SYSTEMATIC REVIEW

Surgical checklists: a systematic review of impacts and implementation

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ABSTRACT

Background Surgical complications represent a significant cause of morbidity and mortality with the rate of major complications after inpatient surgery estimated at 3–17% in industrialised countries. The purpose of this review was to summarise experience with surgical checklist use and efficacy for improving patient safety.

Methods A search of four databases (MEDLINE, CINAHL, EMBASE and the Cochrane Database of Controlled Trials) was conducted from 1 January 2000 to 26 October 2012. Articles describing actual use of the WHO checklist, the Surgical Patient Safety System (SURPASS) checklist, a wrong-site surgery checklist or an anaesthesia equipment checklist were eligible for inclusion (this manuscript summarises all but the anaesthesia equipment checklists, which are described in the Agency for Healthcare Research and Quality publication).

Results We included a total of 33 studies. We report a variety of outcomes including avoidance of adverse events, facilitators and barriers to implementation. Checklists have been adopted in a wide variety of settings and represent a promising strategy for improving the culture of patient safety and perioperative care in a wide variety of settings. Surgical checklists were associated with increased detection of potential safety hazards, decreased surgical complications and improved communication among operating staff. Strategies for successful checklist implementation included enlisting institutional leaders as local champions, incorporating staff feedback for checklist adaptation and avoiding redundancies with existing systems for collecting information.

Conclusions Surgical checklists represent a relatively simple and promising strategy for addressing surgical patient safety worldwide. Further studies are needed to evaluate to what degree checklists improve clinical outcomes and whether improvements may be more pronounced in particular settings.

THE PROBLEM

Although surgery represents a mainstay of medical treatment, in industrialised countries, the rate of perioperative death directly due to inpatient surgery has been estimated at 0.4–0.8%, and the rate of major complications has been estimated at 3–17%.[1][2] These complications include wrong patient/procedure/site surgery, anaesthesia equipment problems, lack of availability of necessary equipment, unanticipated blood loss, non-sterile equipment, and surgical items (eg, sponges) left inside patients. The complexity of most surgical procedures requires a well coordinated team to prevent these events.

STRATEGIES FOR PATIENT SAFETY

Surgical checklists can potentially prevent errors and complications which may occur during surgery or perioperatively. A variety of interventions have shown promise for improving patient safety. For instance, Neily *et al*[3] found that surgical team training which incorporated surgical checklists along with communication strategies was associated with a significant reduction in surgical mortality. Arriaga *et al*[4] found that checklists dramatically improved adherence to critical processes of care in simulated scenarios of surgical crises. Studies have suggested that checklists may reduce errors for many reasons, including ensuring that all critical tasks are carried out, encouraging a non-hierarchical team-based approach, enhancing communication, catching near misses early, anticipating potential complications, and having technologies to manage anticipated and unanticipated complications. The WHO Surgical Safety Checklist is a prominent example of a surgical checklist intended to ensure safe

surgery and minimise complications. Launched in June 2008, it has been translated into at least six languages.[5] The 2009 WHO checklist (http://www.who.int/patientsafety/safesurgery/en/) contains 22 items in three phases:

- Before induction of anaesthesia, covering areas such as patient identification, anaesthesia equipment check and a pulse oximetry check.
- Before skin incision, covering areas such as team introductions, review of critical steps and antibiotic prophylaxis.
- Before patient leaves operating room (OR), covering areas such as checking counts of instruments, specimen labelling and concerns for recovery.

In this paper we discuss the evidence for three patient safety efforts associated with surgical checklists. The WHO Surgical Safety Checklist and the Joint Commission Universal Protocol (UP) for Preventing Wrong Site, Wrong Procedure, Wrong Person Surgery[6] have each been widely implemented to improve care when surgical procedures are performed. We also discuss the Surgical Patient Safety System (SURPASS) checklist,[7–10] which represents a more comprehensive approach, capturing clinical care from admission to surgery to discharge.

REVIEW STRATEGY

We conducted a systematic literature search of MEDLINE, CINAHL, EMBASE and the Cochrane Database of Controlled Trials using a search strategy developed by a medical librarian. The search strategy (available upon request) included studies published from 1 January 2000 to 26 October 2012, and used a combination of medical subject headings and keywords related to checklists ('anaesthesia checklist', briefing, checklist, checkout, communication, documentation, instrument, 'safety checklist', tool, 'surgical checklist', protocol, 'WHO checklist').

