Review Article

Make a difference: implementation, quality and effectiveness of the WHO Surgical Safety Checklist—a narrative review

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Background and Objective: The positive effects of the WHO Surgery Safety Checklist (WHO SSC) have been demonstrated by a large amount of quantitative studies. With this review, the focus changes to the content of qualitative studies on WHO SSC to identify possible research gaps. In this way, gaps in the content of the execution of individual checklists can be closed.

Methods: The two research platforms "Ovid Medline" and "PubMed" formed a solid basis for the literature research. The search was conducted until the 19th of September 2022. The following group terms were used: "checklist", "surgery", "implementation", and "WHO Surgical Safety Checklist". Subsequently, the literature research was limited to studies between 2011 and 2021 in either English or German.

Key Content and Findings: Overall, a positive effect was found in all qualitative studies on WHO SSC with respect to leadership, teamwork, timing and acceptance. Acceptance through effective implementation of the SSC deserves special mention. Several studies highlighted the lack of understanding and training, which led to variation in execution. A large number of studies agree that the WHO SSC is fostering teamwork and improving communication. However, there are also hurdles and barriers in the application that seem to have an influence on the effectiveness.

Conclusions: The exact mechanisms of the advantage and application of the checklist are still poorly understood. Further research in this area is needed for a better understanding of the underlying work culture and consequently improving patient safety.

Keywords: Checklist; implementation; quality

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Introduction

Together with the "Safe Surgery Saves Lives" campaign, a 19-item surgical safety checklist was published by the World Health Organization in 2009 (1). The WHO Surgical Safety Checklist (WHO SSC) consists of three parts, the so-called sign-in, the time-out and the sign-out, which are applied at 3 critical points in the surgical pathway with the aim of increasing patient safety.

The positive effects of the WHO SSC on postoperative patient outcomes, such as decreased complication and mortality rate, has been demonstrated in multiple studies,

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Table 1 The search strategy summary

Items	Specification
Date of search	Ovid Medline (16.07.2021); PubMed (19.09.2022)
Databases and other sources searched	Ovid Medline, PubMed, reference lists of the studies read
Search terms used	Search terms: "checklist", "surgery", "implementation", "WHO Surgical Safety Checklist"
	Example—PubMed research
	Search terms: (((checklist) AND (surgery)) AND (implementation)) AND ("WHO Surgical Safety Checklist")
	2011–2021
	Humans
	Language: English/German
Timeframe	2011–2021
Inclusion and exclusion criteria	Inclusion criteria:
	Peer reviewed articles
	2011–2021
	Checklist: "WHO Surgical Safety" or an adapted version of it, examining at least the part of the "Time-out"
	All surgical specialties
	Emergency and elective surgeries
	Exclusion criteria:
	Impact factor <1
	Studies about patient outcomes, checklist-compliance
	Editorials, reviews, letters, comments
	Studies examining safety campaigns or training programs
Selection process	The literature research was conducted by Wyss M. All titles and abstracts were read by Wyss M and Grande B to select all for the review relevant articles. Discrepancies were resolved by consensus

although the study results sometimes differ vastly in the endpoints chosen, the study design, the population size and the content (2-8). The WHO SSC was also found to have a positive overall effect on the workflow in the operating room (OR) and the perceptions of OR staff (9,10). At the same time, the variety of results suggest that the quality of implementation and execution of the checklist have a major impact on collaboration and patient care. The purpose of this narrative review is to deepen our understanding of WHO SSC use by addressing the following three aspects (11): (I) Which qualitative studies about the implementation of the WHO Surgical Safety Checklist do already exist? (II) How can their content be summarized? (III) Which research gaps can be identified? We focus on qualitative studies which relate to these topics. We present this article in accordance with the Narrative Review reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1807/rc).

Methods

The search strategy summary is included in *Table 1*.

Literature research

The two research platforms "Ovid Medline" and "PubMed" formed a solid basis for the literature research. The search was conducted until 19th of September 2022.

Search terms

A combination of the following group terms was used: "checklist", "surgery", "implementation", "WHO Surgical Safety Checklist". Subsequently, the literature research was limited to studies between 2011 and 2021 in either English or German. Furthermore, only studies concerning humans were included.

Study collection

Titles and abstracts of the studies found were viewed. Relevant studies regarding the following inclusion and exclusion criteria were elected and full text reviewed. Additional relevant papers were found in the reference lists of the studies read, following the same procedure.

Inclusion and exclusion criteria

Only peer-reviewed studies from 2011 until September 2021 were selected. The search was restricted to the "WHO Surgical Safety Checklist", or an adapted version of it, examining at least the checklist part of the time-out. All surgical specialties were analyzed, as well as emergency and elective surgeries. Articles in journals with impact factor <1 were excluded. As we analyzed if the implementation of the checklist had brought a change in ORs, studies about patient outcomes, as well as articles solely addressing the checklist-compliance were disregarded. Only original empirical studies were included; editorials, reviews, letters and comments were excluded. In addition, studies in which the checklist implementation was part of a safety campaign or training program were neglected as well.

Data extraction

Data was extracted from the individual studies, including reference, study methodology, setting, outcome assessed, results and limitations. *Table 2* presents an overview of the characteristics of the articles reviewed.

