2019), found that low compliance is often related to organizational culture, limited training, and healthcare workers' perceptions of the checklist's usefulness. In some cases, the SSC is only carried out symbolically (ritualistically) without active involvement from the entire surgical team, reducing its impact in preventing adverse events (Lim et al. 2024). Low adherence to the SSC is frequently rooted in sociotechnical and behavioral factors. From a Safety-II perspective, safety performance depends on how teams adapt and interact under real clinical conditions, not merely on whether a checklist exists. Human Factors Engineering emphasizes that surgical environments are influenced by cognitive load, hierarchy, workflow friction, and system design. In high-hierarchy operating rooms, nurses and junior staff may hesitate to voice concerns during "sign-in" or "time-out," reducing checklist fidelity (Ilorah et al. 2024). These concepts clarify that adherence gaps often emerge not from unwillingness, but from system complexity, suboptimal ergonomics, limited interprofessional communication, and insufficient leadership empowerment.

Recent developments in surgical operations also highlight broader challenges that indirectly affect SSC fidelity. Bibliometric analyses show that operating room workflows have become increasingly complex due to scheduling optimization systems, digital integration, and resource constraints (Amin et al. 2025). Computational algorithms designed to improve operating room efficiency have also shifted team dynamics, altering communication patterns and cognitive workload during surgical procedures (Vladu et al. 2024). In parallel, modern surgical environments rely heavily on non-technical skills such as situational awareness, teamwork, and decision-making which strongly influence the quality of checklist implementation (Rehman et al. 2025). Major disruptions, such as the COVID-19 pandemic, have further reshaped surgical team structures, staffing patterns, and communication norms, contributing to variability in SSC adherence across settings (Brethauer et al. 2020). These insights reinforce the need to understand how contextual and organizational changes affect the relationship between SSC compliance and patient safety outcomes.

Although evidence consistently demonstrates that high SSC adherence is associated with reductions in surgical site infections, procedural errors, and mortality, previous reviews have not systematically examined how different forms of adherence relate to specific adverse events (Rossi et al. 2024). Most earlier reviews focused on overall SSC effectiveness or implementation barriers, without mapping how adherence has been operationalized whether through completion rates, phase-specific fidelity, communication quality, or observational scoring systems and how these metrics correlate with distinct clinical outcomes across different healthcare contexts. Furthermore, no review has synthesized post-2020 evidence, a period marked by rapid workflow changes, digital transformation, and shifting team dynamics in surgical care.

**Jurnal Keperawatan Suaka Insan (JKSI)**
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Given these gaps, this scoping review aims to map the extent, range, and nature of evidence examining the relationship between SSC adherence and adverse surgical events, while identifying how adherence is measured and conceptualized in contemporary literature. By examining current trends, methodological variations, adherence indicators, and clinical implications, this review provides a structured synthesis to support the development of contextualized and evidence-based surgical safety strategies (Preiksaitis and Rose 2023). This study is guided by the research question: "What is the extent and nature of the evidence describing the relationship between SSC adherence and adverse events in surgical patients?" Through this mapping, the review seeks to clarify current evidence, highlight methodological and contextual gaps, and guide future research.

## Research Methodology

### Research Design

This scoping review was conducted following the methodological framework originally developed by Arksey and O'Malley (2005), refined by Levac, and aligned with the Joanna Briggs Institute (JBI) Scoping Review methodology (Levac et al. 2010). These methodological foundations informed the stages of identifying the research question, searching for relevant studies, study selection, data charting, and collating and summarizing the evidence. In addition, practical guidance for implementing each step of the review was informed by Mak and Thomas (2022), WHO outlined best practices for conducting scoping reviews in contemporary health research. The PRISMA-ScR checklist was used to guide transparent and comprehensive reporting of the review process. The screening and selection process was conducted collaboratively by the reviewers rather than independently. While this approach facilitated consensus-based inclusion decisions, it may introduce a degree of selection bias, which should be considered when interpreting the findings.

### Identification of Research Questions

The first step in the scope review approach is to formulate research questions that form the basis of the entire review process (Mak and Thomas 2022). At this stage, researchers use the PCC (Population, Concept, and Context) approach to ensure that the research focus is targeted and covers important aspects of the subject under review. The PCC approach allows researchers to formulate systematic, relevant, and broad research questions (Rodger et al. 2024). In the context of this study, the population refers to patients undergoing surgical procedures in various healthcare facilities. The conceptual component of the study focuses on compliance with the Surgical Safety Checklist (SSC), which is a standard intervention used worldwide to improve the safety of surgical patients. Meanwhile, the context refers to various types of healthcare facilities that perform surgical procedures, both in developed and developing countries. Based on this approach, the main question formulated in this scoping review is: "What is the relationship between the level of compliance with the Surgical Safety Checklist and adverse events in surgical patients?" This question, formulated precisely at the outset of this process, serves as a crucial foundation for subsequent stages in the scoping review methodology. The purpose of this question is to evaluate the existing literature, identify key findings, and highlight knowledge gaps in the implementation and effectiveness of the Surgical Safety Checklist.

### Identification of Relevant Studies

The process of identifying relevant research was conducted through systematic literature searches based on databases of high- to moderate-quality academic journals (Zhu and Liu 2020). The databases used in this study include Scopus, PubMed, and Springer Nature Link. These databases were selected because they have broad coverage in the fields of medicine, public health, and nursing, and provide scientific articles that have undergone a rigorous peer review process. The researchers developed a Boolean-based search strategy to ensure that the search results were relevant to the research subject (Biron et al. 2024). **Table 1** presents the Boolean formula structure used in this study. This strategy consists of combining various keyword groups using the logical operators OR and AND. The OR operator combines synonyms or terms with the same meaning, while the AND operator connects main concept groups to make search results more focused (MacFarlane et al. 2022).