Given the limited scope of this review, we focused on any articles describing actual use of the WHO checklist, the SURPASS checklist, a wrong-site surgery checklist or anaesthesia equipment checklists. We recognise other surgical checklists exist; however, many of these have only been implemented at a single institution. We also included articles describing use of anaesthesia checklists to detect equipment failure in simulated scenarios. This manuscript summarises all but the anaesthesia equipment checklists, which are described in an Agency for Healthcare Research and Quality (AHRQ) publication.[11] An overview of the three types of checklists discussed in this paper is given in table 1. We included a total of 33 studies of these checklists and tabulated the reported outcomes, facilitators and barriers to checklist implementation.

BENEFITS AND HARMS
Benefits
WHO checklist
The 2008 WHO Surgical Safety Checklist was tested at eight sites around the world.[5] These settings varied greatly in the number of beds (range 371–1800), the number of ORs (range 3–39), and the income level of the country (four low, four high). Surgical safety policies prior to implementation of the WHO Checklist also differed regarding the use of routine intraoperative monitoring with pulse oximetry (six of eight sites), oral confirmation of patients' identity and surgical site in the OR (only two of eight sites), and routine administration of prophylactic antibiotics in the OR (five of eight sites). None of the eight sites had a 'standard plan for intravenous access for cases of high blood loss', or formal team briefings preoperatively or postoperatively.

Baseline data were obtained at each site for 3 months prior to checklist introduction, involving a total of 3733 surgical procedures. In the subsequent 3–6-month period after checklist introduction, involving 3955 procedures, data showed decreases in patient mortality (from 1.5% to 0.8%) and inpatient complications (from 11% to 7%). No single site was driving

Table 1 Overview of the three checklists

Checklist	Clinical scope	Staff involvement	Categories and numbers of items
WHO Surgical Safety Checklist	Surgical care	Surgeon(s), anaesthetist(s), nurse(s)	Total of 22 items, in three categories: - Before induction of anaesthesia (7 items) - Before skin incision (10 items) - Before patient leaves operating room (5 items)
SURPASS	All surgical care between patient admission and discharge	Ward doctor(s), surgeon(s), anaesthetist(s), nurse(s) or operating assistant(s)	Total of 90 items, in 11 categories
Checklists based on the Universal Protocol	Surgical care, but also (if applicable) when the procedure is scheduled, when the patient enters the healthcare facility, and anytime care is transferred between caregivers	Varies by site	Varies by site

SURPASS, Surgical Patient Safety System.

the findings, as evidenced by the persistence of findings after the removal of any single site in a sensitivity analysis. The authors found that the performance rates for six specific safety indicators (eg, using a pulse oximeter) also increased after checklist introduction, suggesting that the safety indicators may have been responsible for the lower rates.

In discussing the results, the authors acknowledged that the underlying explanations were 'most likely multifactorial' and included the following:

► The checklist itself.
► A Hawthorne effect (ie, rates may have decreased because OR personnel knew they were being measured). The authors argued against this possibility based on two aspects of their data: this knowledge was in place before and after checklist introduction, and the subset of procedures for which study personnel were present in the OR had the same reductions in complications as procedures when study personnel were absent from the OR.
► The simple existence of a formal pause or preoperative briefing (which could be done without a 'checklist'). Such a pause is a necessary component of the checklist.
► Increased uptake of safety technologies (eg, administering antibiotics in the OR rather than in preoperative wards). This change could be considered a byproduct of checklist introduction (ie, hospitals made more antibiotics directly available in the OR because of the presence of an antibiotics-related item on the checklist).
► A broad change in safety culture and teamwork at that site, an explanation supported by the finding that greater increases in safety attitudes at the pilot sites were associated with greater reductions in complications.[12]

Subsequent publications about the WHO Surgical Safety Checklist have found improvements in urgent surgery[13] and safety attitudes.[12] [14] Haynes *et al*[12] reported that 80% of respondents considered the checklist easy to use, 20% believed it took too long and 93% of respondents would want the checklist used if they were undergoing surgery. Likewise, Helmio and colleagues[15] found that 76% of OR staff agreed the checklist improved safety, 68% agreed it improved error prevention and 93% would want the checklist used if they were having surgery. Team members reported high satisfaction and positivity about the checklist, and estimated that it only took about 2 min to complete.[16]

SURPASS checklist

The WHO checklist focuses primarily on events occurring within the OR. However, an estimated 53–70% of surgical errors occur outside the OR.[8] [17] [18] The SURPASS checklist[7–10] attempts to address these errors by encompassing all care between patient admission and discharge. Within the OR itself, the SURPASS checklist is less specific than the WHO checklist (eg, the SURPASS checklist does not specifically mention any of the following: pulse oximetry, difficult airway, risk of blood loss (although it asks whether blood products are available), team introductions, and anticipation of critical events).