Analysis

Due to the heterogeneity of the data, an inductive thematic analysis was used for the analysis.

Key content and findings

Initially, we aimed to organize the review according to the questions: (I) Which qualitative studies about the implementation of the WHO surgical safety checklist do already exist? (II) How can their content be summarized? (III) Which research gaps can be identified? However, while compiling suitable studies a different categorization proved more helpful for presenting and understanding the study reports. Thus, we have structured the results as follows: application of the WHO SSC (I) awareness and exchange of patient safety relevant aspects, (II) knowledge about the use of the SSC, (III) communication and teamwork, (IV) time management and timing, (V) presence of team member, (VI) checklist coordinator/leadership, and (VII) acceptance, and (VIII) for a modification and implementation of the WHO SSC (I) value, and (II) education.

Study selection

The literature research yielded 128 studies from "OVID Medline" and 49 from "PubMed", whose title and abstract were read. Of the 177 found studies, 25 met the inclusion criteria and were reviewed in full text. After considering the exclusion criteria, 16 studies from the literature research were selected. Three additional studies from the reference lists of the reviewed studies also met the criteria, resulting in a total of 19 studies, which were included in this narrative review.

Study characteristics

The selected studies are very heterogeneous in terms of their study design. Due to the lack of qualitative studies, studies with a mixed study design and quantitative studies were also considered. Focus groups, interview studies, observational studies, and survey studies were examined as well as those that combined the different data collection tools. Endpoints and measurement data varied greatly. Characteristics of the included studies are listed in *Table 2*.

Application of the WHO SSC

Awareness and exchange of patient safety relevant aspects

The awareness of patient safety relevant aspects was frequently measured via self-reports through surveys or focus group while the exchange of patient safety relevant aspects was measured through direct observation.

Participants in most of the survey studies agreed that the introduction of the checklist increases awareness of patient safety-related data, although they differed in their

