A Systematic Review of Interventions Used to Enhance Compliance and Implementation of the WHO Surgical Safety Checklist in adult surgery

Abstract

This systematic review aimed to identify and synthesize the evidence for effectiveness of interventions on compliance of the WHO Surgical Safety Checklist (SSC) in adult surgery. Databases searched included CINAHL, MEDLINE, PsycINFO and Cochrane Central. Our review was limited to 24 peer-reviewed articles with quantitative (N=17), qualitative (N=4) and mixed methods design (N=3) published in English from 2008 to 2020. Intervention models were: 1) Modifying the ways of delivering the SSC; 2) Integrating or tailoring SSC to local contexts or existing practice; 3) Promoting clinician awareness and engagement; 4) Institutional policy management. Despite a lack of common outcome measures, all 17 quantitative studies and three mixed method studies found a significant intervention effect on SSC compliance. A few studies reported insignificant or negative changes in certain aspects with the interventions. Further studies must address compliance measures and outcomes in developing countries.

Key Words: WHO Surgical Safety Checklist, Compliance, Adult Surgery, Systematic review

Background

Approximately 234 million surgical procedures are undertaken across the world every year [1]with an estimate of more than 7 million people suffering post-operative complications each year[1], including at least 1 million deaths. As many as 50 percent

of those deaths and complications are preventable, as they are due to human errors[2]. It is reported that one in six safety incidents are related to perioperative adverse events in the UK, and half of them are potentially avoidable[1]. Preventable adverse events represent significant economic burden in healthcare system and also have detrimental impact in patients. The UK Department of Health estimates that iatrogenic harm costs the National Health Service more than £1 billion (£1 = approximately $1.33) each year, NHS errors costing billions per year [1, 3].

Checklists have been utilized in complex and high intensity areas of work such as aviation to prevent accidents due to human errors since the 1930s.[4] At the beginning of 1999, the use of checklists was recommended to prevent human error, by the Institute of Medicine report “To err is human”.[5,]. Subsequently, several surgical safety checklists have been developed in the 2000s. The Universal Protocol was first developed and implemented in 2003 and consists of three elements: 1) A pre-procedure verification process. 2). Surgical site marking. 3). Surgical "time out" immediately prior to starting the procedure. In 2004, the *Joint Commission* introduced The Universal Protocol as a mandatory quality standard [6,7,]

Another checklist named SURgical PAtient Safety System (SURPASS) checklist was developed in 2007 to enhance standardization in the surgical pathway and improve surgical patient safety, and was subsequently validated by observation of the surgical pathway and practical evaluation[8]. This multidisciplinary checklist involves the entire surgical pathway alongside many other items, such as administration of antibiotic prophylaxis in the operating room before induction of anaesthesia.

In 2008, the World Health Organization (WHO) launched the "Safe Surgery Saves Lives" campaign and created a Surgical Safety Checklist (SSC) [9]. It consists of 19 items and is used at three critical perioperative points: (1) before anaesthesia - the sign in, (2) before incision - the time out (3) before the patient leaves the operating room - the sign out. The 19-item WHO SSC is shown in Appendix I. The items contain verbal confirmation by the surgical team of the completion of some key steps for ensuring safe delivery of anaesthesia, antibiotic prophylaxis, effective teamwork and other essential practices in surgery[9].

Among these checklists, the Universal Protocol is reported to be too limited to reduce deaths and overall complications[5]. The WHO and SURPASS checklists have both been found to reduce significantly patient mortality and any complications [5, 10-14]. However, the SURPASS checklist has been reported as being more complex to implement. Additionally, the effectiveness of this tool has been mainly investigated in one European country, and generalization to other countries and health systems is uncertain[8, 12]. The WHO SSC has advantages in terms of effectiveness and generalisability to a variety of settings and health care systems. [15] Indeed, a large amount of data suggests that the WHO SSC reduces preventable mistakes in the operating room together with reductions in mortality and postoperative complications. [1,10, 16] Weiser and colleagues carried out a prospective cohort study to assess the effect of implementing WHO SSC on mortality and postoperative complications. They analysed outcomes of 1750 consecutively enrolled patients

undergoing urgent noncardiac surgeries, before and after the introduction of the WHO SSC in eight hospitals around the world. They found that the death rate decreased from 3.7% to 1.4%, and the complication rate decreased from 18.4% to 11.7% after introducing the WHO SSC.[16] Based on the number of 234 million operations undertaken each year globally, at least half a million deaths per year worldwide could be prevented with effective implementation of the WHO SSC.[1]

