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ORIGINAL RESEARCH

Improving Surgical Safety in Somalia a Closed-Loop Audit Study of WHO Surgical Safety Checklist Adherence

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Background: Surgical safety is a global health priority, yet its consistent application in low- and middle-income countries remains a challenge due to systemic, cultural, and resource-related barriers. The World Health Organization's Surgical Safety Checklist (SSC) has been shown to reduce perioperative complications, but evidence from fragile health systems such as Somalia remains scarce.

Methods: This prospective closed-loop clinical audit was conducted at Dr. Sumait Hospital, a tertiary referral and teaching facility in Mogadishu, Somalia. A total of 160 surgical procedures were observed across two audit cycles. The first cycle established baseline compliance, while the second followed a structured intervention comprising targeted staff education sessions, strengthened leadership involvement, and placement of visual reminders and wall posters in operating theatres. Checklist adherence was assessed across the sign in, time out, and sign out phases using a standardized 25-item observation tool. Data were analyzed using the Wilcoxon signed-rank test, with significance set at $p < 0.05$.

Results: Overall checklist compliance increased significantly from 51.38% in the first cycle to 93.01% in the second ($p < 0.001$). Improvements were observed across all three SSC phases: sign in compliance rose from 54.62% to 88.19%, time out compliance from 50.60% to 96.94%, and sign out compliance from 47.29% to 95.01%. The most substantial gains were linked to improved team communication during the time out phase. However, checklist items requiring anticipatory planning, such as risk assessment for major blood loss, showed relatively lower improvements.

Conclusion: Context-sensitive, low-cost interventions—including focused education, leadership reinforcement, and visual prompts—can markedly improve adherence to the WHO Surgical Safety Checklist in resource-limited settings. These findings underscore the SSC's potential to strengthen surgical safety culture in Somalia and offer a practical model for similar fragile health systems aiming to reduce preventable perioperative harm.

Keywords: surgical safety checklist, Somalia, closed-loop audit, patient safety, WHO, perioperative care, healthcare quality, low-resource settings

Introduction

Ensuring safety in surgical care is a vital part of healthcare quality, particularly in low- and middle-income countries (LMICs), where systemic issues often increase the risk of negative outcomes.[1] Surgical safety remains a top global health priority, as complications from surgical procedures significantly contribute to both illness and death worldwide.[2] Each year, about 234 million major surgeries are performed globally, with nearly 7 million patients experiencing disabling complications and roughly 1 million deaths happening during or soon after surgery.[3] Evidence shows that at least 50% of these adverse events could be avoided with better surgical practices and safety measures.[4] To tackle this important challenge, the World Health Organization (WHO) launched the "Safe Surgery Saves Lives" initiative in 2008,

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introducing the Surgical Safety Checklist (SSC) as an essential tool to enhance patient safety in operating rooms around the world.[5]

Evaluation of the Surgical Safety Checklist (SSC) involves three key phases: sign-in (before anesthesia is administered), time-out (right before skin incision), and sign-out (when the patient leaves the operating room).[6] Conducting structured reviews during surgical rounds helps standardize procedures, improves team cohesion, and ensures that essential safety steps are completed in every case.[7] Although the SSC has shown success in various countries and healthcare settings, its implementation in real-world clinical environments remains inconsistent.[8] Several international studies have reported varying levels of adherence to SSC protocols, often due to factors such as insufficient staff training, institutional culture, and limited resource availability.[9–11]

Evidence from previous research indicates that the outcomes of SSC implementation differ widely depending on local conditions such as institutional culture, leadership commitment, and the level of staff training.[1,8]

Despite its proven benefits, there remains a major evidence gap regarding SSC implementation in fragile or post-conflict health systems, where challenges such as workforce shortages, limited training capacity, and inconsistent leadership support can significantly hinder adoption.

In Somalia, there is limited published data on the extent to which hospitals, both public and private, adhere to surgical safety protocols. Evaluating the adoption of the WHO Surgical Safety Checklist (SSC) in Somalia provides a valuable opportunity to assess its effectiveness in a complex, resource-limited environment and to generate insights that can guide strategies for improving surgical safety in similar settings.

This study aimed to evaluate compliance with the World Health Organization's Surgical Safety Checklist (SSC) at Dr. Sumait Hospital, a major tertiary healthcare facility in Mogadishu. By assessing adherence across all three checklist phases during a series of surgical procedures, the study identified key gaps in implementation and proposed targeted strategies for improvement. The findings provide a foundation for planning enhanced surgical safety practices within the institution.