Table 2 Study characteristics

Reference	Study methodology	Setting	Outcomes/Endpoints	Results	Limitations
Conley *et al.*, 2011 (12)	Qualitative – interview – post-implementational, conducted during 4 months	USA. 5 State hospitals (different sizes & forms of implementation). 60–90 min interviews with 5 implementation leaders + 1 surgeon, 30–45 min interviews with surgeons.	Factors for effective SSC implementation	Explain why (education) and adaptively show how (training) to use the checklist led to buy-in among surgical staff and sustained checklist use	Phone interviews. Small number of interview partners. Different stages of checklist implementation
Haynes *et al.*, 2011 (13)	Quantitative – survey – pre-/post-interventional, data collection during 2 weeks each pre- and post-implementational	Canada, India, Jordan, New Zealand, Philippines, Tanzania, England, USA. 8 hospitals. Different surgical specialties. 538 questionnaires from 7 hospitals (281 before & 257 after implementation)	SSC's effect on postoperative outcomes. OR staff's attitudes & perceptions towards SSC	Mean SAQ score increased from 3.91 to 4.01. Perception of teamwork and safety climate improved post-implementational and were associated with enhanced postoperative outcomes	Voluntary participation. Hospital sample may not be representative. Staff's knowledge about an on-going quality improvement project could lead to bias. Only 10% of SAQ was used
Takala *et al.*, 2011 (14)	Quantitative – survey – pre-/post-interventional, data collection during 4–6 weeks each pre- and post-implementational with an implementation time in between of 2–4 weeks	Finland. 4 university & teaching hospitals. Different surgical specialties. 1,748 questionnaires (901 before & 847 after implementation)	SSC's effect on safety-related issues & communication	Awareness of patient-safety related issues, the procedure and its risk got increased by the checklist. Team communication improved and communication failures decreased post-implementational	Prospectively collected data. Use of checklist could not have been blinded. Heterogeneity of participating units might be a weakness or strength
Böhmer *et al.*, 2012 (15)	Quantitative – survey – pre-/3 months post-interventional	Germany. 1 university hospital. Traumatology & Orthopedics. 71 questionnaires	SSC's effect on perioperative safety standards & interprofessional cooperation	Checklist implementation leads to changed staff attitude with increased awareness of patient-safety relevant factors and improved rating for interprofessional cooperation	None written
Fourcade *et al.*, 2012 (16)	Mixed methods – interview, observation, survey – post-implementational	France. 18 cancer centers. Surgical procedures performed under general or loco-regional anesthesia. Collective interviews with 16 staff members, individual interviews with 8 key surgical staff members. Email questionnaire from 1 person per center (OR staff or quality department staff). 20 hours of direct observations	SSC's compliance/completeness rates, identify barriers & develop a strategy for effective SSC use	Mean compliance rate was 90.2%, mean completeness rate was 61%. The main barriers were duplication of items with existing processes, lack of communication between surgeon & anesthetist, time management, lack of timing and understanding of items, ambiguity and risks not covered by the checklist	Hawthorne effect. Overestimation of the use of checklists due to the mandatory use of it. Staff members participating in the collective interviews were also involved in the evaluation. Interventional radiology and local anesthesia were excluded
Delgado Hurtado *et al.*, 2012 (17)	Quantitative – survey – post-implementational, 1 year after implementation	Guatemala. 3 hospitals (2 public teaching hospitals, 1 private). 147 questionnaires	OR staff's knowledge & acceptance of the SSC	93.8% of the respondents were aware of the existence of the checklist, 88.8% knowing its content. Majority of staff members accepted the SSC and its implementation	The differences on the number of participants in the subgroups. Self-reported nature of the questionnaire
Levy *et al.*, 2012 (18)	Quantitative – observation, survey – post-implementational, data collection of observations during 7 weeks	USA. 1 teaching pediatric hospital. Different pediatric surgical specialties. Only elective operations. 29 questionnaires, observation of 142 operations	SSC adherence, OR atmosphere, OR staff's attitude, perception & understanding of the SSC	Despite a documented compliance rate of 100% in hospital data, adherence was significantly less with an average number of 4/13 checklist items checked. Significant differences in survey results were seen in the content, responsible person, and presence of staff members during checklist implementation, indicating a lack of understanding and timing of the checklist	Hawthorne effect. Lack of outcome measures correlating with checklist adherence, no conclusions can be drawn about the impact of checklist adherence. The checklist is made for adults, not pediatrics
Böhmer *et al.*, 2013 (19)	Quantitative – survey – pre-/post-interventional, data collection before implementation and after 3, 18 and 24 months	Germany. 1 university hospital. Traumatology & Orthopedics, Anesthesiology & Intensive Care Medicine. 99 questionnaires	SSC's effect on perioperative safety standards & interprofessional cooperation	Some aspects of patient-safety relevant information were rated more positively even 2 years after implementation. Teamwork and communication did not improve in a long-term, except from surgeon's point of view	Self-reported nature of the questionnaire. The questionnaire was not validated
Haugen *et al.*, 2013 (20)	Quantitative – survey – pre-/post-interventional, data collection during 4 weeks each pre- and post-implementational,	Norway. 1 tertiary university hospital. Different surgical specialties, Anesthesiology & Intensive Care Medicine. Elective and emergency operations. 641 questionnaires (349 before & 292 after implementation)	SSC's effect on safety culture perceptions, SSC compliance	The checklist intervention group showed significant improvements on several baseline culture factors compared to the control group. Post-implementational, the intervention group showed only a significant improvement on 2/12 factors of patient safety culture factors	No statement on checklist adherence. The low response rate might be a limitation for sample representativeness. Differences in professional backgrounds between responders and non-responders
Pickering *et al.*, 2013 (21)	Quantitative – observation – post-implementational, data collection during 21 months	United Kingdom. 5 hospitals (1 district general hospital, 3 teaching hospitals, 1 tertiary referral center). Different surgical specialties. Elective & emergency operations. Observation of 294 operations	Quality of SSC performance	While time-out was performed in 87.4%, sign-out was only conducted in 8.8%. In time-outs, all items were checked in 54.9%, the whole team present in 77.4% and active participation was observed in 72.8%. There were no significant differences between surgical specialties, but between hospital sites	Hawthorne effect. Limited spread of hospitals & specialties involved. Degree of subjectivity in observations. Small sample of hospitals may not be representative
Cullati *et al.*, 2014 (22)	Quantitative – survey – data collection during 1 day	Switzerland. Participants of the joint meeting of the Swiss Society of Surgery and the Swiss Society of Anesthesia and Reanimation. 152 questionnaires	SSC implementation, perceived compliance & personal opinions towards it	67.7% of respondents reported having a checklist in their hospital. While 8/10 respondents answered they would apply the sign-in and time-out very often/always, only 5/10 respondents acknowledged the sign-out was performed never/rarely. Most respondents agreed that the SSC improves intraoperative safety and team communication. Fewer respondents agreed that the SSC enhances teamwork and reduces social hierarchy	Low participation rate. Self-reported & voluntary nature of the questionnaire

Table 2 (*continued*)

Table 2 (*continued*)