**Jurnal Keperawatan Suaka Insan (JKSI)**
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**Table 1**. Boolean Formula Structure Research

| Conceptual Components | Keywords |
|---|---|
| Surgical Safety Interventions | "surgical safety checklist" OR "safety protocol" OR "safety guidelines" OR "checklist adherence" |
| Negative clinical results or incidents | "adverse events" OR "complications" OR "outcomes" OR "incident reporting" |
| Surgical procedure | "surgery" OR "operation" OR "procedure" OR "intervention" |
| Level of compliance or implementation | "compliance" OR "adherence" OR "implementation" OR "observance" |

**Table 2.** Boolean Research Formulas

| Database | Boolean Formulas |
|---|---|
| Scopus<br>PubMed<br>Springer Nature Link | ("surgical safety checklist" OR "safety protocol" OR "safety guidelines" OR "checklist adherence") AND ("adverse events" OR "complications" OR "outcomes" OR "incident reporting") AND ("surgery" OR "operation" OR "procedure" OR "intervention") AND ("compliance" OR "adherence" OR "implementation" OR "observance") |

Structure in Table 1, the results of the research were searched in the four academic journal databases presented in Table 2. This strategy was applied consistently to all four databases without filtering by publication year, language, or document type at the initial stage to ensure that all potentially relevant literature could be identified before the selection process was carried out.

**Research Selection**

The study selection process in this scoping review was conducted systematically by following the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines with the aim of providing a flow and validity of the selected studies in accordance with systematic guidelines (Haddaway et al. 2022). The selection process was carried out in several stages, starting with the removal of duplicate search results, screening based on titles and abstracts, and a full-text review to determine the suitability of the studies for the focus of the review. At this stage, inclusion and exclusion criteria are applied to ensure that only studies relevant to compliance with the Surgical Safety Checklist and its impact on adverse events in surgical patients are included in the analysis presented in **Table 3** (Swift and and Wampold 2018). To ensure comprehensive evidence mapping and minimize selection bias, this review applied no exclusion based on publication access type (open, hybrid, or closed access). Paywalled articles were retained when they met empirical relevance to the structured Boolean query, aligning with best-practice scoping review recommendations for reputable international publication.

**Tabel 3**. Inclusion and Exclusion Criteria

| Criteria | Inclusion | Exclusion |
|---|---|---|
| Publication Period | January 2020 – April 2025 | outside the period |
| Document Type | Article Empiric | Conference paper, Book/Book Review, Article Review, Report, |
| Language | English | Not in English |
| Country | All Countries | does not mention specific regions |
| Scope | Relevant to boolean formulas | not relevant to boolean formulas |

This selection process is then illustrated in the form of a PRISMA-ScR flowchart presented in **Figure 1**, which transparently shows the article screening process, from the initial number of articles found to the final number of studies included in the review. Overall, this process can be presented transparently and provides research results that are in line with the scope through critical and comprehensive review. The study selection process was carried out collaboratively by the research team using a standardized eligibility checklist to ensure consistent application of the inclusion and exclusion criteria. Titles, abstracts, and full texts were reviewed together in discussion-based sessions to reach agreement on study eligibility. Because the screenings were not conducted independently by separate reviewers, the process may introduce selection bias. This limitation has been acknowledged in the Limitations section. Consistent with the purpose of scoping reviews to map the breadth of available evidence rather than assess study quality, no formal critical appraisal or risk-of-bias assessment was conducted.

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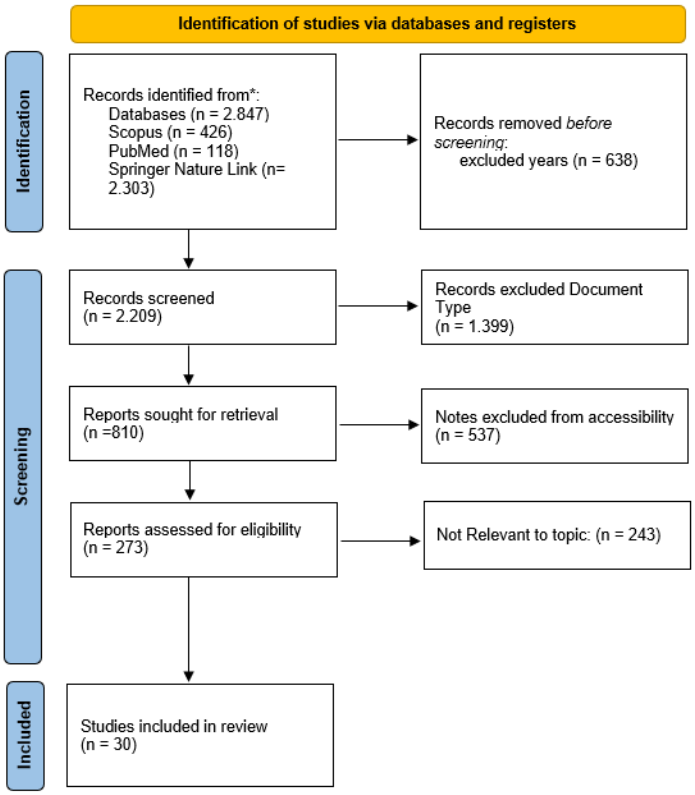


**Figure 1.** PRISMA-ScR Research Diagram
Source: PRISMA ScR guidelines with modifications (Haddaway et al. 2022)

**Protocol and Registration**

Although scoping reviews increasingly emphasize protocol transparency to enhance methodological rigor, this review did not undergo formal preregistration on platforms such as the Open Science Framework or Figshare. Instead, the review protocol was internally developed and refined through an iterative consensus process involving multiple raters to ensure clarity in objectives, eligibility criteria, and data-charting procedures. This approach aligns with the guidance of Mattos et al. (2023), WHO highlight that structured protocol development even when not publicly registered remains essential for maintaining methodological consistency in scoping reviews. The absence of a publicly registered protocol is acknowledged as a limitation of this study.