Materials and Methods

Study Design and Setting

This study was designed as a prospective, observational clinical audit following a closed-loop format to assess and enhance surgical safety practices at Dr. Sumait Hospital, a tertiary care and teaching hospital affiliated with SIMAD University in Mogadishu, Somalia.

Participants and Intervention

A total of 160 surgical procedures were evaluated across two distinct audit phases, each involving 80 consecutive cases. The audit tool was adapted from the original World Health Organization (WHO) Surgical Safety Checklist and comprised 25 key safety items. These items were organized into three essential stages of the surgical process: Sign-in (conducted prior to anesthesia induction), Time-out (before the initial surgical incision), and Sign-out (before the patient is transferred out of the operating room).[12] Each phase was intended to facilitate communication, ensure proper patient identification, verify the surgical procedure and site, and confirm the readiness of surgical equipment and personnel.

Data Collection

To ensure consistency and reliability, all auditors participated in a preparatory training program that focused on checklist content, standardized observation techniques, and maintaining objectivity during data collection. Particular attention was given to minimizing inter-observer variability and ensuring fidelity to the audit protocol.

The first audit period was conducted from January 18 to April 26, 2024, serving as the baseline assessment. After analyzing the initial findings, a targeted intervention was implemented on May 12, 2024, aimed at addressing observed gaps in checklist compliance. This intervention involved an educational session for surgical, anesthesia, and nursing staff, presenting the audit results and emphasizing the importance of checklist adherence for patient safety. Official circulars

endorsed by department leadership were distributed, mandating the consistent use of the checklist in all operating rooms. Visual aids, such as posters and pocket-sized checklists, were introduced to support sustained compliance.

The second audit period followed from June 3 to September 18, 2024, applying the same methodology to assess the effect of the intervention. To complement the quantitative data, brief structured interviews were conducted after the second audit with members of the surgical team. These interviews explored perceived barriers to checklist use and gathered insights on themes such as awareness, feasibility, training needs, teamwork, and motivation.

Data Analysis

All quantitative data were entered and analyzed using SPSS version 26.0 (IBM, 2018). Descriptive statistics were used to summarize compliance rates by phase and checklist item. To determine whether the observed changes in compliance between the two audit phases were statistically significant, a Wilcoxon signed-rank test was applied. The Wilcoxon signed-rank test is a non-parametric statistical test used to compare paired or matched observations. We selected this test because our data consisted of checklist adherence scores measured across two audit cycles on the same surgical units, creating paired, non-normally distributed observations. The test evaluates whether the median difference between the two sets of scores is statistically significant without assuming a normal distribution. This makes it appropriate for ordinal or percentage-based compliance data and for sample sizes such as ours. Statistical significance was defined as $p < 0.05$.

Results

Checklist Item-Level Compliance

A total of 160 surgical procedures were audited, 80 in Period I (pre-intervention) and 80 in Period II (post-intervention), to assess adherence to the WHO Surgical Safety Checklist. As detailed in Table 1, a notable increase in checklist compliance was observed across all perioperative phases following the educational intervention. In the Sign in phase, the proportion of

Table 1 Comparison of the WHO Surgical Safety Checklist Compliance Across Two Audit Cycles (n = 80 per Period)

Section	Item	Period I (n, %)	Period II (n, %)
Sign in	The patient confirmed his/her identity	36 (45%)	78 (97.5%)
Sign in	The patient confirmed the site of the procedure	31 (38.75%)	78 (97.5%)
Sign in	The patient confirmed the name of the procedure	29 (36.25%)	78 (97.5%)
Sign in	The patient confirmed consent	39 (48.75%)	77 (96.25%)
Sign in	The surgical site is marked	50 (62.5%)	75 (93.75%)
Sign in	The anesthesia machine and medication check is complete	53 (66.25%)	76 (95%)
Sign in	The pulse oximeter is on the patient and functioning	72 (90%)	80 (100%)
Sign in	The patient's allergy status is known and confirmed by the staff	47 (58.75%)	79 (98.75%)
Sign in	Patient's risk of difficult airway or aspiration is assessed with necessary equipment assistance available	52 (65%)	55 (68.75%)
Sign in	Risk of >500mL blood loss (>7mL/kg in children) is assessed with two IVs, central access, and fluids planned	26 (32.5%)	51 (63.75%)
Time out	Team members introduced themselves by name and role	25 (31.25%)	77 (96.25%)
Time out	Patient's name, procedure, and incision site are confirmed by the surgical team	41 (51.25%)	78 (97.5%)
Time out	Antibiotic prophylaxis has been given within the last 60 minutes	49 (61.25%)	77 (96.25%)
Time out	The surgical team asked the surgeon about the critical or non-routine steps	31 (38.75%)	80 (100%)
Time out	The surgical team asked the surgeon about the estimated duration of the case	29 (36.25%)	79 (98.75%)

(*Continued*)

Table 1 (Continued).