Reference	Study methodology	Setting	Outcomes/Endpoints	Results	Limitations
Russ *et al.*, 2015 (23)	Quantitative – observation – post-implementational, data collection during 21 months	England. 5 hospitals (different health regions, larger teaching & smaller community hospitals). Different surgical specialties. Elective & emergency procedures. Observation of 565 time-out & 309 sign-out sessions	Usage & quality of SSC performance	Average adherence to checklist items was 2/3, in 40% of the cases team members were absent and in 70% they failed to pause or focus on checks. Information sharing improved across the OR team. Sign-out was not completed in 39% of cases, mostly because of lack of knowledge when to perform it. There was large variation in checklist use between hospital sites, but not between surgical specialties and between elective and emergency procedures. When a surgeon led the SSC and when all team members were present and paused, quality of SSC performance was improved	Hawthorne effect. Sign-in part is missing. Only certain surgical specialties were observed. Observations may be biased because of cultural factors and results cannot be generalized. No long-term data
Russ *et al.*, 2015 (24)	Qualitative – interview – post-implementational, data collection during 1 year	England. 10 hospitals (different geographic regions & sizes, teaching & community hospitals, different incident reporting levels, different stages of checklist implementation). 119 interviews	SSC implementation and its barriers & facilitators	Some barriers mentioned in the interviews were related to the checklist itself, such as its design, or overlap with existing processes. The most common barrier was resistance from senior clinicians. Facilitators mentioned modifying the checklist, providing education/training, providing feedback on local data, fostering strong leadership, and establishing accountability	Small sample of hospitals may not be representative. Voluntary nature of the questionnaire. Long data collection period. The opinion of the management staff was neglected
Molina *et al.*, 2016 (25)	Quantitative – survey – pre-/post-interventional, data collection before implementation and 1–2 years after baseline survey	USA. 13 hospitals. 1,744 questionnaires (929 before & 815 after implementation)	SSC's effect on OR staff perceptions & perioperative safety	54.1% of respondents answered their team would always use the SSC effectively. 73.6% indicated it would prevent problems or complications. The implementation of the SSC was associated with improvements in OR staff's perception of teamwork, communication, coordination between surgeons and anesthesia, effective leadership, the ability to be assertive when necessary to improve safety and mutual respect	No data about change over time. No statement possible about consequences on patient outcome. Non-response bias was neglected. Only inpatient hospitals in South Carolina. Only hospitals that completed the post-implementation questionnaire. Only 54.1% of respondents reported using the SSC effectively; question if changes in perception is really from SSC implementation
Santana *et al.*, 2016 (26)	Quantitative – survey – pre-/post-implementational, data collection was conducted 2 weeks before the pre-intervention period and 2 weeks after the post-intervention period	Brazil. 3 public hospitals (different sizes). Different surgical specialties. 472 questionnaires (257 before & 215 after implementation)	OR staff's attitudes & opinions towards surgical safety	A statistically significant improvement of the perception of safety and teamwork from nursing staff and anesthesiologists was observed after SSC implementation. Concerns about patient safety and compliance with standards and rules improved post-implementational, especially from nursing staff. The majority of staff considered the checklist easy and quick to use, felt that it improved communication, contributed to the development of a surgical safety culture and helped prevent errors. There was only little improvement in surgeon attitudes	Small sample of hospitals. Results may not be representative due to the differences of staff/hospitals/patients. Prospective design. Changes in politic may increase awareness of patient-safety independently from SSC implementation
Korkiakangas, 2017 (27)	Qualitative – observation – post-implementational, data collection during 6 months	England. Teaching hospital. Different surgical specialties. Only elective surgery. Observation of 20 operations	Identifying communication mechanisms influencing team mobilizing for the SCC execution	Key aspects of team mobilization for the SSC, which influenced each other were the timing, the distribution of staff in the OR and the instigation practices used. An appropriate timing seemed when most staff members were present, poor timing when staff were scattered through in the OR or busy with other tasks. Participation improved with instigation practices, such as a loud inclusive call informing everyone that the time-out was about to begin	Small sample sizes may not be representative. Not about completing the entire checklist
Sokhanvar *et al.*, 2018 (28)	Quantitative – survey – data collection during 8 months	Iran. 8 tertiary general hospitals. 145 questionnaires	OR staff's attitude, awareness & knowledge of the SSC and its acceptance	92% of the respondents were aware of the existence of the SSC and 73.9% knew its content. 60% strongly agreed that the SSC improved patient safety and more than 90% answered that it enhanced teamwork. Acceptance of the checklist was high among all professions, lowest among surgeons. Lack of time and training were the main barriers. Surgeons were more sensitive to these barriers. Training courses were mentioned as facilitating checklist implementation	Participation was voluntary. Locally adapted version of SSC. Self-reported questionnaire. Differences in numbers of subgroups
White *et al.*, 2018 (29)	Mixed methods – survey, observation, focus groups – 12–18 months post-implementational, data collection during 4 weeks	Madagascar. 14 hospitals (different sizes and different performances of checklist utilization). 149 questionnaires. 1 focus group per hospital. Observation of 1–3 operations/simulations per hospital	Usage of the SSC and its impact, safety attitude, team behavior, implementation barriers	Sustained checklist use got reported by 74% after 15 months. The majority of respondents reported improved understanding of patient safety, which was associated with sustained checklist use, and job satisfaction. Implementation of the SSC showed improvements in hospital culture and hospital practice. Main barriers to effective checklist implementation were lack of time in an emergency and obstructive leadership	Self-reported questionnaire. Small sample size of observations. Sometimes observation of simulations. Focus groups were not recorded and thus evaluation could be more subjective. Social pressure in focus groups due to hierarchical authority culture. Follow-up rate was only 37%. Only 2/3 of original hospital sites were visited
Schwendimann *et al.*, 2019 (30)	Mixed methods – interview, observation – post-implementational, data collection during 5 months	Switzerland. 1 university hospital. Observation of 72 time-outs & 32 sign-outs. 11 interviews	Barriers & facilitators of SSC application, quality of usage	Time-outs were performed in 96–100% of cases, sign-outs only in 22%. The poor performance rate of the sign-outs was mainly due to the absence of key staff members. Facilitators for effective checklist usage were well-informed specialists who supported the SSC, as well as teams focused on checklist performance and its content. Barriers were staff insecurity, a negative attitude towards the SSC, lack of teamwork and hesitation to complete the checklist	Sample bias may not be representative. Hawthorne effect

SSC, Safe Surgery Checklist; SAQ, Self-Assessment Questionnaire; OR, operating room.