De Vries *et al*[7] tested the 90-item SURPASS checklist. In six test hospitals, the 3-month period after the checklist was initiated (compared with the 3 months before) saw numerous improvements: decreases in the percentage of patients with complications, in-hospital mortality, patient temporary disability and reoperations. No such improvements were found among the five control hospitals. Interestingly, the degree of improvement was associated with greater compliance with the checklist, providing greater confidence that the checklist itself was responsible for improvements. A subsequent retrospective review of 294 medical claims[10] estimated that 40% of deaths and 29% of liability incidents might have been prevented if the SURPASS checklist had been used. Further review of 6313 checklists performed found that 41% detected at least one oversight, with the most common occurring postoperatively (lack of postoperative instructions concerning ventilation by the anaesthesiologist and missing medication prescriptions at discharge).[19]

Wrong-site surgery checklists

In January 2004, the Joint Commission launched the first version of the UP for Preventing Wrong Site, Wrong Procedure, Wrong Person Surgery.[6] [20] Preoperative verifications of person, procedure and site are supposed to occur in the OR and (if applicable) when the procedure is scheduled, when the patient enters the healthcare facility, and anytime care is transferred between caregivers. Site marking should involve only the operative site and should be visible before the patient is draped. The 'time out' is to occur before incision and involve the entire OR team. The UP is not a checklist[21] but could be implemented using one or more checklists. Steps 1 and 3 specifically mention the potential use of a checklist.

Wrong-site surgery is rare; estimates for various procedures range from 1 in 13 000 procedures for wrong-site anaesthesia block to 1 in 4200 for wrong-side ureteral stents.[22] A general systematic review estimated that the overall rate was 1–5 per 10 000 procedures.[23] Given the rarity, demonstrating a statistical reduction would require an unfeasibly large study. A systematic review searched for literature and concluded there was 'no literature to substantiate the effectiveness of the current Joint Commission Universal Protocol in decreasing the rate of wrong site, wrong level surgery.'[23] Therefore, the preventive benefits of a checklist to prevent wrong-site surgery are generally assumed based on clinical expertise.

HARMS

Direct harms of surgical checklists have not been reported. In 2011, Sewell *et al*[24] reported that after WHO implementation, the rate of lower respiratory tract infections actually increased from 2.1% to 2.5%.

Whether this increase was caused by the checklist is unclear; however the authors attributed rate *reductions* to the checklist, so they could also have attributed rate *increases* to the checklist. Despite the absence of reported direct harms, some checklist users have expressed concern regarding potential harms. For instance, some worry that checklist use decreases OR efficiency or creates unnecessary patient anxiety. In 2011, Kearns et al[25] reported that 3 months after WHO checklist implementation, 30% believed it was an inconvenience in emergency cases; however, this percentage was lower than it had been prior to implementation of the checklist when staff were asked hypothetically whether they believed it would be an inconvenience in emergency cases (53% said it would be). OR efficiency might also be compromised if checklists duplicated already existing safety procedures or if nurses responsible for performing the checklist were unfamiliar with its execution due to high staffing turnover. [26 27] In one study,[27] staff expressed concerns that prompting patients for their name several times immediately before induction of anaesthesia might create unnecessary anxiety.

IMPLEMENTATION CONSIDERATIONS AND COSTS
WHO checklist
We included 23 reports of WHO checklist implementation. Twenty-one studies reported WHO checklist implementation at other sites and two reported experience at institutions involved in the original study (table 2).

Results from the 23 implementation reports appear in table 3. In keeping with WHO recommendations, checklists were tailored and implemented differently for a wide variety of contexts. At present, it remains unclear whether OR posters, paper tick boxes or electronic medical records perform better. Feedback from surgical teams was generally positive, but support tended to be greater from nurses and anaesthetists than from surgeons. For example, Vats et al[26] found that anaesthetists and nurses were 'largely supportive' but some surgeons were 'not very enthusiastic'.