Since its inception, the WHO SSC has been rapidly adopted more than in 3900 hospitals across 122 countries worldwide before 2011[15] . In the UK, the WHO SSC was introduced into the NHS in February 2010, and supported by the National Patient Safety Agency and the Royal Colleges of Surgeons across the UK[17]. In the United States, the Centres for Medicare and Medicaid Services has made "safe surgery checklist use" one of the measures in the Ambulatory Surgical Centre Quality Reporting payment program since 2015. While the WHO SSC has been used across the world and many hospitals adopted it as a standard practice, previous studies suggested that any positive effects of SSC on patient outcomes were dependent on the checklist being fully complied with. For instance, Abbott and colleagues (2018) conducted a large sample cohort study including 44,814 patients from 4,997 hospitals in 27 countries together with a systematic review of a further 11 studies. They concluded that patients exposed to the use of the WHO SSC had significantly reduced mortality and postoperative complications[1]. However, they suggested such positive effects only reflected that the checklist was being properly implemented, indicating the importance of good staff compliance. Likewise, Bergs and colleagues (2014) conducted a systematic review of seven non-randomized clinical studies and performed a meta-analysis for three main outcomes (any complication, mortality and Surgical Site Infection rate[12]. They found significant

reductions in postoperative complications and mortality following implementation of the WHO SSC. Again, their findings also showed that significant decrease in postoperative complications was strongly associated with compliance to the items in the checklist.

In contrast, poor compliance with the items on the WHO SSC has been associated with a failure in improving surgical patient outcomes [5,18-20] . For example, in the UK, NHS England initiated a programme of work to understand why surgical never events persist despite the requirement in the NHS to use the WHO SSC as standard practice. They analysed 38 surgical never event cases occurring in English hospitals between April 2016 and March 2017. Their findings indicated that failing to comply with using the SSC at different stages by all levels of the surgical team were key factors contributing to those cases[21]. Similarly, a lack of staff acceptance and surgeon engagement of SSC has been shown to contribute to the failure in improving surgical complications or 30-day mortality rates in the checklist-based quality improvement program in Michigan [22].

Taken together, the successful implementation and full compliance with the checklist is critical to ensuring positive outcomes for patient safety. Yet poor compliance of checklists has been widely reported in the literature[12,18-20,23]. The key challenges associated with poor compliance and implementation of the checklist have been addressed in the literature. These include a lack of understanding of the purpose and ownership of the SSC, lack of clarity about roles and responsibilities of team members, lack of leadership and institutional support.[23-26] . While these exploratory studies are essential in understanding barriers and identify potential facilitators of the use of SSC, it is important to utilize these studies to develop and evaluate interventions designed to improve the compliance and successful implementation of

the WHO SSC. Different strategies or interventions may be required by the heterogeneous settings, surgical procedures and patient populations. Thus far, there is a lack of clear descriptions of how SSCs have been introduced within organizations in practice settings, and a lack of evidence of the effectiveness of implementation processes in surgical checklist literature. It is difficult for clinicians and healthcare providers to know what works, in terms of ensuring meaningful compliance and successful implementation of WHO SSC among surgical teams. Previous study suggested that when staff did not understand the rationale behind SSC implementation, or were inadequately prepared to use the checklist, it lead to frustration, disinterest, and eventual abandonment[27]. In an era of evidence-based practice, clinical practice should be informed by the best available scientific evidence. We therefore conducted this systematic review to identify the updated evidence on what interventions work in implementing the WHO SSC, in terms of enhancing compliance and implementation, and to make recommendations for future studies on implementing the use of the WHO SSC for surgical safety enhancement.

We sought to address three specific research questions:

1) What intervention methods are used to promote compliance and implementation of WHO SSC?

2) How has the compliance of WHO SSC been measured?

3) What is the efficacy and/or effectiveness of the interventions used for promoting compliance and implementation of WHO SSC?

Method

We devised a full systematic review protocol for article identification and retrieval, alongside evidence appraisal. The systematic review was registered in the PROSPERO database in September 2019 (http://www.crd.york.ac.uk/ PROSPERO/) with registration number CRD42019150649. The search strategies in each database are available on request.