extent (13-15,20,22,26,28,29). OR staff also agreed that the checklist prevents errors and complications (13,17,25,26). White *et al.* showed that sustained checklist use was associated with an increased understanding of patient safety (29). The study by Haugen *et al.* was conducted with a randomized stepped wedge design. The results showed that a positive significant effect could only be found for two factors in relation to the measured dimensions of patient safety, in favor of the intervention group compared to the control group and post-interventional compared to pre-interventional. These two factors were "frequency of events (near misses) reported" and "adequate staffing", which improved in favor to the checklist. Due to the complex and guideline-compliant implementation process, the author spoke of a paradoxical effect of a successful introduction of the SSC, but without major consequences for the working culture (20). The included observational studies resulted in very similar observations. While the time-out was performed in more than 87% of the cases in four different studies, sign-out was performed significant less often and adherence to the individual items were significantly less as well. Russ *et al.* observed the performance of the time-out in 97.5% versus the sign-out in 61% of cases: adherence to the individual items only reached 64%, respectively 68% (23). Compliance to the time-out, which was documented in the patients' electronic medical record, was 100% according to Levy *et al.*, whereas the average number of checklist items checked was 4 out of 13 (18). Schwendimann *et al.* found that although documented compliance with time-outs was very high at 96–100%, compliance with sign-outs was only 22%. In addition, only 22% of time-outs were correctly initiated and performed, and sign-outs were generally not fully executed (30). Another observational study by Pickering *et al.* in which the time-out had a compliance rate of 87.4%, the sign-out was performed in only 8.8% of cases. The full checklist was performed in 54.9% of the time-outs and in 77% of the sign-outs. A difference in adherence was found between hospitals, but not between surgical specialties (21). This observation was also made by Russ *et al.* who also did not find a difference between elective and emergency interventions (23).

Knowledge about the use of the SSC

More than 90% of the staff members surveyed in two studies by Delgado Hurtado *et al.* and Sokhanvar *et al.* were aware of the existence of the checklist, while 74.6% and 88.8% of respondents had actual knowledge of its contents. Surgeons (80%, 70%) in both studies had significantly less knowledge about the objectives of the checklist than nurses (87.8%, 77.1%) and anesthesiologists (95.5% of anesthesiology residents/100% of anesthesiologists, 74.3%) (17,28). At the same time, surgeons (91%) were most likely to report that they found the checklist "easy/really easy" to use, compared to the other occupation groups (86.3% of anesthesiology residents, 66% of anesthesiologists and 63.5% of nurses). On the other hand, in the prospective cross-sectional study by Santana *et al.*, surgeons (87%) reported the checklist as less easy to use than their colleagues (95.5% of nurses, 100% of anesthesia team) (26).

Communication and teamwork

Teamwork and communication were measured either self-reported through surveys and interviews or through direct observation. Most of the examined surveys agreed that the introduction of the checklist had enhanced communication in the OR as well as interdisciplinary collaboration (13-15,17,20,22,25,27,29). Böhmer *et al.* showed an improvement in communication and teamwork 3 months after the introduction of the checklist (15). A follow-up study investigated the long-term effect and indicated that these improvements could, at least from the entire staff's point of view, no longer be confirmed 2 years after the implementation of the checklist. Divided into professional groups, surgeons were the only profession who perceived an improvement in communication both in the short-term and 2 years after implementation, in contrast to anesthesiologists and nurses. Böhmer *et al.* discussed that this could be due to the fact that communication towards the anesthesiologists and nurses improved in the short-term but did not show any improvement in the long-term, while conversely, communication towards the orthopedic surgeons remained at a high level. Although all three professional groups reported some improvement in teamwork, this was not statistically relevant. Overall, surgeons perceived teamwork as more positive than anesthesiologists and nurses (19). Takala *et al.* stated the opposite in their prospective study. According to the survey they had conducted, communication improved from the perspective of anesthesiologists and nurses 4–6 weeks after its implementation, but not from the perspective of surgeons (14). Similar results were found by Delgado Hurtado *et al.* and Santana *et al.* Although all three professional groups perceived an improvement in communication post-implementational, surgeons noticed

the smallest change (17,26). In regard to teamwork, Santana *et al.* showed a significant improvement post-interventional by anesthesiologists and nurses, but not by the surgeons (26). The observational study by Korkiakangas in 2017 found several approaches to communication to support the best possible execution of the checklist (27). For example, participation of the entire team should be sought. As both team time-out and sign-out occur at a time of high workload for anesthesia and nurses, it should first be asked if the team members would be ready and not still busy with monitoring the patient or counting compresses, for example. A loud and clear announcement, defined by the author as an "inclusive call", was recommended to invite all team members to participate and mark the start (27). These measures were discussed to prevent team members being responsible for certain items from being absent or distracted, and execution from being hampered by interruptions and disruptions, which Schwendimann *et al.* and Fourcade *et al.* identified as barriers to a successful checklist implementation (16,30).

Time management/timing

There was considerable disagreement on the appropriate length of time used for the checklist. While some studies agreed that the checklist would not take long to complete (13) and would be quick to use (26), others mentioned it took too long to complete (16,24). The mixed-method longitudinal study by White *et al.* showed no statistically association between sustained checklist use and a reduction in work stress. Nevertheless, half of the hospital reported a decrease in work stress post-implementational, which was also confirmed by the focus group interviews (29). The long-term study by Böhmer *et al.* also showed that the surgeons and nurses felt increasingly under pressure, despite the introduction of the checklist (19). While Pickering *et al.* and Russ *et al.* in their observational studies agreed that the time-out required approximately one minute, the length of time required for the sign-out differs significantly. According to Pickering *et al.* it also required about one minute, while Russ *et al.* observed less than half a minute (21,23).