**Results Analysis and Presentation**

After the study selection process was completed, the next step was to analyze and present the findings systematically. The analysis was conducted using a thematic approach to group the data based on patterns, focus, and the contribution of each study to the understanding of compliance with the Surgical Safety Checklist and its implications for adverse events in patients. Each included study is thoroughly reviewed to extract important information such as research objectives, methods, implementation context, compliance levels, and the types and frequencies of adverse events reported. Findings are then summarized in a descriptive narrative supported by a study categorization table to clarify the distribution of study characteristics, along with supporting visualizations if necessary. This step aims not only to map the available evidence but also to identify knowledge gaps and potential directions for future research. The entire research procedure is presented in **Figure 2.**

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**Figure 2**. Research Procedures

## Results

Compliance with the Surgical Safety Checklist (SSC) and its implications for adverse events in surgical patients shows an increase from year to year with some fluctuations. **Figure 3** The graph shows the number of publications and the total number of publications, indicating that publications began with a relatively low number in 2020, with only 2 articles. However, there was a significant increase in 2021 to 5 articles, and continued to rise in 2022 and 2023, each with 6 relevant articles. The peak in the number of publications occurred in 2024, with a total of 9 articles published, indicating growing attention to surgical safety issues and the importance of implementing SSC in global clinical practice. Interestingly, in 2025, there was a sharp decline to only 2 articles, likely due to the limited publications available up to the time of data collection. The total number of publications corresponding to these findings amounted to 30 articles included in the research study. Overall, these data indicate that topics related to SSC have remained a key focus in the global health literature over the past five years, with a significant intensification of research, particularly in the years following the COVID-19 pandemic, when patient safety standards became increasingly critical.

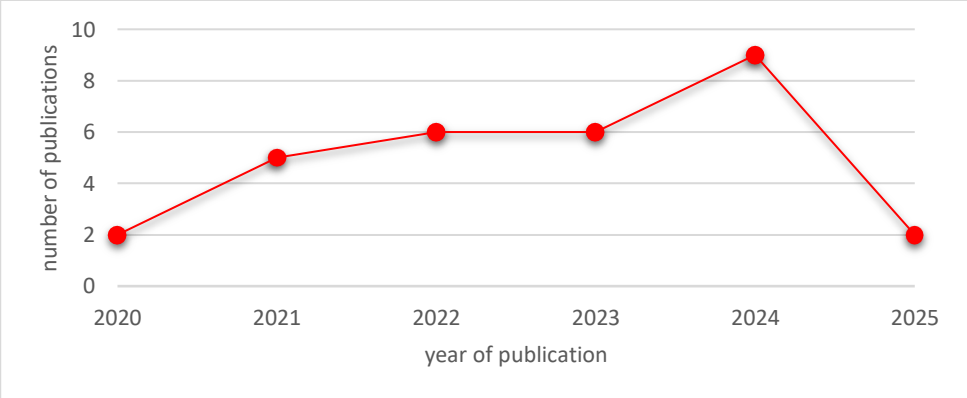


**Figure 3**. Number of Publications by Year Period

The distribution of publications analyzed in this scoping review approach shows variation based on the various database sources used. As shown in **Figure 4**, The majority of articles included were from Scopus, with a total of 17 publications. This indicates that Scopus is the dominant source for providing literature related to compliance with the Surgical Safety Checklist (SSC) and its impact on adverse events in surgical patients. The second most common source was PubMed, with 10 articles identified on the topic. This database is widely recognized as the primary repository for medical and biomedical literature, making it highly relevant for supporting this study, particularly in the context of patient safety and clinical practice. Meanwhile, Springer Nature Link contributed only 3 publications and total 30 article publications to this study. Although the number is smaller compared to the other two databases, the articles from Springer Nature still provide valuable contributions, particularly in studies that combine aspects of policy, risk management, and ethnographic approaches to the implementation of SSC. Overall, these findings indicate that literature on SSC is scattered across various medical and health databases, highlighting the importance of combining multiple sources to achieve a comprehensive understanding in this scoping review study.

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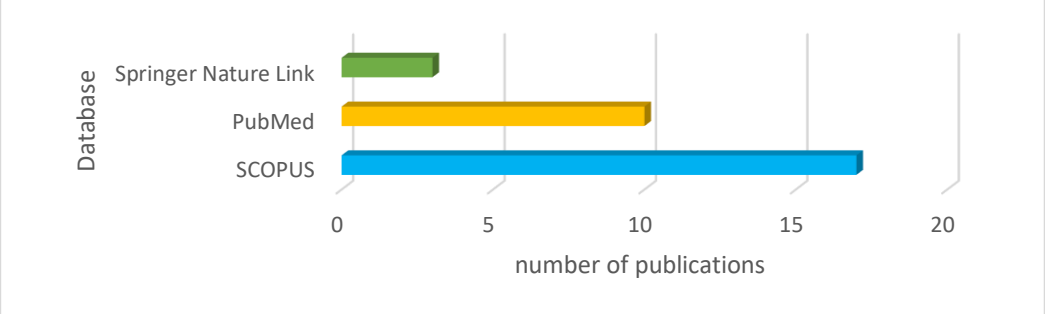


**Figure 4**. Number of Publications by Database Source

**Figure 4**, This section presents a literature review covering the methodology, main results, and future research directions of relevant studies to provide a comprehensive overview of previous research. To understand the progress of research on compliance with the Surgical Safety Checklist and its effect on adverse events in surgical patients, this table is used. After screening and analyzing 30 selected articles, a thematic mapping was conducted to identify the main focus of research relevant to compliance with the Surgical Safety Checklist (SSC) and its impact on adverse events. Based on the literature presented in **Table 4**, the researchers sought to identify the main findings and future research directions based on each author. The researchers were able to identify findings that were relevant and interrelated between variables for grouping. The results of this scoping review were grouped into seven main themes reflecting the trends and contributions of previous studies in the field of surgical safety as presented **Tabel 5**.

**Table 4.** Characteristics of Included Studies

| Authors & Year | Country / Region | Study Design | Surgical Context / Type of Surgery | SSC Compliance Measure | Main Outcome(s) Assessed |
|---|---|---|---|---|---|
| (Yaseen et al. 2025) | LMIC (Middle East) | Cross-sectional audit | Multiple OR procedures | Checklist completion rate | Compliance level across sites |
| (Rossi et al. 2024) | Italy | Retrospective analysis | General surgery | Compliance–outcome linkage | Surgical complications |
| (Dirie et al. 2024) | Somalia | Implementation report | General surgery | Pre–post SSC use | Postoperative safety outcomes |
| (Hawker et al. 2024) | USA | Survey | Veterinary surgery | Attitudes & perceived compliance | SSC acceptability |
| (Facey et al. 2024) | Canada | Qualitative ethnography | General surgery | Ritualization vs. fidelity | Team communication & culture |
| (Ilorah et al. 2024) | South Africa | Cross-sectional | Neurosurgery | KAP survey | Compliance & perceptions |
| (Saadah et al. 2024) | Multi-country | Technical development | Radiosurgery | Protocol adherence | System performance |
| (Taiswa et al. 2023) | Kenya | Cross-sectional | Mixed procedures | Completion rate | Associated factors |
| (van Zyl et al. 2023) | South Africa | Observational | General surgery | SSC use consistency | Nurse perspectives |
| (Ferorelli et al. 2022) | Italy | Pre–post intervention | General surgery | Training → adherence | Staff compliance |
| (Mejia et al. 2022) | Brazil | Retrospective cohort | Cardiac surgery | Checklist adherence | Mortality outcomes |
| (Bajracharya et al. 2021) | Nepal | Cross-sectional | Pediatric surgery | Completion rate | Compliance level |
| (Tan et al. 2021) | China | Multicenter survey | General surgery | Attitudes & compliance | Safety behaviors |