Search methods for identification of studies

Electronic databases searches

We searched all relevant literature published from 2008 to 2020 up to 8th July 2020 in four databases without any language restrictions. We used free-text and keyword/MESH terms for each of the following databases: Medline, CINAHL, PsycINFO, and the Cochrane Central Register of Controlled Trials. We entered subject sub-headings and word truncations according to database requirements in order to map all possible keywords. Search strategies: we applied no language restrictions during searches. We used free-text and keyword/MESH terms for each database. Search terms for surgery included surgery, surgical or procedure. Search terms for checklist included WHO Safety checklist, SSC, check list, questionnaires. Search terms for compliance included compliance, adherence, concordance and acceptance. Search terms for implementation included implement*, application, administrat*, complet*. Searches for other resources included National Institute for Health and Clinical Excellence (NICE) and Scottish Intercollegiate Guidelines Network (SIGN), and WHO websites were searched for relevant published guidelines. In addition, we screened the reference list of included studies and other available reviews for any potential studies meeting our criteria.

Inclusion criteria for this review

To capture all relevant evidence, we included both qualitative studies and quantitative studies as eligible studies. Quantitative studies refer to experimental studies such as randomized controlled trials, nonrandomized controlled trials, pre- and post- studies, and observational studies defined as cohort studies, case series and case control studies. Further study inclusion criteria were applied as follows: primary research studies published in peer-reviewed journals; Studies with a target population including any Operating Room personnel or any type of surgical procedures for adults aged above 18 years old; Studies exploring or evaluating any type of interventions, strategies or approaches aimed to enhance WHO SSC compliance or implementation; Studies measuring the compliance or implementation of WHO SSC. Outcomes of compliance including frequency and item or domain completeness. We excluded literature reviews, book chapters, conference proceedings, dissertations/thesis, letters or editorial opinions, paediatric surgery, and non-English articles. We also excluded the studies that did not explore or examine any of intervention, strategies or approaches aimed to enhance compliance or implementation of WHO SSC checklist.

Data extraction and analysis

We exported all articles searched from the databases to Endnote to enable removing of duplicates and sifting of abstracts. The first reviewer (L.Q.L) identified all articles that met the inclusion criteria first and then the second reviewer (SM) verified all articles.The first reviewer (L.Q.L) extracted the following data from eligible articles and the second reviewer (SM) double-checked for accuracy: author, year of publication, country of origin, sample characteristics (sample size and participants

included operation room role, type of surgical procedures), type of study design, description of intervention and outcome measures and findings.

We assessed the findings to determine whether meta-analysis was possible. Meta-analysis requires common intervention types, uniform outcome measures and homogenous populations. It was impossible for us to perform a formal meta-analysis with statistical pooling of results across studies because of the absence of both a uniform mode of intervention and standardization of outcome measures.

Results

Search results and description of studies

We identified a total of 1196 unique references from the literature search, which were all exported to Endnote (Endnote version X9.2 for Windows, Thomson Reuters, Philadelphia, PA, USA). We identified three additional articles from other sources. Of these 1199 articles, 653 were identified as duplicates, thus resulting in 546 abstracts and titles that were available for sifting for eligibility.

We further screened all 546 abstracts, and this subsequently generated 64 abstracts that were potentially relevant. We retrieved the full texts of these 64 abstracts and considered for eligibility for inclusion in the final systematic review. The outcome following this procedure was that a total of 24 studies met the inclusion criteria and were subjected to full-data extraction. Figure 1 provides a flow chart of the process and results for screening eligibility and study selection.

Sample characteristics

All 24 articles [27-50] described the intervention or facilitators to enhance WHO SSC compliance or successful implementation. Of the 24 studies, six of the studies were conducted in the USA, five of the studies were conducted in the UK, two studies in New Zealand and Switzerland respectively; the other nine studies were conducted in Austria, Benin (in collaboration with UK), Brazil, Canada, Cameroon (in collaboration with UK), Congo, India, and Thailand respectively. Table 1 illustrates the distribution of countries where the studies were carried out.

Seventeen studies were designed as quantitative studies to examine the effectiveness of interventions or approaches to enhance compliance or successful implementation of WHO SSC. Four studies were designed as qualitative studies to explore strategies or facilitators to enhance compliance or implementation of the checklist. The remaining three studies adopted mixed methods, using both quantitative and qualitative research methods. Among those seventeen quantitative studies, one study was a randomized control trial (RCT), two studies were descriptive studies, and the other fourteen studies were either non-RCT, prospective, retrospective or cross-sectional cohort studies. Details of sample characteristics are shown in Table 2.