Many studies focused on the exact timing of the checklist. In a survey study by Molina *et al.*, 45% were neutral or negative about the entire team stopping at all three critical points to complete the checklist (25). In Levy *et al.*, 21% of respondents knew that the time-out occurred between patient prepping and draping. It was performed at the correct time in 54% of the interventions observed (18). In an observation study by Russ *et al.* in 2015, team members failed to stop or focus on the checklist in 73% of the time-outs and even 88% of the sign-outs. The observers noticed some confusion from the team members about the correct moment the sign-out was supposed to occur. When all the team members stopped when the time-out was about to begin, more items were checked, more information shared within the team and the time-out took less time to complete (23). For Molina *et al.*, the hospital-level evaluation showed a statistically significant association between agreement with the statement "The entire surgical team always stops at three critical points" and "In the ORs where I work, potential problems or complications could be avoided by using the checklist" as well as "The entire surgical team always stops at three critical points" and "Using the checklist helps my cases run more smoothly" (25). From the low implementation rate of only 8.8% for sign-outs across 5 different hospitals, Pickering *et al.* argued that it was difficult to integrate into the work routine at the operation room because it occurred at a time with a high workload for the team (21). As a facilitator for successful checklist application, Schwendimann *et al.* recommended to stop action for a moment before beginning the checklist (30). Korkiakangas advocated that the sign-out should be done either before or during skin closing, but not during the counts (27). Lack of timing was one of the most frequently mentioned barriers for checklist implementation from several studies, mostly in combination with uncertainty as to when the appropriate time for it would be (18,22-24,28,29).

Presence of team member

Pickering *et al.* observed the whole team being present within the time-out in 77.4% of the cases (21). Russ *et al.* found that in over 40% of the time-outs and sign-outs required team members were missing (23). In the observational study by Levy *et al.*, required staff members were absent in as many as 55% of the observed time-outs (18). If everybody required was present, more information was shared, more items checked and less time used for the checklist (23). Korkiakangas recommended the whole team to assemble at a center point, for example the operation table, to review the checklist, instead of remaining scattered across the room (27). The low performance rate of the sign-out observed by Schwendimann *et al.* was mostly due to essential team members, who already were absent or busy with other tasks (30).

Checklist coordinator/leadership

In some studies, the circulating nurse was specified as the person responsible for the WHO SSC from the outset (14,20). Even if it was not defined that way from the beginning, circulating nurses were often designated as checklist coordinators (17,23). Studies disagreed on whether the choice of checklist executor influenced the quality of implementation or not. While Pickering *et al.* did not observe any differences in quality depending on the leader (21), the observational study by Russ *et al.* came to a different conclusion. Significantly more team members stopped and focused on checklist execution when a senior surgeon was the checklist leader than when another team member was leading (23). According to the interview study by Russ *et al.*, the checklist coordinator should have strong leadership and assertive skills, ideally a senior clinician (surgeon or anesthesiologist) (24). Obstructive leadership and negatively dominant people were even mentioned as the most difficult barrier to successive checklist implementation by the longitudinal study by White *et al.* (29).

Acceptance

Participants from various studies agreed by over 90% that as a patient they would want the checklist used, indicating a high level of acceptance by staff members (13,17,26,28). Although the survey resulted an over 80% improvement in job satisfaction in the study conducted by White et al, the same study was unable to establish a statistical relationship between sustained checklist use and improved job satisfaction (29). Schwendimann *et al.* identified several personal factors influencing the implementation of the checklist. Personal attitudes like "standing behind the checklist concept, considering it important and believing in its philosophy" were considered facilitators, whereas negative attitudes like "lack of insight and acceptance as to the meaning and purpose" as well as resistance of team members belonged to the barriers (30).

Form and modification

Displaying the checklist on the OR wall of the OR to read from it instead of performing it from memory was brought as an advantage (12,24). The checklist should be adapted and modified to local conditions, surgical specialty and aligned with existing processes to avoid repetition and additional work (18,24).

Implementation of the WHO SSC

Value

Explaining the purpose was used to communicate the evidence-based effectiveness of the checklist to invite team members to actively support it and convince hesitant employees of its benefit (12,24). According to Conley *et al.* explaining the importance of the checklist means giving a clear reason for the checklist implementation, to state the scientific evidence about its benefit and to bring out the expected enhancements for patient safety, efficiency and teamwork. At an institutional level, explaining the benefit of the checklist involved declaring the checklist to be consistent with the institution's values and building on previous successes on improving the patient safety. On a personal level, demonstrating the advantage of the checklist indicated understanding, acceptance, and appreciation for patient safety efforts. It increased the probability of overcoming barriers and involving team members in the implementation process, thus improving subsequent execution (12). In addition, Russ *et al.* emphasized the importance of periodic feedback to staff members through data showing the local impact and benefits of the initiative. They also recommended introducing consequences for non-compliance. Explaining the value of the checklist helped to convince resistant team members of the checklists benefit, because active resistance or passive non-compliance to the introduction of change, predominantly from senior doctors (surgeons and anesthesiologists), was the most frequently reported barrier (24).