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| Authors & Year | Country / Region | Study Design | Surgical Context / Type of Surgery | SSC Compliance Measure | Main Outcome(s) Assessed |
|---|---|---|---|---|---|
| (Gong et al. 2021) | China | Survey | Gynecology/Obstetrics | Awareness & fidelity | Implementation barriers |
| (Ališić et al. 2023) | Bosnia | Qualitative | General surgery | Assistant nurse roles | Perceptions of SSC |
| Turley et al., 2023 | International | Survey + qualitative | Multiple surgeries | Modifications of SSC | Adaptation patterns |
| (Alidina et al. 2021) | Tanzania | Prospective study | General surgery | Multi-component adherence | Patient outcomes |
| (Emond et al. 2022) | Netherlands | Cluster RCT | Multiple surgeries | Perioperative guideline adherence | Patient safety composite |
| (Toru et al. 2023) | Pakistan | Audit | General surgery | Compliance rate | Audit outcomes |
| (Munthali et al. 2022) | Zambia | Qualitative | General surgery | Barriers/enablers to SSC | Implementation factors |
| (Moore et al. 2022) | New Zealand | Retrospective audit | Mixed surgeries | Implementation fidelity | PDOH outcomes |
| (Gasoma 2024) | Rwanda | Prospective | General surgery | SSC implementation | Surgical outcomes |
| (Amrita et al. 2024) | India | Prospective comparative | OBGYN | Adherence to SSC | Morbidity/mortality |
| (Röhsig et al. 2020) | Brazil | Quality improvement | General surgery | Compliance improvement | Adherence trend |
| (Patel et al. 2024) | USA | Intervention | Cesarean section | Modified SSC adherence | Maternal outcomes |
| (Sibhatu et al. 2022) | Ethiopia | Nationwide survey | Mixed surgeries | Facility-level compliance | Postoperative outcomes |
| (Panda et al. 2021) | Global | Expert consensus | Multiple surgeries | Adaptations during COVID-19 | Implementation guidance |
| (Wæhle et al. 2020) | Norway | Ethnography | Multiple specialties | Integration with risk systems | System alignment |
| (Elam et al. 2024) | USA | Mixed methods | General surgery | Implementation strategies | Fidelity determinants |
| (Kapira et al. 2023) | Malawi | Impact evaluation | Rural hospital | Implementation adherence | Patient outcomes |

Based on **Table 4**, summarizes the 30 articles that were analyzed in the scoping review. This table presents the authors, methods, main findings, and directions for further research. In general, these studies show that compliance rates with the Surgical Safety Checklist (SSC) still vary across countries and types of hospitals. Most studies found that high compliance with the SSC was associated with a reduction in surgical complications and patient mortality, while non-compliance was often linked to institutional factors, organizational culture, training limitations, and healthcare workers' perceptions of the benefits of the SSC. In addition, several studies also highlight the importance of training and educational interventions, the role of surgical team communication, and modification of the SSC to suit the local context (e.g., during a pandemic or for special operations). This table also shows a trend toward mixed methods research and the need for longitudinal studies to evaluate the long-term effects of SSC implementation on patient safety.

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**Table 5.** Scoping Review Results

| Main Theme | Summary of Findings | Authors |
|---|---|---|
| compliance with surgical safety checklist | Measure the level of compliance of surgical staff with the implementation of the surgical safety checklist and the factors that influence it. | (Yaseen et al. 2025; Taiswa et al. 2023; Bajracharya et al. 2021; Toru et al. 2023; Dirie et al. 2024) |
| Communication and Surgical Teamwork | Explore the importance of communication, team synergy and the role of the leader in the effective implementation of the surgical safety checklist. | (Facey et al. 2024; Elam et al. 2024; Gong et al. 2021; Mejia et al. 2022; Patel et al. 2024; Wæhle et al. 2020) |
| Effectiveness of Surgical Safety Checklist on Complications & Mortality | Assess the impact of surgical safety checklists in reducing postoperative complication rates and improving patient clinical outcomes. | (Rossi et al. 2024; Amrita et al. 2024; Alidina et al. 2021; Emond et al. 2022; Mejia et al. 2022; Moore et al. 2022; Sibhatu et al. 2022) |
| Healthcare Worker Training and Education | Examining the effect of training on surgical staff compliance and understanding of the surgical safety checklist | (Ferorelli et al. 2022; Ilorah et al. 2024; Ališić et al. 2023; Röhsig et al. 2020; Toru et al. 2023) |
| Barriers to Implementation of Surgical Safety Checklist | Identify contextual, structural and behavioral barriers to the implementation of the surgical safety checklist in the operating room. | (Munthali et al. 2022; van Zyl et al. 2023; Facey et al. 2024; Gong et al. 2021; Taiswa et al. 2023) |
| Modification and adaptation of surgical safety checklist | Report on the adaptation of the surgical safety checklist in various contexts, including during the pandemic and in specific operations | (Turley et al. 2023; Panda et al. 2021; Wæhle et al. 2020; Patel et al. 2024) |
| Technology & Innovation in procedures Surgical safety checklist | Implement technology systems such as integration to EMR, patient position cameras, or PDSA-based SSC control systems. | (Saadah et al. 2024; Patel et al. 2024; Röhsig et al. 2020) |