Quality of Methodology

We used the mixed methods appraisal tool (MMAT version 2018) to determine the methodological quality of each study. [51, 52] The MMAT is a critical appraisal tool that is designed for the appraisal of systematic reviews including qualitative, quantitative

and mixed methods studies. We assessed the methodological quality of each study using seven criteria based on different type of study design.[51,52]

We ranked the methodology of studies included in this review as moderate or low as we included any type of studies that explored or examined the effectiveness of interventions to enhance the compliance of WHO SSC. It appears that most studies used observational or descriptive research methods such as retrospective studies or cross-sectional survey methods rather than interventional prospective controlled trial methods, with four studies using qualitative research methods. None of the studies met all seven criteria, five out of 24 studies met six criteria, and four studies only met three out seven criteria. Numbers of criteria met by each study were shown in Table 2.

Intervention features /models and effectiveness

For the four qualitative studies, potential strategies to enhance the compliance of SSC recommended by the participants are: organizational support and policy management, staff training, increasing self-awareness of SSC, incentives to prompt SSC use or consequences associated with non-adherence. Others include having senior surgeons and anaesthesiologists lead the review of the SSC, modifying/adapting SSC implementation to the hospital's context and incorporating it into existing practice, and including patient involvement. Feedback from local data and anecdotal evidence focusing on the beneficial impact of the checklist helps reinforce to staff that it is not just a tick-box exercise.

The interventional procedures reported by the quantitative and mixed method studies include: staff education and training, deliberately allocating leadership responsible for each domain, using digital SSC or aviation-style computerized format, integrating the SSC into the electronic health record with build-in clinical decision support, displaying the checklist on large wall-mounted posters or a centrally located screen in the operating room, using audio prompt to deliver the questions in the checklist, and ongoing feedback for sustainability of SSC implementation.

With respect to intervention effectiveness, all quantitative studies examined the effect of an intervention on either compliance or successful implementation. We noted positive changes in compliance with some elements of the SSC process in all 17 quantitative studies and three mixed method studies. The significant improvements seen in compliance and implementation include: increased completion rate of SSC items [30,32,33,42,44,45,47], increased use of or attempt of using SSC [39_41,48-50], improved team communications [37,42, 44]; improved completion of team brief [36], and decreased specimen labelling error. [38]

Although all quantitative and mixed method studies reported improvement in some elements of compliance or implementation of SSC, a few studies reported insignificant changes with the intervention in other outcomes. Kieffer and colleagues [38]reported that their intervention, which involved assigning a dedicated person, the operating room co-ordinator, to arrange a briefing with the team before each list began improved completion of the Team Briefing significantly. However, there was no statistically significant change in the completion of the team de-brief and WHO SSC completion rate after this intervention was introduced. In another study carried

out by Dixon and colleagues, in which they assessed the digital version of SSC on compliance, they found that the duration of time-outs increased significantly using the digital version of SSC (49 seconds with standard version vs 79 seconds with digital version). However, there was significant improvement in the performance of key safety elements and most participants preferred to use the digital version of SSC[28]. A survey was taken of 742 participants who completed the attitudes-questionnaire before a SSC implementation program, which included a series of mandatory training activities, and 660 participants who completed after the intervention, Mascherek and colleagues reported that there were no significant differences in attitudes and acceptance of SSC use although the intervention significantly increased in knowledge of SSC and frequency of checklist use, showing that the main impact of the intervention was in closing the gap between what was considered a relevant tool in theory and what was actually applied for use in practice.

WHO SSC Compliance measurement

Seven quantitative studies and three mixed method studies assessed the WHO SSC across all three phases including 'sign in', 'sign out' and 'time out'. The other ten quantitative studies assessed selected one or two SSC phases. All seventeen quantitative and three mixed method studies measured the compliance in different ways such as evaluating the usage of SSC, completion rate of SSC items [30,32,33,42,44,47], directly observing whether SSC sign–in, time-out and sign-out were attempted, and whether fully complied with [39-41,48,49], or the presence and engagement of staff during checklist administration [37,42,44]. Other studies reported perioperative risk events and key safety elements in checklists such as specimen labelling error,

incorrect counts, wrong site, and wrong procedure and patient identification [28,30, 38] .
Table 2 shows details of intervention and outcomes of compliance in the 24 studies.