Education

Proper checklist implementation on an institutional level meant first developing a plan for implementing the checklist that involved all affected employees. In addition, management needed be visibly involved in the introduction and support it, showing the organizational priority and so that it could be perceived as a corporate goal (24). On a practical level, showing how to implement the checklist involved teaching best practice and organize education and trainings sessions to train proper technique for checklist use. Short- and long-term observation, including real time coaching and feedback should be part of the implementation to guarantee correct checklist use in the long-term and sustained compliance (12,24). At a team level, the entire multidisciplinary team should be involved in the implementation process as well as the management

responding directly to team members' concerns. Acceptance and support by senior clinical staff should be promoted as well as identifying and encouraging champions or early adopters of the checklist (12,24,30). Lack of understanding and training was reported as a barrier for checklist implementation from several studies (16,18,28). Russ *et al.* showed that if there was no planned implementation, or if it was simply imposed on the employees, the acceptance of the checklist decreased because they neither supported the checklist nor understood its benefits. Concern was reported that if the checklist was not executed correctly, it could even have negative consequences on patient safety (24).

Discussion

It is important to distinguish between two aspects in qualitative studies: the quality of the implementation of checklists and the quality of the content of individual checklists. In our narrative review we found an overall positive impact of the WHO SSC on patient safety. White *et al.* demonstrated a link between sustained checklist use and increased understanding of patient safety, the importance of high compliance and full adherence is reiterated (29). The poor adherence of the checklist shown by Levy *et al.* with an average of 4 out of 13 items checked was in contrast to the 100% compliance documented in the patient record. According to Levy *et al.*, the poor adherence correlated with the weak implementation strategy of the hospital, and they referred to the necessity of measuring and evaluating the implementation fidelity as part of the implementation process (18). Only if an intervention is carried out as intended, a statement can be made about its effectiveness (31).

On the other hand, the findings of the study in the tertiary university hospital by Haugen *et al.* revealed that there was no major impact on patient safety despite guideline-compliant and elaborate implementation. Haugen *et al.* described the results as a "paradoxical effect" that may have several reasons such as the short timeline of the study, an already high baseline in patient safety or that the working culture and the usage of the checklist are not causally related (9). However, the results of this narrative review speak against the latter argument. Although the documented compliance was relatively high in the previous mentioned study (85% for the sign-in, 84% for the time-out, and 77% for the sign-out), there was no indication in the article of how or even if the adherence was measured (9). The studies examined showed that adherence usually is lower than anticipated which likely affects the outcome (18,21,23,30).

The low implementation rate of 8.8–61% of the sign-out indicates deficits in this area (21,23,30). According to Russ *et al.* this shows that the sign-out was not integrated into the workflows in the OR, which according to Schwendimann *et al.* requires future measures (23,30). Pickering *et al.* explained the poor implementation rate of the sign-out with the incompatibility of the checklist with practical work standards in the OR and work culture. The sign-out occurred at a time when the anesthesia and nursing staff are exposed to a high workload, which therefore caused them additional stress and competed with other important tasks. Pickering *et al.* called for a revision of the sign-out to better integrate it into the existing workload (21). Another argument for the low compliance rate in general is, according to Russ *et al.*, that many staff members do not understand the relationship between checklist compliance and patient outcome (23). This relationship was demonstrated by the randomized-control trial study by van Klei *et al.* who showed that mortality could be reduced post-implementational and that this effect strongly correlated with checklist compliance (32). Mayer *et al.* did not observe a reduction in mortality but a reduction in postoperative complications, the effect of which was even bigger if all three components of the checklist were executed (33).

Several studies highlighted the lack of understanding and training, which led to variation in execution and which was also cited as an important barrier to successful implementation of the checklist (16,18,24,28). This finding and the indication that the checklist, if not used as intended, can even have a negative impact on patient safety (24), emphasize the importance of correct and complete application of the checklist.

According to the studies examined, the following points were important regarding the execution of the checklist: The entire team should assemble in one place, for example around the operating table, before starting the checklist. This could be done, for example, by a loud inclusive call that informs all required team members (27). It should be quiet in the OR and the entire team should pause and focus for a moment (23,30). The checklist should be read aloud and not recited by heart (12). The checklist-leader should be a senior surgeon or anesthetist, although research is divided at this point as if the choice of checklist-coordinator really has an impact on the execution of the checklist (21,23,24). The time-out should occur between prepping and draping the patient, but latest before skin incision. The sign-out

should occur before or during skin closure, but definitely before the patient or the surgeon leave the OR (18,23,34). To prevent the time-out or sign-out from interfering with anesthesia or nursing staff performing other tasks, such as monitoring the patient or counting compresses, the start of the time-out should be agreed upon or not performed until signaled by the team member who had been busy (27).