Reasons cited for success included good training and staff understanding, a local champion, support from upper management, being able to modify the checklist, distribution of responsibility, the feeling of ownership by team members, a stepwise implementation process which incorporated real-time feedback, and enhanced communication and teamwork. Regarding communication, for example, Sewell et al[24] found that 77% of users thought the checklist improved team communication; this percentage was 70% in the study by Kearns et al.[25] The implementation study by Conley et al[28] emphasised that the local champion should 'persuasively explain why and adaptively show how to use the checklist'. Styer et al[29] and Bohmer et al[30] attributed success to recruiting senior leaders of their institutions to be local champions and

incorporating real-time feedback into checklist protocols.

Barriers to implementation generally fell into four categories: confusion regarding how to properly use the checklist, pragmatic challenges to efficient workflow, access to resources, and individual beliefs and attitudes. First, OR staff were sometimes confused about how to properly execute the checklist.[15 27 31] For instance, Levy et al[31] found significant confusion about the timing of checklist items and who was responsible for prompting checklist questions among OR staff. While inadequate education may play a part, Fourcade et al[27] found that nurses were unfamiliar with the checklist because of high staffing turnover. Vogts et al[32] suggested that performance of 'sign out' may be low since this section is not linked to a specific event in patient management, unlike the 'sign in' and 'time out' domains and thus lacks clarity.

Second, checklist implementation occasionally created pragmatic problems for OR workflow. Particular challenges include extra time,[27 32] especially during emergency procedures,[33] and duplication of safety checks already routinely performed.[26 27] In the study by Kearns et al[25] 30% felt that in emergency cases, the checklist was inconvenient. Third, developing countries often lacked regular access to resources. Yuan et al[14] reported that inconsistent access to antibiotics and batteries hampered checklist use in two Liberian hospitals. Likewise, Kasatpibal et al[34] reported that surgical sites were not routinely marked because marking materials were unavailable in a Thai hospital. Finally, individual attitudes of staff towards the checklist played a major role in the outcome of implementation. Barriers included general surgeon resistance to changing habits, awkwardness of self-introductions and steep interpersonal hierarchy. Some nurses reported concerns about incurring legal responsibility if a complication occurred after they signed the checklist form.

Health outcomes
In terms of improved health outcomes (rightmost columns of table 3), 10 of the 21 implementation studies reported relevant data. Among the 10 reporting studies, however, reductions were generally impressive. For example, Askarian et al[35] found that surgical complications decreased from 22.9% to 10%. Yuan et al[14] reported that two Liberian hospitals found checklist introduction was significantly associated with fewer surgical site infections (adjusted OR (AOR) 0.28; 95% CI 0.15 to 0.54) and surgical complications (AOR 0.45; 95% CI 0.26 to 0.78).

Similarly, the study at Royal Bolton[36] found that nine potential safety incidents were averted during a 1-month period of checklist use. Other reported improvements appear in table 3.