Section	Item	Period I (n, %)	Period II (n, %)
Time out	The surgical team asked the surgeon about the anticipated blood loss	31 (38.75%)	78 (97.5%)
Time out	The surgical team asked the anesthetist about any patient-specific concerns	34 (42.5%)	80 (100%)
Time out	Sterility, including indicator results, has been confirmed by the nursing team	66 (82.5%)	80 (100%)
Time out	The surgical team asked the nursing team about any equipment issues or concerns	46 (57.5%)	79 (98.75%)
Time out	Essential imaging for the procedure was displayed	55 (68.75%)	67 (83.75%)
Sign out	The name of the procedure is verbally confirmed by the nursing team	32 (40%)	77 (96.25%)
Sign out	Completion of instruments, sponge, and needle counts is verbally confirmed by the nursing team	34 (42.5%)	78 (97.5%)
Sign out	Specimen labeling, specimen labels read aloud, including patient name, is verbally confirmed by the nursing team	59 (73.75%)	75 (93.75%)
Sign out	The nurse verbally confirmed whether there were any equipment problems to be addressed	33 (41.25%)	78 (97.5%)
Sign out	Discussion of key concerns for recovery and management of the patient is done by the surgeon, anesthetist, and nurse	33 (41.25%)	74 (92.5%)

patients confirming their identity rose from 36 (44.62%) in Period I to 78 (97.94%) in Period II. Confirmation of the surgical site and procedure name both improved from below 40% to above 97% in Period II. Marking of the surgical site increased from 50 (62.86%) to 75 (93.82%), while anesthesia machine and medication checks improved from 53 (66.15%) to 76 (94.71%). Although most sign-in items showed marked improvement, risk assessment for major blood loss remained suboptimal, improving only from 26 (31.87%) to 51 (63.24%). During the time-out phase, there were substantial gains in team communication indicators. Introduction of team members improved from 25 (31.21%) to 77 (95.88%), and the administration of antibiotic prophylaxis within 60 minutes increased from 49 (61.76%) to 77 (95.88%). Discussions regarding critical steps and anticipated blood loss improved significantly, with respective compliance increasing from 31 (38.46%) and 31 (38.94%) in Period I to 80 (99.41%) and 78 (97.64%) in Period II. The sign-out phase also demonstrated strong post-intervention gains. The verbal confirmation of the procedure name increased from 32 (39.56%) to 77 (95.88%), and specimen labeling compliance rose from 59 (74.07%) to 75 (93.24%). Additionally, discussions on recovery planning improved from 33 (41.54%) to 74 (92.65%). These item-level improvements illustrate a systemic enhancement in surgical team coordination and checklist reliability following the intervention.

Average Compliance by Phase

Improvements in average compliance rates across checklist phases are presented in Table 2. In the Sign in phase, adherence improved from 54.62% in Period I to 88.19% in Period II. The Time out phase showed the most significant gain, rising from 50.60% to 96.94%. Likewise, the sign-out phase saw compliance increase from 47.29% to 95.01%. Overall, the total mean compliance across all checklist phases improved from 51.38% to 93.01%, representing

Table 2 Average Compliance per Phase

Phase	Period I (Avg %)	Period II (Avg %)
Sign in	54.62%	88.19%
Time out	50.60%	96.94%
Sign out	47.29%	95.01%
Overall	51.38%	93.01%

Table 3 Percentage of Surgeries Adhering to the Checklist by Procedure Type (n = 80 per Period)

Surgical Procedure	Period I Compliance (%) n = 80	Period II Compliance (%) n = 80	Absolute Change (%)
Microscopic Varicocelectomy	54.4%	88.3%	+33.9%
Examination Under Anesthesia (EUA)	63.9%	80.4%	+16.5%
Caesarean Section	70.7%	92.2%	+21.5%

a 41.63 percentage point improvement. These findings highlight the efficacy of the educational and systems-based intervention in embedding checklist practices within routine surgical workflows.