Synthesis of **Table 5,** shows the results of thematic mapping from thirty articles analyzed in this scoping review. Overall, these studies can be grouped into seven main themes that describe the dynamics of Surgical Safety Checklist (SSC) implementation in various surgical service contexts. The first theme relates to compliance with the SSC, highlighting the level of implementation of the checklist by surgical staff and various factors that influence it, such as organizational culture, managerial support, and individual perceptions of the benefits of the SSC. The next theme emphasizes the importance of communication and cooperation within the surgical team, where effective communication between team members and strong leadership have been shown to contribute to the successful implementation of the checklist in the operating room. In addition, the theme regarding the effectiveness of SSC on patient complications and mortality shows that high compliance with checklists is positively correlated with a decrease in unexpected events, postoperative infections, and mortality rates. Other studies highlight the role of training and education of health workers as important factors in increasing knowledge, skills, and commitment to the consistent use of SSC. On the other hand, various implementation barriers have also been identified, including structural, behavioral, and cultural constraints in the operating room that can hinder the effective application of checklists. Several studies also describe modifications and adaptations of SSC according to local needs, such as adjustments to procedures during the COVID-19 pandemic or adaptations to specific types of surgery. Meanwhile, technological developments and innovations are also an important focus, with the emergence of initiatives to integrate SSC into electronic medical record systems, the use of patient positioning cameras, and PDSA-based control systems to ensure the continuous implementation of checklists. Overall, the findings in this table show that the success of SSC implementation is multidimensional and requires synergy between training, team communication, organizational support, and the use of technology to achieve continuous improvements in patient safety and reduce the risk of surgical complications.

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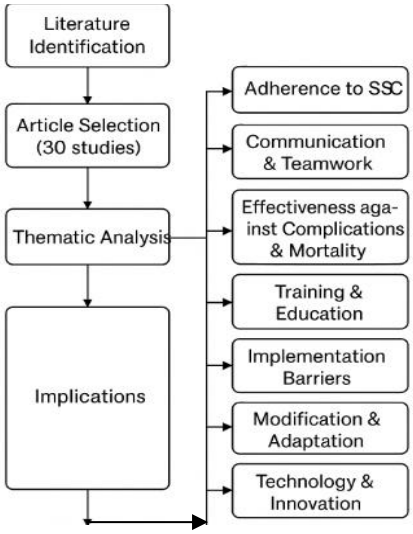


**Figure 5**. Flowchart Scoping Review

Across the **Figure 5**, this flowchart illustrates the research process in a scoping review that focuses on compliance with the Surgical Safety Checklist (SSC) and its implications for adverse events in surgical patients. The research process begins with the literature identification stage, where researchers conduct a systematic search of various databases to find relevant articles. The next stage is article selection, which resulted in 30 studies selected according to the inclusion and exclusion criteria. This was followed by thematic analysis, which aimed to group the findings from each study into several main themes. From the synthesis results, seven major themes were obtained that reflect important aspects in the implementation of SSC, namely the compliance of surgical staff with the checklist, communication and teamwork, the effectiveness of SSC on complications and mortality, training and education of health workers, barriers to implementation, modification and adaptation of SSC, and the role of technology and innovation in the application of checklists in the digital era. All of these themes then converged in the implications section, which emphasized that increased compliance with SSC had a significant impact on improving patient safety and reducing postoperative complications. Visually, this flowchart showed the logical connection between the identification process and the thematic findings, which ultimately provided practical and scientific recommendations for strengthening the culture of surgical safety in hospitals.

## Discussion

### Gaps in the Literature

Mapping of the 30 included studies reveals several persistent gaps in the evidence base. First, although adherence to the Surgical Safety Checklist (SSC) is consistently associated with improved patient safety outcomes, few studies examine *how* specific phases of the checklist contribute to these outcomes. For example, almost no studies evaluate why adherence often declines during the *time-out* or *sign-out* phases, especially in high-workload or high-hierarchy operating rooms. Second, there is limited qualitative exploration of the behavioral and sociotechnical factors that influence adherence, despite recurring themes in the literature related to team dynamics, perceptions of checklist value, ritualistic completion, and communication barriers. Third, methodological diversity remains narrow; the majority of studies are observational, and only a small proportion employ interventional, experimental, or mixed-method designs that can clarify causality or mechanism. Fourth, there is no standardized approach to measuring SSC adherence, with studies variably using completion rates, observational scoring, or self-reported perceptions, making cross-study comparisons difficult. Lastly, post-2020 evidence is still fragmented, particularly regarding how COVID-19–driven workflow changes and digital transformation have influenced checklist execution and team communication.

### Compliance with Surgical Safety Checklist

Compliance with the Surgical Safety Checklist (SSC) is the main foundation in ensuring the effectiveness of the implementation of this safety instrument in the operating room. Based on the results of a scoping review,

**Jurnal Keperawatan Suaka Insan (JKSI)**
Volume 10, No 2, Juli-Desember 2025
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several studies highlight variations in compliance levels across different hospitals, both in terms of the number of checklists completed in full and the consistency of their implementation during the preoperative, intraoperative, and postoperative phases. For example, two research findings Taiswa et al (2023); Yaseen et al (2025), shows that most SSCs are only partially filled or even left empty, especially in public sector hospitals and remote areas, indicating a significant gap between policy and practice. This phenomenon is also supported by findings Jin et al (2019), in their study in China, which showed that only about 60% of checklist items were implemented correctly, and the dominant factors influencing compliance were organizational culture and operational leadership in the operating room. Furthermore, a study by Haugen et al (2019) states that the existence of a checklist does not guarantee effective implementation if it is not accompanied by a continuous monitoring and evaluation mechanism. Compliance with SSC is also closely related to the clarity of roles within the team, understanding of the checklist items by all parties involved, and perceptions of the direct benefits of SSC to patient safety. As shown in research by Søreide (2022), Compliance levels tend to increase significantly when there is specific training on the importance of SSC as a safety instrument, rather than merely as an administrative obligation. Overall, the results of this study reinforce that compliance levels are a key indicator of SSC success, but achieving this requires synergy between institutional policies, regular training, and the establishment of a safety culture that is deeply rooted in the surgical service system.