A large number of studies agree about that WHO SSC fosters teamwork and improves communication (9,13-15,17,22,25,26,28,29). These findings were supported by the systematic review from Russ *et al.* which addressed the question of whether safety checklists increase teamwork and communication in the OR. Their results indicated an increase of self-perceived teamwork and communication quality after checklist implementation and a decrease in consequences caused by communication errors. Teamwork seemed to improve, because the use of the checklist promoted an open dialogue at the outset as well as discussing case-related information, uncovering knowledge gaps, articulating concerns, discussing possible changes to postoperative care, supporting interdisciplinary decision making and improving team spirit. In addition, a tendency for interdisciplinary differences emerged in the review from Russ *et al.*, namely that OR nurses saw the greatest positive impact for teamwork and surgeons saw the least (35). The findings from Russ *et al.* about communication and teamwork contrast with the longitudinal study by Böhmer *et al.*, where surgeons experienced the biggest improvement in communication and teamwork. From the perspective of the entire OR staff, the introduction of the checklist did not lead to any long-term improvements in interdisciplinary communication. Böhmer *et al.* argued that a pleasant team- and safety atmosphere were influenced by communication elements such as gestures, facial expressions, tone and choice of words. However, these elements were neither part of the implementation training nor of the checklist itself, which is why they demanded additional measures to prevent a regression to pre-implementational communication patterns (19). What these two studies by Russ *et al.* and Böhmer *et al.* (19,24) imply but do not address is stated by Russ *et al.* in the observational study from 2015. They referred to checklists as behavioral interventions and argued that only a fundamental change in behavior would cause the checklist to have an impact (23). The exact mechanisms of team behavior and the communication based on it are often still unknown and need future investigation.

The qualitative observational study by Korkiakangas identified some communication patterns regarding the team behavior which resulted in improved quality of information exchange (i.e., the inclusive call to assemble all team members and mark the start of the checklist execution) and thus increased the checklist execution. The WHO implementation manual was criticized for not providing sufficient guidance on the timing and performance of competing tasks (27).

These communication patterns and behaviors are ultimately an expression of the hospital's prevailing work culture, which has a significant influence on patient safety. This statement is supported by the fact that according to two studies, there was little variation among surgical specialties, but a great deal of variation among hospitals. This indicates that an intervention like a safety checklist is largely influenced by the hospitals' local conditions (21,23). Haugen *et al.* argued that an underlying cultural change was needed for successful implementation of the checklist and that, in contrast, a weak organizational culture could greatly reduce its effectiveness (9). The exact mechanisms of what constitutes a good work culture were largely neglected in the studies examined in the context of this review, as the predominantly quantitative studies are rather unsuitable for this purpose.

The implementation strategy should aim to make a sustained and effective change in the hospital's underlying work culture, that will lead to a greater understanding and priority of patient safety. Russ *et al.* emphasized that the implementation strategy should be tailored to the local conditions of the hospital and adapted to local needs and barriers. Due to the different working cultures, measures that work in one hospital may be ineffective in another (23). This statement was supported by Fourcade *et al.*, who emphasized that any implementation strategy should consider the cultural maturity and history of the team (16). In terms of the process itself, the qualitative study by Conley *et al.* explained a successful implementation strategy in detail, composed of explaining the advantage and application of the checklist. They argued that explaining the value would create understanding, acceptance, and support, which leads to a more sustained and correct execution of the checklist (12). Finally, it is important to make a plan that includes all professional groups and the management before starting the implementation process. Education on the scientific evidence and benefits, teaching best practice, regular feedback on application and providing local data highlighting the benefits of the initiative are known as key elements of a successful implementation strategy. Furthermore, it is essential to achieve interdisciplinary and

institutional support and acceptance for the implementation (12,24). This review demonstrates the demand for studies looking at cultural aspects to get a better understanding of how OR teams behave and the aspects for promoting an optimal and sustainable implementation of the checklist to increase the patient safety.

Limitations

This systematic review has several limitations. The studies examined were very inhomogeneous, in terms of content and study designs such as interviews, questionnaires and observations or mixed study designs. Questionnaires have the disadvantage that they reflect the subjective opinion of the respondents. Since the surveys were usually voluntary, the answers are likely to be positively or negatively overestimated, since they are filled out in particular by people with strong opinions in this regard. Observational studies can also be assumed to be overestimated, since they may involve to the Hawthorne effect to some degree. This states that observed study participants, in this case OR personnel, change their natural behavior because they know they are being observed (36). Furthermore, the studies had different ways to measure the effectiveness of the WHO SSC, for example through staff perceptions or checklist adherence, making it more difficult to compare the study results. Many of the articles used tools for their measurements, such as the Safety Attitudes Questionnaire (SAQ) for example, impeding to get the important information out of it. The studies examined differ greatly in terms of sample size, hospital size and number, and geographic location and stage of development (low *vs.* high-income countries). As we have seen, staff attitudes often depend on the cultural context of the hospital, which can lead to large differences in outcomes between hospitals. Because of this, the large variability of the participants is a limitation and a strength at the same time.

Conclusions

Research on the WHO SSC has made great strides in the last decade and its evidence cannot be denied (2). Nevertheless, the exact mechanisms of the advantage and application of the checklist are still not fully understood (2). As this review shows, some of these mechanisms were recognized at the level of team behavior and process implementation through qualitative studies. At the same time the lack of qualitative studies is also becoming apparent. Further research in this area is needed for a better understanding of the underlying work culture and consequently improving patient safety.

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Footnote

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