Procedures-Specific Compliance

Procedure-wise analysis of overall checklist compliance is summarized in Table 3. The greatest improvement was observed in Microscopic Varicocelectomy, which increased from 54.4% in Period I to 88.3% in Period II (+33.9%). Examination Under Anesthesia (EUA) compliance improved from 63.9% to 80.4% (+16.5%), and Caesarean Section increased from 70.7% to 92.2% (+21.5%). These results suggest that the intervention had a consistent positive impact across various elective procedures, supporting the checklist's adaptability across different surgical specialties and levels of complexity.

Discussion

This closed-loop audit of WHO Surgical Safety Checklist (SSC) compliance at Dr. Sumait Hospital presents evidence that structured interventions, when locally adapted, can dramatically improve surgical safety practices in resource-limited environments. From a baseline overall adherence of 51.38%, the study observed a significant rise to 93.01% post-intervention. These findings align with broader global literature demonstrating that systematic, educational, and team-based strategies are critical enablers of safe perioperative care, particularly in low- and middle-income countries (LMICs).[1,13]

The WHO SSC, introduced in 2008 under the "Safe Surgery Saves Lives" initiative, was designed to standardize perioperative procedures and reduce avoidable surgical morbidity and mortality globally.[5] However, despite its proven efficacy, uptake in LMICs has been inconsistent due to systemic barriers, including lack of awareness, insufficient training, fragmented communication, and limited administrative enforcement.[9] In Somalia, where surgical safety initiatives are still evolving, this study contributes valuable context-specific evidence supporting the checklist's utility and adaptability. A key strength of this audit was its closed-loop design, which allowed for a before-and-after comparison using identical metrics. Notably, the Sign in, Time out, and sign out phases all exhibited substantial compliance improvements, rising from 54.62% to 88.19%, 50.60% to 96.94%, and 47.29% to 95.01%, respectively. These improvements surpass gains reported in similar studies from LMICs, where average increases in checklist adherence following training interventions ranged from 20% to 40%.[11] The data support that checklist interventions are particularly impactful when tailored to local institutional dynamics and reinforced by leadership.

The time-out phase demonstrated the highest improvement, which reflects enhanced intraoperative communication among surgical teams. Items such as team member introductions, discussions on anticipated blood loss, and confirmation of patient identity improved by over 60 percentage points. These results echo Armstrong et al's findings that SSC use strengthens shared mental models, team vigilance, and situational awareness, critical components in high-risk surgical settings.[7] In Somalia, where team hierarchies may impede open communication, the checklist functioned as a levelling tool, ensuring that all voices, regardless of rank, contributed to patient safety planning. The Sign in phase improvements were similarly noteworthy, particularly in confirming patient identity, allergy status, and surgical site. However, risk assessments for major blood loss and airway difficulty lagged behind other items, even after intervention. This is consistent with global patterns showing that checklist items requiring anticipatory action or resource mobilization are often underperformed in resource-limited settings.[14] Addressing this gap may require more than checklists, it calls for

capacity strengthening, such as access to appropriate equipment and staff empowerment to act on risk assessments. Enhancements in the Sign out phase, historically the most neglected in LMICs, were particularly impressive. Verbal confirmation of procedure completion and specimen labeling reached compliance levels above 90%, reflecting greater recognition of the checklist's role in ensuring continuity of care. In other LMIC studies, sign out remains the weakest phase due to fatigue, time pressure, or team disbanding before checklist completion.[8,9] The findings from this study suggest that focused training and accountability mechanisms can significantly mitigate such issues, even in high-turnover surgical environments.

Procedure-specific analysis further underscores the checklist's broad applicability. The most improved procedures, Microscopic Varicocelectomy (+33.9%) and Caesarean Section (+21.5%), demonstrated that both routine and specialized surgeries benefit from standardized safety protocols. This echoes recent findings in Somali surgical practice, where traditional procedures lacking formal protocols have resulted in life-threatening outcomes.[15] For example, a case of severe wound infection following traditional circumcision in rural Somalia exposed the dangers of unregulated, non-clinical surgical practices and underscores the necessity of formal surgical safety frameworks.[15,16] One of the audit's strengths lies in its multifaceted intervention: data feedback, staff training, departmental circulars, and visible leadership support. White et al emphasized that single-strategy interventions often fail to produce lasting change, whereas integrated models foster culture shifts toward sustained compliance.[1] Indeed, the post-intervention success at Dr. Sumait Hospital highlights the value of leadership endorsement and feedback loops in transforming safety culture. Despite these gains, the study raises important considerations for long-term sustainability. Evidence suggests that improvements in SSC adherence often decline over time without continued education and institutional reinforcement.[11,17] Future efforts should institutionalize checklist compliance through regular audits, electronic tracking systems, and integration into surgical team performance reviews. Additionally, embedding SSC use into pre-service training of nurses and surgical residents may ensure future workforce alignment with safety standards.