Discussion

In appraising current available evidence of interventions used to enhance WHO SSC compliance in adult surgery, diverse aims were described for the different type of interventions in the literature. This reflects the broad outcome measures in compliance and implementation of the WHO SSC.

In this systematic review of 24 studies, 20 of them (80%) investigated the effectiveness of interventional procedures to enhance SSC compliance by using either a quantitative research method (17 studies) or a mixed method (three studies), while the other four (20%) qualitative studies explored the facilitators to enhance SSC compliance. The quality of methodology was moderate or weak, as we included all types of studies. It appears that most of the studies were underpowered using observational methods rather than prospective controlled trials. Seventeen studies (71%) were carried out in high income countries. De Jager and colleagues carried out a systematic review of 25 studies: to examine the effects of the SSC on postoperative outcomes [13]. They found that postoperative mortality rates were significantly decreased in most of studies conducted in developing countries, but this changes were not found in those studies carried in developed countries. While there is a lack of evidence to explain such findings, different societal, cultural aspects or implementation of SSC methods may be contributing factors. More evidence on SSC implementation strategies in developing countries are needed.

We identified the heterogeneous descriptions of interventional methods among the studies included in our review. On the whole, the interventional methods described in this review fall into four types: 1) Modifying the ways of delivering the SSC, e.g. using digital SSC instead of a paper version, displaying the checklist on large wall-mounted posters or operating room flight boards, for the whole process, using audio prompts to deliver the questions in the checklist; 2) Integrating or tailoring SSC to local contexts or existing practice, e.g. integrating patients electronic health records with clinical decision support built into SSC; 3) Promoting clinician awareness and engagement, i.e. staff education, training and coaching, allocating leadership responsibility for SSC, physicians' and surgeons' involvement and ongoing feedback; 4) Institutional policy management, i.e. evaluation, mandatory activities, incentives to promote SSC use and highlighting consequences of non-compliance. Our findings support the explanatory models identified previously by Gillespie and colleagues, who reported a realist synthesis of the evidence, that implementation interventions improve adherence of the use of safety checklists in surgery [53]. They described the model as 'the sustained use of surgical checklists is discipline-specific and is more successful when physicians are actively engaged and leading implementation. Secondly, involving clinicians in tailoring the checklist to their context and encouraging them to reflect on and evaluate the implementation process enabled greater participation and ownership'[53].

In this systematic review, we reported a comprehensive synthesis of multiple study designs and pooled the data from peer reviewed articles on any form of interventional procedures aiming to enhance SSC compliance and implementation. The findings of this review provided enriched subjective data on a range of international methods described in the literature to enhance SSC compliance since

its inception. Whilst the patient involvement and incentive/disincentive associating with adherence or non-adherence of SSC was suggested to promote SSC compliance by the qualitative studies reviewed, there were no studies looking at the effectiveness of them as interventional methods in any quantitative or mixed method studies.

In terms of the effectiveness of the interventional procedures, all quantitative and mixed method studies examined the effect of an intervention on SSC compliance. Positive changes were reported as increased completion rate of SSC items, or increased attempts of using SSC, improved team communications [37,42,44], completion of team brief [36] and decreased perioperative risk events[38]. Despite all these studies reporting positive changes related to compliance, a few studies reported insignificant or negative changes with the interventional procedures. For instance, Dixon and colleagues found that duration of time-outs increased significantly using digital version of SSC in comparison with the paper version of SSC [28]. Kieffer et al 2013 reported that there were no statistically significant changes in completion of the team de-brief and WHO SSC completion rate after assigning a dedicated person who arranged the briefing with the team[36]. Moreover, Mascherek and colleagues reported that there were no significant differences in attitudes and acceptance of SSC use although implementing SSC with mandatory training activities significantly increased staff knowledge of SSC and the frequency of checklist use[39]. Team members' engagement did not significantly vary using audio delivery of the time-out and sign-out sections[44].