Table 2 Implementation studies of the WHO Surgical Safety checklist

Author [year]	Description of Patient Safety Practice (PSP)	Study design	Theory or logic model	Description of organisation	Safety context
Sewell et al [2011][24]	2008 WHO surgical checklist, unmodified	Before and after study, comparing pre-training period to post-training	'The underlying philosophy of the checklist is that a true team approach with good communication between operating room team members is safer and more efficient than a hierarchical system that relies on individuals'	A UK hospital, orthopaedic operations. 28% of operations were urgent, and 77% involved general anaesthesia	Pre-training period February–May 2009 (480 operations). During this period: correct checklist use was 8%, and 47% thought it improved team communication; pre-training staff perceptions: 55% thought it caused an unnecessary time delay, 28% thought it improved patient safety, 47% thought it improved team communication and teamwork, 64% would want the checklist used if they were having an operation
Helmio et al [2011][55]	2008 WHO surgical checklist. No specialty-related changes, but some 'minor changes.' Checklist included in publication; modifications did not exclude any items	Before and after study	'The idea of the checklist is to be an add-on security tool for the defined safety standard'	Finland, otorhinolaryngology head and neck surgery ORs. 747 operations in the 2-month study periods combined. All subgroups of otorhinolaryngology head and neck surgery were included	One-month pre-implementation period in May 2009 (304 operations): 17% were urgent operations; 24% were on children; 16% were local anaesthesia. Before implementation: knowledge of OR-teams' names and roles ranged from 61% to 92%. Discussing risks was 24%. Postop instructions recorded 7–84%. Successful communication 79–93%
Conley et al [2011][28]	2008 WHO surgical checklist, unmodified	Case series	None explicitly stated	Five Washington State hospitals. Two hospitals had <10 ORs, one had 10–20 and two had >20. Two urban, two suburban and one rural	Nothing reported about pre-existing safety culture. The Vice President for Patient Safety at the Washington State Hospital Association provided 'significant assistance'. Checklist introduction December 2008 to January 2009. Interviews conducted September–December 2009. One of the five hospitals had a recent wrong-site incision that motivated surgical staff and 'opened people's eyes to the need for ongoing patient safety efforts'
Bell and Pontin [2010][56], Bell[57]	2008 WHO checklist adapted different for different surgical specialties. Checklist not included in publication	Case series	'Without a doubt, the checklist works best when all staff members are engaged'	Large two-hospital trust in the UK with 10 000 staff and 850 000 patients annually	Nothing about pre-existing safety culture. To prepare for the checklist, they set up a Patient Safety Working Group
Sparkes and Rylah [2010][58]	2008 WHO checklist locally adapted. Checklist included in publication; modifications did not exclude any items	Case series	Discussed various ways a checklist could enhance safety, including teamwork and effective communication	Teaching hospital in the UK with 29 ORs in five locations performing specialised complex surgery	NR
Royal Bolton [2010][36]	2008 WHO checklist, unmodified. Local adaptation of it was considered but ultimately not done	Case series	Improve patient safety by enhancing teamwork and communication	Trust in the UK with eight ORs	Prior to the checklist, the trust already had a core group of patient safety experts assembled; this group met to discuss how to introduce the checklist. They examined the previous year's 41 safety incidents and all were 'found to be avoidable had the checklist been in use'

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Systematic review

Table 2 Continued

Author [year]	Description of Patient Safety Practice (PSP)	Study design	Theory or logic model	Description of organisation	Safety context
Vats et al [2010][26]	2008 WHO surgical checklist adapted for England and Wales. Checklist included in publication; modifications did not exclude any items	Case series	'the checklist ensures that critical tasks are carried out and that the team is adequately prepared for the operation'	UK academic hospital	Nothing reported about pre-existing safety culture. Piloted March–September 2008 at a London hospital in 58% of operations (424/729) among the two ORs selected (one for trauma/orthopaedics OR, the other for GI/GYN)
Kearns et al [2011][25]	WHO surgical checklist, version NR. Some obstetric-specific checks had been added, but the list of revisions was not reported. Checklist not included in publication	Before and after study	'Checklists may be used to improve patient safety by ensuring that all elements of a practice are instituted for each new clinical event'	UK study in obstetrics ORs. Tertiary referral obstetric centre with ~6400 deliveries per year	Before introducing the checklist, they measured staff attitudes, preserving respondent anonymity: 30% 'felt familiar' with others in the OR, 81% felt communication could improve, 85% felt that in elective cases the checklist would be useful, 53% felt that in emergency cases the checklist would be inconvenient
Norton and Rangel [2010][59]	2008 WHO checklist modified for paediatric operations and also to meet the 2009 Joint Commission Universal Protocol. Checklist included in publication. Removed the following three items from the WHO checklist: pulse oximetry, difficult airway, anticipated blood loss	Case series	Checklist can help to reduce breakdowns in communication, ineffective teamwork and lack of compliance with process measures	Children's hospital in the USA performing numerous types of paediatric surgery	At this hospital they had been building a quality infrastructure for 5 years prior, and had already implemented the Universal Protocol
Styer et al [2011][29]	2008 WHO checklist modified and implemented as hospital policy. Selected modifications listed. Checklist not included in publication	Qualitative description	Implementing checklist using a PDSA cycle stepwise approach leads to smoother transition and sustained outcomes	Teaching hospital in the USA with 44 ORs	'This initiative … was introduced to see how the checklist might fit within our hospital culture'
Bittle [2011][60]	2008 WHO checklist adapted for individual hospital. Checklist not included in publication	Qualitative description	Checklists 'ensure there is adherence to proven standards or care'	Large city hospital in New Zealand	Quality service improvement team
Yuan [2012][14]	2008 WHO checklist modified for local practice. Checklist included in publication	Before and after study	Checklists are an inexpensive and feasible way to potentially improve quality of surgical care in 'resource-limited settings'	Two hospitals (each with 2 ORs) in Monrovia, Liberia. Hospital 1 (150-bed primary community hospital), hospital 2 (200-bed, government referral hospital)	Liberia is rebuilding health system infrastructure after 14 years of conflict. Checklist implementation was a collaboration with the Ministry of Health and Social Welfare in Liberia to characterise its impact in low resource context
Kasatpibal et al [2012][34]	2008 WHO checklist modified and translated. Hair removal added to checklist. Other modifications not described. Checklist not included in publication	Case series	Checklists may reduce preventable adverse surgical events, but may be difficult or inappropriate to implement in a developing country	University hospital in northern Thailand (1400 beds, 21 877 operations annually)	Average rate of surgical site infection in Thailand is 1.7%
Bohmer et al [2012][30]	2008 WHO checklist modified. Checklist included in publication	Before and after	Checklists may improve staff's perception of patient safety and job satisfaction	Institute for research in Operative Medicine of the University of Witten/ Herdecke	NR