**Communication and Surgical Teamwork**

Effective communication and collaboration among surgical team members are key elements in ensuring the meaningful implementation of the Surgical Safety Checklist (SSC) and have a direct impact on patient safety. The results of the scoping review indicate that most of the studies reviewed concluded that the success of SSC implementation is greatly influenced by the quality of team communication during the surgical process. Based on research Facey et al (2024); Gong et al (2021), highlights that checklists are often carried out symbolically without active communication between teams, thereby failing to establish a true culture of safety. These findings are consistent with the results of research by Cabral et al (2016), which found that in more than 30% of surgical cases, SSC was not accompanied by open discussion, especially during the “sign-in” and “time-out” phases, which are crucial moments for the exchange of important information. In the study, clear two-way communication between nurses, anesthesiologists, and surgeons was associated with a significant reduction in patient identification errors and procedural errors. In addition, Valerio et al (2017), emphasizes the importance of leadership in the surgical team to ensure that SSC is performed correctly and that all team members feel they have equal responsibility. When the hierarchical structure is too rigid, non-physician team members tend to be reluctant to raise potential problems or discrepancies in procedures. Therefore, creating an open and respectful communication environment is essential for SSC to function optimally. Meanwhile, a study by Freytag et al (2017), reinforcing the argument that teams that routinely conduct SSC-based briefings and debriefings have lower rates of postoperative complications than teams that only perform administrative checklists. Communication-based interventions, including team communication simulations, are considered capable of improving compliance and preventing system failures due to miscommunication. Thus, this scoping review demonstrates that surgical team communication is not merely an adjunct to SSC but the foundational element for ensuring checklists are fully internalized into the workplace culture. Future interventions should prioritize enhancing team communication competencies through interprofessional training and strengthening feedback systems among team members.

**Analysis of the causes of Surgical Safety Checklist regarding Complications and Mortality Rates**

The reduction in mortality among high-adherence teams may not be caused by the checklist alone but by the team climate that surrounds its execution. Checklists act as a sociotechnical trigger structuring pause-and-share moments that enable error interception. When adherence is high, it signals stronger psychological safety, cross-checking behavior, and information symmetry in the operating room. Thus, clinical effectiveness may emerge because the checklist functions as both a safety instrument and a performance marker of a more mature safety culture. Ritualization occurs when the checklist persists in form but not function. To reverse this decoupling, institutions must redesign SSC delivery from a perfunctory task into an interactive, team-owned verification ritual, supported by leadership accountability and local human-factor-aligned workflows. This enables the transition of SSC from symbolic performance back to meaningful safety affordance A number of studies, such as those conducted by Mejia et al (2022), provides evidence that consistent implementation of SSC can reduce

**Jurnal Keperawatan Suaka Insan (JKSI)**
Volume 10, No 2, Juli-Desember 2025
P-ISSN : 2527-5798, E-ISSN : 2580-7633

the risk of adverse events, including surgical site infections, procedural errors, and even patient deaths. However, its effectiveness is highly dependent on the quality of implementation and the full involvement of all members of the surgical team. This finding is supported by a meta-analysis conducted by Habtie et al (2025), which shows that full implementation of SSC is associated with a 30% reduction in postoperative complications and a 40% reduction in mortality in various low- and middle-income countries. These positive effects are most pronounced when SSC is used not only as an administrative document, but as an effective team communication tool during the perioperative phase. Another study by Gillespie et al (2018), found that surgical units that implemented SSC with compliance rates above 90% experienced a significant reduction in surgical site infections (SSI) and the need for reoperation compared to units with compliance rates below 60%. They concluded that SSC can serve as an effective preventive tool if accompanied by regular monitoring and training. In addition, Mayer et al (2016), A cross-country study found that the impact of SSC on reducing mortality was greater when checklists were integrated into electronic medical record (EMR) systems, as these systems promote consistency in documentation and provide automatic alerts if key steps are missed. Thus, the results of this study show that the effectiveness of SSC in reducing complications and deaths is very real, but remains conditional on the quality of implementation, team involvement, and system support. Further research is recommended to explore mediating factors such as clinical leadership and digital technology in maximizing the impact of SSC on patient safety.

**Healthcare Worker Training and Education**

Training and education for healthcare workers are key factors in improving compliance and effectiveness in implementing the Surgical Safety Checklist (SSC). Studies in this scoping review, such as those conducted by Ilorah et al (2024), shows that regular training, especially in the form of simulations or integrated briefing sessions, can improve understanding of SSC functions and encourage more consistent implementation in the operating room. These findings are reinforced by research Barimani et al. (2020), WHO found that structured team-based training increased awareness of SSC items and strengthened the collective responsibility of all surgical team members. They noted that training focused on risk communication, checklist usage flow, and cross-professional empowerment resulted in a significant increase in active engagement during SSC implementation. In addition, Habtie et al (2025), highlights that education that is not only technical but also touches on aspects of safety culture will have a more sustainable impact. In his research in a number of British hospitals, surgical teams that received SSC training based on safety values showed an increase in long-term compliance, compared to teams that only received brief procedural instructions. Notch (2021), highlights that education that is not only technical but also touches on aspects of safety culture will have a more sustainable impact. In his research in a number of British hospitals, surgical teams that received SSC training based on safety values showed an increase in long-term compliance, compared to teams that only received brief procedural instructions.

**Barriers to Implementation of Surgical Safety Checklist**

Although the Surgical Safety Checklist (SSC) has been widely adopted as a safety standard in operating rooms, its implementation still often faces significant obstacles. The results of a scoping review show that low compliance with the SSC is not solely due to a lack of instructions or regulations, but also to challenges at the individual, team, and organizational levels. Studies such as van Zyl et al (2023), noted that the implementation of SSC tends to be formalistic and lacks active involvement, especially when there is no full support from clinical leaders or hospital management. These findings are consistent with the results of a qualitative systematic review by Paterson et al (2024), which states that the main obstacles to SSC implementation include a hierarchical professional culture, a lack of ownership of the checklist process, and high time pressure in the operating room. In a hierarchical environment, nurses often do not feel they have the authority to ensure that the checklist is followed according to procedure, especially when senior surgeons are passive or ignore the process. Furthermore, Lim et al (2023), In its integrative review, it was found that SSC designs that do not match local practice needs pose a barrier in themselves. When the contents of the checklist are perceived as too long, irrelevant, or not tailored to the operational context, healthcare workers tend to view it as an administrative burden rather than an effective safety tool. This challenge is exacerbated by the lack of ongoing training and the absence of an evaluation system to monitor SSC implementation in real-time. Additionally, the perspective of nurses as the primary implementers of SSC is a key focus area. In a study by Do Prado Tostes & Galvã

**Jurnal Keperawatan Suaka Insan (JKSI)**
Volume 10, No 2, Juli-Desember 2025
P-ISSN : 2527-5798, E-ISSN : 2580-7633

(2019), It was found that nurses identified several key barriers, such as a lack of team involvement, limited human resources, and unclear roles when implementing the checklist. Although nurses recognized the benefits of SSC in improving patient safety, they often faced a dilemma between thoroughly implementing the checklist and completing other clinical responsibilities within a limited time frame. Overall, this theme underscores that SSC implementation barriers are systemic and multidimensional, encompassing technical, structural, and organizational cultural aspects. To address this, context-based strategies need to be developed, such as interprofessional training involving the entire surgical team, local adaptation of checklist formats, and a more participatory managerial approach.