Regardless of the methodological challenges, or whatever the compliance measures applied,. 20 of the 24 (83%) quantitative and mixed method studies found significant differences between intervention and comparison groups or pre- and post-intervention, This suggests that the success of the use of SSC is dependent on planning interventions in introducing it to staff. However, the diversity of interventions and lack of ability to conduct a full meta-analysis means that we should interpret the findings with caution. Our findings provided an insight for clinicians and stakeholders to consider those interventional procedures that could fit into their practice to enhance the SSC implementation and compliance, with the aim, ultimately, of improving patient safety.

With respect to SSC compliance measurements, the definition of compliance among the studies is inconsistent in the 17 quantitative studies and three mixed method studies reviewed. As a result, the measurement of compliance varies among studies included here. Some studies reported the completion rate of SSC either in all three phases through audit, i.e. sign in, sign out and time out, or in selected phases; whereas others used a self-assessment scale or were evaluated by use of direct observation with measures of SSC compliance, such as communications within the team for all specified information and presence of all the team member. Other studies [36,38] measured perioperative risk events, such as incorrect counts, wrong site, wrong specimen labelling, and wrong procedure to determine the effectiveness of interventions for SSC compliance. The purpose of developing SSC was to reduce surgical error and improve patient care. It has been well established that SSC compliance is associated with improved patient outcomes [1,10,16]. In appraising the compliance measurement, we recognise the challenges of selecting appropriate

outcome measures for the purposes of a study to validate a tool is not usually possible. In fact, the definition of compliance and measuring true compliance has always been debatable in the literature[26,52,53] While it may seem easy to measure attainment of compliance with the SSC by defining completion of any item of the checklist as simply looking for a tick in the relevant box in the tool, true compliance with meaningful use of the entire checklist is more important and may not be as easy to evaluate or obtain [26,54]. Furthermore, in order to enable comparison, the use of commonly reported tools is usually advocated. There is no clear standardized compliance measurement that applies for surgical settings. Future work is needed to generate item banks that reflect true compliance and which can be validated for further outcome research. This may require a core tool that has additional items for different surgical produces /populations (e.g. elective surgeries, emergency surgery, and keyhole and open surgeries).

Referring to the background literature and currently available evidence, we would advocate for future studies focus on generating and robustly evaluating a range of interventional methods for the use of SSC by designing robust prospective controlled trials or reviews of compliance in areas coupled with a revision of use / ways of updating staff. As the needs of different surgical settings are diverse, and worth to note that each institution will often adopt different models (e.g. applying new technologies, team work, staff training and incentive policy), theoretically sound models of intervention must be adapted to meet the feasibility of various settings and populations.

Limitations:

We are aware of several limitations inheritated by the nature of systematic reviews such as publication bias (particularly against negative findings), language restrictions, and coding of keywords. However, we designed a well-structured search strategy with guidance by a clinical librarian and supplemented all “explode” functions. In addition, we carried out hand searches for grey literature to minimize the potential for publication bias. Another limitation is including qualitative studies in the review, which was classified as providing a low level of evidence in terms of the effectiveness of interventions. Including such qualitative studies in our review has undoubtedly enabled provision of a more thorough understanding and broader evidence of current interventional procedures that may confer potential benefit for and increases in SSC compliance.

A further limitation is that we could not perform a meta-analysis due to heterogeneous study design alongside diverse aims and outcome measures, combining heterogeneous quality of studies. Nevertheless, we conducted this systematic review with aim to identify the updated evidence, and to make recommendations for future research, implementing interventional procedures to enhance SSC compliance, ultimately improving surgical safety.

Conclusion:

We draw several tentative conclusions. Firstly, it appears that a range of interventional methods can be effective. These include modifying ways of delivering the SSC in the operating room, promoting team interaction, targeted staff training, and senior clinicians’ involvement/leadership/ownership of the process. Also effective is organizational policy management and ongoing evaluation/feedback.

Integrating SSC to existing practices by building a patient electronic health record with clinical decision support into an electronic SSC and designing interactive prompts to prevent any missing items during each phase seems to be particularly effective. Secondly, the concept of true SSC compliance with meaningful use of the entire checklist needs to be articulated. Thirdly, appropriate outcome tools need to be developed and validated to measure SSC compliance. Future work is therefore recommended and needed in the form of well-designed prospective controlled trials to confirm the beneficial effect of interventions on the enhancement of SSC compliance and patient safety. Further studies are also required to identify which interventions work among low-/middle-income countries. Research-based approaches are necessary to identify the institutional needs and styles of surgical settings to ensure that interventions harness these styles and address specific needs.

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