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Table 2 Continued

Author [year]	Description of Patient Safety Practice (PSP)	Study design	Theory or logic model	Description of organisation	Safety context
Fourcade et al [2012][27]	2008 WHO checklist modified. Checklist included in publication	Case series 1. Random sample of 80 surgeries from each centre performed over 18-day interval. 2. Interviews and surveys of participating staff	Checklists may improve surgical outcomes, but face barriers to efficient implementation	18 cancer centres in France	The French National Authority for Health introduced a modified checklist as mandatory. Implemented by French National Federation of Cancer Centres along with research team from Coordination for Measuring Performance and Assuring Quality of Hospitals, Institut Gustave Roussy
Perez-Guisado et al [2012][62]	2008 WHO checklist. Checklist included in publication	Descriptive cross-sectional study of plastics, reconstructive surgical procedures	Checklist 'involves new philosophy of organisation that is easier to achieve in health workers with lower hierarchy' (ie, nurses, surgeon residents)	Reina Sofia Hospital (1684 surgeries)	NR
van Klei et al [2012][33]	2008 WHO checklist modified. Checklist available in online supplementary material	Before and after	Checklists enhance teamwork and improve handovers decreased avoidable errors and complications	University Medical centre Utrecht (The Netherlands)	Checklist implemented in accordance with mandatory policy by the Dutch Health Care Inspectorate
Takala et al [2011][63]	2008 WHO checklist, modified. Checklist available in appendix	Before and after	'Checklist would improve awareness of safety-related issues and the fluency of operations as well as communication during surgery'	Four university teaching hospitals in Finland	Pilot study to investigate usefulness of the checklist in a variety of surgical specialties to inform development of a national checklist
Truran et al [2011][64]	2008 WHO checklist, modified. Checklist not included	Before and after	The checklist may improve compliance with venous thromboembolism prophylaxis guidelines	Hospitals in the UK	NR
Vogts et al [2011][32]	2008 WHO checklist, modified. Checklist included in appendix	Case series	Checklists 'promote communication and teamwork within the OR'	Auckland City Hospital, New Zealand	Checklist implemented 2 years prior
Askarian et al [2011][35]	2008 WHO checklist. No modifications noted, checklist not included in publication	Before and after	Checklist may improve patient safety by reducing surgical complications	Referral educational hospital in Shiraz, southern Iran (374 beds, 6 ORs)	The Iranian Ministry of Health, Treatment and Medical Education approved nationwide use of checklist in 2009
Levy et al [2012][31]	2008 WHO checklist modified. Modified checklist not included in publication	Case series	Low fidelity of checklist execution may be a barrier to improving health outcomes	Academic tertiary care children's hospital (Texas, USA)	Checklist compliance reported at 100%, but fidelity of checklist use is unclear
Helmio et al [2012][15]	WHO checklist (unclear if modified). Checklist not included in publication	Case series	'This checklist has reduced complications and deaths significantly'	Otorhinolaryngology department in four Finnish hospitals	Checklist implemented in these hospitals during WHO pilot project in 2009

GI, gastrointestinal; GYN, gynaecology; NR, not reported; OR, operating room; PDSA, plan–do–study–act.