**Modification and adaptation of surgical safety checklist**

In its application in various healthcare contexts, the Surgical Safety Checklist (SSC) often undergoes modification or adaptation to suit operational needs, patient characteristics, procedure types, and healthcare system conditions. Based on the results of a scoping review, several studies such as Patel et al (2024), shows that SSC modifications were made both structurally and functionally, for example by simplifying items, adjusting the flow of the surgical phase, and integrating it into the electronic medical record system. These adaptations have also been shown to increase the effectiveness of SSC in improving surgical team engagement. A study by Wæhle et al (2020), shows that checklists tailored to local needs can improve compliance and have a significant impact on reducing post-operative complications. Adaptations made through the participation of the medical team also encourage a sense of ownership, making it more likely that the checklist will be applied consistently. Adaptive implementation of SSC has also proven effective in a national context. In a report by White et al (2020), The use of the Knowledge to Action Framework approach in the implementation of SSC across all hospitals in Cameroon allows for the adaptation of checklist formats based on resource capacity, organizational culture, and local practices. The results show a significant increase in user acceptance and the effectiveness of checklist implementation nationwide. A collaborative, interprofessional approach in the adaptation process is considered crucial to ensuring the long-term success of implementation. Additionally, the COVID-19 pandemic has underscored the necessity of adapting SSC. A study by Assadian et al (2021), shows that to ensure the safety of patients and medical personnel during the pandemic, the checklist needs to be modified by adding specific protocols such as the use of personal protective equipment, cross-infection control, and adjustments to the communication flow between surgical team members. These adaptations not only maintain the relevance of SSC in emergency situations but also expand its scope as a strategic tool in systemic risk mitigation. Overall, the results of this scoping review emphasize that modifications and adaptations to the SSC are essential strategies, not deviations, as long as they remain grounded in patient safety principles and based on clinical team involvement. Local adaptations developed through collaborative processes have proven to enhance the acceptance and sustainability of checklist implementation across various healthcare systems.

**Technology & Innovation in procedures Surgical safety checklist**

The implementation of the Surgical Safety Checklist (SSC) in digital form has become a growing trend in line with advances in information technology in the healthcare sector. Technology-based innovations are considered to have great potential in improving checklist compliance, time efficiency, and documentation accuracy in the operating room. Based on the results of a scoping review, several studies emphasize that the use of technology, whether in the form of integrated electronic systems or digital cognitive aids, can contribute to strengthening safety culture in the operating room. (Röhsig et al. 2020; Saadah et al. 2024). Research by Patne & Kanyal (2025), highlighting that the use of digital audit systems to monitor SSC compliance enables hospitals to conduct real-time data-driven evaluations. This system not only measures checklist completeness but also facilitates error reporting, identification of non-compliance trends, and the development of improvement plans in line with national and international safety standards. They concluded that integrated audit technology promotes higher accountability among surgical teams. Meanwhile, a digital cognitive aid-based approach is one of the innovations beginning to be used to support intraoperative crisis management. Schild et al (2019), developing a digital application for anesthesia that acts as an interactive guide during emergency situations in the operating room. Although the focus is not directly on SSC, the design principles applied demonstrate that digitizing safety aids can improve focus, consistency, and coordination among surgical teams during procedures. Furthermore, Gardiner et al (2024), It should be noted that technological interventions such as interactive dashboards or automated reminders also help improve transparency and compliance with SSC implementation, particularly in

**Jurnal Keperawatan Suaka Insan (JKSI)**
Volume 10, No 2, Juli-Desember 2025
P-ISSN : 2527-5798, E-ISSN : 2580-7633

large hospitals with high workloads. Thus, the findings of this study reinforce the understanding that technological innovations can strengthen SSC implementation through improved efficiency in execution, more accurate monitoring systems, and the integration of checklists into hospital digital workflows. However, it is important to balance the use of technology with direct team involvement to ensure that SSC does not lose its primary function as a tool for communication and collaboration in ensuring patient safety.

**Implications for Nursing Leadership and Surgical Team Management**

The findings of this scoping review from **Table 4**, underscore several actionable points for nurse managers and perioperative leaders. First, rather than emphasizing checklist "completion," managers should focus on the quality of critical communication steps, particularly the *time-out*, which multiple studies have shown to be vulnerable to ritualization. Second, structured interprofessional training including simulation, team briefings, and debriefings can enhance shared mental models and improve checklist execution. Third, nurse managers play a central role in cultivating psychological safety, empowering nurses and junior staff to speak up during checklist processes without fear of hierarchy. Fourth, workflow and ergonomic adjustments such as optimizing positioning, simplifying documentation, or integrating digital prompts can reduce cognitive load and improve adherence. Finally, consistent monitoring, feedback loops, and leadership accountability mechanisms can help sustain adherence improvements over time.

**Implication for Future Research**

Future research should adopt more diverse and rigorous methodological approaches to address these gaps. Longitudinal studies are needed to monitor adherence patterns over time, particularly during different surgical phases. Mixed-methods research would offer deeper insights into how behavioral, cultural, ergonomic, and organizational factors shape checklist fidelity. Interventional studies, including targeted training, digital augmentation, or redesign of workflow processes, would help clarify which strategies most effectively improve compliance. Additionally, future research should prioritize standardizing SSC adherence metrics, allowing more robust comparisons across settings and supporting meta-inference in future evidence syntheses. Studies conducted in low- and middle-income countries (LMICs) should also examine contextual adaptations, resource constraints, and the role of leadership support, given the variability observed across settings.