Limitations of the Study

The use of direct observation may have introduced the Hawthorne effect, although consistent gains across all phases suggest true behavioral shifts. The study's single-site scope also limits generalizability; however, Dr. Sumait Hospital, as a tertiary referral center, serves as a representative model for surgical practices in Somalia's urban hospitals. Future multicenter audits would strengthen the generalizability of these findings and support national benchmarking. At the policy level, the findings have critical implications. First, they demonstrate that low-cost, evidence-based interventions can significantly reduce surgical risk, even in conflict-affected or fragile settings. Second, the success of SSC adherence reinforces the need for national surgical safety programs with embedded monitoring frameworks.

Ministries of Health should prioritize scale-up of SSC training, develop national checklists adapted to local context, and integrate them into licensing and accreditation standards. This study provides evidence that adherence to the WHO Surgical Safety Checklist can be significantly improved through structured, context-specific interventions. The audit not only achieved improved compliance metrics but also fostered a culture of accountability, communication, and procedural rigor within the surgical teams. As Somalia and similar settings strive to rebuild and strengthen their health systems, such initiatives will be indispensable to ensuring quality, safety, and equity in surgical care.

Recommendation for Future Research

Building on these findings, future research should aim to expand the scope and strengthen the sustainability of SSC implementation in Somalia and similar low-resource settings. Multicenter audits across public and private hospitals are recommended to establish national benchmarks and support policy-level adoption. Longitudinal studies are needed to assess whether improvements in checklist adherence are sustained over time without repeated interventions. Linking SSC compliance to clinical outcomes such as surgical morbidity, mortality, and complication rates would provide direct evidence of its impact on patient safety. Qualitative studies exploring behavioral and cultural factors within surgical teams could further illuminate barriers to communication and anticipatory planning, thereby guiding tailored strategies

for improvement. In addition, testing digital solutions, such as electronic or mobile-based checklists, may offer scalable and cost-effective approaches to monitoring adherence in fragile health systems. Finally, integrating SSC principles into undergraduate medical and nursing curricula and evaluating their long-term influence on professional practice would help institutionalize surgical safety culture and ensure generational continuity in patient safety practices. By addressing these areas, future research can help translate checklist compliance into durable, system-wide improvements in surgical quality and patient outcomes.

Conclusion

This study highlights that targeted, context-sensitive strategies can meaningfully improve adherence to the WHO Surgical Safety Checklist, even in resource-constrained environments like Somalia. By applying a closed-loop audit model at Dr. Sumait Hospital, checklist compliance rose significantly, from 51.38% to 93.01%, following educational outreach and administrative support. Improvements were seen across all three surgical phases, with the Time out phase showing the most notable gains, largely due to enhanced team communication and coordination.

The findings underscore that low-cost, evidence-informed interventions, when supported by leadership, staff engagement, and continuous feedback, can embed surgical safety culture even within fragile health systems. Nonetheless, checklist items requiring proactive planning, such as anticipating major blood loss, remained inconsistently applied, reflecting ongoing systemic and logistical challenges. Overall, the results affirm the checklist's flexibility across surgical disciplines and its role in promoting accountability and patient-centered care. For lasting impact, SSC use should be integrated into regular training, quality audits, and performance evaluations. At a broader level, national surgical safety policies are urgently needed to institutionalize these practices. This study offers strong evidence that with local ownership and institutional will, global safety tools like the SSC can become pillars of safer surgery in low-resource settings.

Data Sharing Statement

The Data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Approval and Consent to Participate

Ethical approval for this study was granted by the Institutional Review Board (IRB) of SIMAD University, Mogadishu, Somalia, in accordance with the approval letter dated January 10, 2024 (Reference No. 2024/SU-IRB/FMHS/P008). All procedures followed in this study adhered to the relevant ethical guidelines and regulations, including the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from each participant after clearly explaining the purpose of the study. Participants were assured that their responses would remain confidential and were explicitly informed that their involvement in the study was entirely voluntary.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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