Table 3 Findings of implementation studies of the WHO Surgical Safety Checklist

Author/year	Training	Study phases and checklist fidelity	Reasons for success or failure	Opinions, knowledge and behaviour	Health outcomes
Sewell et al [2011][24]	Checklist forms placed in ORs, compulsory training video detailing correct and incorrect uses of the checklist, emphasis placed on all team members being responsible. Active discouragement of a simple tickbox approach. Checklist training was not associated with reductions in any complications or mortality	Training phase first (unreported duration). Post-training period June–October 2009 (485 operations). Correct checklist use 97%: 2 min. 20% thought it caused an unnecessary time delay	'The initial implementation of the checklist was met with resistance by some operating room team members as there was a belief that many of the points were already in practice'	77% thought it improved team communication, 68% thought it improved patient safety, 80% would want the checklist used if they were having an operation	Early complications 8.5% before checklist training and 7.6% after. Mortality 1.9% before checklist training and 1.6% after. Lower respiratory tract infections 2.1% before checklist training and 2.5% after. Surgical site infection 4.4% before checklist training and 3.5% after. Unplanned return to OR 1.0% before checklist training and 1.0% after
Helmio et al [2011][55]	Training involved a presentation from an outside expert and three 45 min lectures. Specific guidelines were in the OR, and short instructions on the back of the checklist	One-month implementation period in September 2009 (443 operations)	'Use of the checklist improved verification of patient identity, but this was still inadequate.' 'Our study confirms that the surgical checklist fits well into otolaryngology.' 'We recommend the use of this checklist in all operations'	'… overall, the operating room personnel were supportive'. Anaesthesiologists' knowledge about patients had improved compared with the pre-implementation period. Preoperative check of anaesthesia equipment increased from 71% to 84%. After implementation, staff were more likely to accurately report patient identity, procedure and operative side. After implementation, there was improvement in: knowledge of OR-teams' names and roles ranged from 81% to 94%. Discussing risks was 38%. Postop instructions recorded 86%. Successful communication 87–96%	NR
Conley et al [2011][28]	NR	Duration of rollout: <2 months at three hospitals, >6 months at two hospitals	The key is whether the local champion can 'persuasively explain why and adaptively show how to use the checklist.' Implementation was incomplete at three hospitals: One cancelled attempts to implement the checklist due to 'fear of insurmountable resistance and poor interdisciplinary communication'. Another cancelled attempts because they were unable to move beyond pilot testing. The third had less effective implementation because of a laissez-faire leadership style; no training; staff understood neither why	Interviews conducted, but no quantitative summary of opinions provided. Three hospitals were discussed in detail	NR

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Table 3 Continued

Author/year	Training	Study phases and checklist fidelity	Reasons for success or failure	Opinions, knowledge and behaviour	Health outcomes
			nor how the checklist could be implemented		
Bell and Pontin [2010][56], Bell[57]	Training provided to prevent 'teething problems.' Instead of requiring paperwork, they used in each OR an A3 board (a drawing board about 14×20 inches) that was colour-coded to aid completion. Publicity campaign in both hospitals	Piloted the checklist at one of the two hospitals first	'To implement the checklist effectively, it was essential to engage all staff to ensure the theatre team worked together.' 'Working with individuals to identify any gaps or issues with implementation.' Currently it is 'being used as standard throughout theatres'	'Communication and staff morale have definitely improved since the checklist was implemented'	NR
Sparkes and Rylah [2010][58]	"Extensive educational support and training"	3-month pilot, during which changes to the checklist were made. After the pilot, and training, the checklist was introduced to all 29 ORs in November 2009	Even though people agreed with the checklist in theory, it was difficult to change attitudes and behaviours, particularly the senior team. The checklist was required to be signed by team members and 'This had led to the fear that legal colleagues will apportion blame to those who have signed the checklist when complications occur'	Before checklist introduction: 'Although all found the checklist to be useful, many senior clinicians felt that such communication already took place informally, and that more paperwork would not add to safety.' Audit of 250 cases in February 2010 found that team briefings occurred in 77% and time outs in 86%	NR
Royal Bolton [2010][36]	Drop-in educational sessions which involve 120 participants	May and June 2009 were spent getting the word out about plans to start using the checklist. Piloted first for 1 month in two of the Trust's hospitals in 62 operations. September 2009 was the trust-wide launch of the checklist. 'Every Trust is different but implementing the checklist across the Trust rather than a prolonged pilot period.' Within the first week 33% of operations employed the checklist. By 1 month it was at 72%. Currently all eight ORs use it	'The importance of communicating with and involving people beyond this core group was recognised straight away.' 'Essentially it is all about changing the culture, which can be a long process, but it's well worth it'	'The feedback we received from staff was very positive. Most people were keen to introduce the checklist as quickly as possible'	1-month pilot identified nine potential incidents that were avoided as a result of the checklist
Vats et al [2010][26]	Limited time given to training	Checklist accelerated with use. Large variability in how the checklist was used: sometimes incompletely, hurried, dismissive replies, and without some key participants. Compliance was initially good, then fell when the research team was absent, and so the team had to re-enter ORs to encourage greater use. Compliance	Need a local champion as well as local organisational leadership. Importance of being able to modify to fit local needs, for example, there was no need to check pulse oximetry because it is already always used	Anaesthetists and nurses were 'largely supportive'. Some surgeons were 'not very enthusiastic'. Awkward self-introductions, takes time to achieve comfort, steep interpersonal hierarchy, ID the patient BEFORE draping, not after. Complaints about duplication; perhaps a revised checklist could have less duplication	'At our hospital, we found no significant change in overall morbidity or mortality, which were already very low, after the introduction of the checklist. However, there was a noticeable improvement in safety processes, such as timely use of prophylactic antibiotics, which rose from 57% to