**Study Limitations**

This scoping review has several limitations that should be acknowledged. First, the review only included studies published between 2020 and 2025, which may have excluded earlier yet relevant research that could provide a broader understanding of long-term adherence patterns to the Surgical Safety Checklist (SSC). Second, the review was limited to articles available in English and indexed in three major databases: Scopus, PubMed, and Springer Nature Link potentially omitting valuable findings published in other languages or local databases. Third, heterogeneity among included studies in terms of design, measurement of adherence, and reporting of adverse events made it difficult to perform a comparative or quantitative synthesis. Additionally, most of the studies analyzed were observational in nature, which restricts the ability to draw causal inferences regarding the relationship between SSC compliance and clinical outcomes. The review also relied on published data, which may be subject to publication bias, as studies with positive results are more likely to be reported. Lastly, contextual variations such as cultural differences, hospital policies, and available resources were not uniformly reported across studies, thereby limiting the generalizability of the findings. Although no access-type filter was applied during initial search, early protocol drafts narrowly emphasized open-access trials, which may have inadvertently delayed the inclusion of some closed-access evidence. This introduces potential selection bias and limits broader generalizability. Future reviews are advised to ensure unrestricted access screening and consider institutional mechanisms for paywalled full-text retrieval to support comprehensive evidence synthesis. Future studies are encouraged to address these limitations by incorporating multicenter longitudinal designs, including diverse healthcare settings, and standardizing the measurement of SSC adherence and its clinical impact.

## Limitations

This scoping review has several methodological limitations that must be acknowledged to ensure transparency and adherence to the PRISMA-ScR reporting standards. First, although the review process followed the methodological framework of Arksey and O'Malley (2005), Levac et al. (2010), and the Joanna Briggs Institute

**Jurnal Keperawatan Suaka Insan (JKSI)**
Volume 10, No 2, Juli-Desember 2025
P-ISSN : 2527-5798, E-ISSN : 2580-7633

(JBI), the review protocol was not preregistered in platforms such as the Open Science Framework (OSF) or Figshare. Lack of preregistration may limit external verification of the analytical steps, even though the protocol development and refinement were guided by established scoping review recommendations (Mattos et al. 2023). Second, the database search included Springer Nature Link, which is a publisher platform rather than a formal bibliographic database such as CINAHL, Embase, or Web of Science. This may have restricted the comprehensiveness of the search and increased the possibility of missing relevant studies. Although Scopus and PubMed were used, the inclusion of a publisher platform represents a methodological constraint that may influence the breadth of captured literature.

Third, although the screening procedure was conducted systematically, not all stages were performed by multiple independent reviewers. Ideally, two reviewers should independently screen titles, abstracts, and full texts, with discrepancies resolved through consensus or adjudication by a third reviewer. Because the screening process in this review relied on a single primary reviewer supported by iterative expert consultation, this may introduce selection bias and reduce reproducibility.

Fourth, no formal critical appraisal or risk-of-bias assessment was performed. While such assessment is optional in scoping reviews and not required under the JBI methodology, its absence limits the ability to comment on the strength or robustness of the included evidence. As stated in scoping review guidance, the purpose of this review was to map the breadth and nature of SSC adherence research rather than to evaluate study quality; however, the implications of varying methodological rigor across studies should be acknowledged.
Another limitation of this review is that the study selection process was conducted collaboratively rather than independently by two reviewers. Although a standardized eligibility checklist was used to maintain consistency, the absence of independent screening may introduce reviewer bias.
Finally, the reasons for exclusion at the full-text screening stage may not fully capture the specificity expected in high-impact scoping reviews. Although articles deemed irrelevant were excluded, a more granular categorization such as wrong population, wrong outcomes, wrong setting, or non-empirical design could strengthen auditability of the study selection process. Future scoping reviews should incorporate more detailed exclusion reporting to enhance methodological transparency.

## Conclusion

The results of this scoping review indicate that adherence to the Surgical Safety Checklist (SSC) is strongly associated with a reduction in adverse events in surgical patients, such as postoperative complications, procedural errors, surgical site infections, and mortality. Through the identification and analysis of 30 relevant articles, it was found that the success of SSC implementation depends not only on the formal existence of the checklist but also on contextual aspects such as surgical team communication, continuous training, organizational support, and technological integration. Seven main themes identified reflect various dimensions of SSC implementation, ranging from compliance levels, effectiveness on patient clinical outcomes, to technology-based innovations. Barriers such as organizational cultural resistance, checklist designs that are not contextually appropriate, and hierarchical team structures have proven to be significant challenges. On the other hand, supportive factors such as relevant checklist modifications, supportive clinical leadership, and SSC digitalization play a crucial role in enhancing implementation success. This scoping review makes a significant contribution to enriching the surgical safety literature by highlighting the empirical link between SSC compliance levels and their impact on patient safety. This study also fills a gap in previous research, which typically only reviewed the effectiveness of checklists without comprehensively considering implementation and contextual factors. Based on the results of this scoping review, it is recommended that the implementation of the Surgical Safety Checklist (SSC) should not only focus on administrative compliance but also be strengthened through interprofessional training, enhanced surgical team communication, and active involvement of clinical leadership. Hospitals need to adapt the checklist design to the local context and integrate it into digital systems such as electronic medical records to enhance accountability and efficiency. Additionally, policymakers are encouraged to establish national regulations supporting routine evaluation of SSC implementation. Further research is recommended using a mixed-methods approach to assess the long-term impact of the SSC on patient safety, particularly in healthcare facilities with limited resources.

**Jurnal Keperawatan Suaka Insan (JKSI)**
Volume 10, No 2, Juli-Desember 2025
P-ISSN : 2527-5798, E-ISSN : 2580-7633

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## Conflict of Interest
The authors declare that they have no competing interests.

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**Wisnu Baskoro:** Conceptualization, Methodology, Software, Validation, Format Analysis, Investigation, Resources, Data Curation, Writing – Original Draft, Writing – Review and Editing, Visualization, Project administration, and Funding acquisition. **Muzakar Isa:** Conceptualization, Methodology, Writing – Review & Editing, Visualization and Supervision. **Siti Soekiswati:** Conceptualization, Validation, Writing – Review & Editing, Visualization and Supervision.

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