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Table 3 Continued

Author/year	Training	Study phases and checklist fidelity	Reasons for success or failure	Opinions, knowledge and behaviour	Health outcomes
		ranged from 42% to 80% in the 6-month period			77% of operations after the checklist was introduced'
Kearns et al [2011][25]	Training, humorous posters provided, and 'all staff empowered to remind the team to perform the checklist if it was forgotten.'	Compliance with the preoperative part of the checklist was 61% after 3 months and 80% after 1 year. Compliance with the postoperative part of the checklist was 68% after 3 months and 85% after 1 year	Authors cited four contributors to success: allocation of responsibilities, local champion, sense of ownership by team members, and ongoing staff consultation	Staff attitudes 3 months after checklist introduction: 50% now 'felt familiar' with others in the OR; 70% felt communication had improved; 80% felt that in elective cases the checklist was useful; 30% felt that in emergency cases the checklist was inconvenient. Fifty-eight patients were asked whether they noticed the operating team performing a series of checks before the operation, and 75% said they did, and another 19% remembered it after being prompted. Of the combined 94%, they all disagreed with the idea that the checks would make them worried, and 93% said they were reassuring	NR
Norton and Rangel [2010][59]	3×5 foot posters in each OR. Launch involved formal letter to staff, electronic training application, multiple in-service training sessions, and mention in hospital newsletter	December 2008 pilot test in six paediatric surgical services (general, neuro, orthopaedic, otolaryngology, plastic surgery, and urology). February 2009 pilot test on the revised procedures, and more minor edits were made. 'Go-live' date 1 April 2009 in all of the hospital's ORs. Surgical chiefs were local champions, and one nurse champion was paired with each surgeon champion. They divided the responsibility for leading the Time Out phase among all team members, and identified key speaking points. Compliance at ORs improved over time during this period from July 2009 to February 2010	'Use of the Paediatric Surgical Safety Checklist encourages multidisciplinary teamwork and has brought increased communication to our ORs and in other areas'	December 2008 pilot test of 30 procedures had 80–90% compliance, with 'overwhelmingly positive' feedback. 'Team members have expressed satisfaction with the flow and content of the checklist'	Checklist caught one near miss during sign in (site not marked), several near misses during time out, (antibiotics not given, problems with consent forms, site marking not visible after draping, missing equipment), and sign out (one team realised a patient needed straight catheterisation, and reviewing procedure name helped nurse documentation, one specimen was incorrectly labelled)
Styer et al [2011][29]	Slide presentations, educational posters in ORs, one on one sessions, frequent email updates	October 2008, 2-week trial. Day 1: checklist used by 2 surgeons; anaesthesia/nursing teams recruited to participate and provide same day feedback. Day 2: feedback incorporated, used in 4 ORs, with 8 surgeons December 2008: chiefs of nursing, surgery, anaesthesiology and surgical services asked to endorse use as	Early endorsement by executive leadership. Each discipline equally involved in leading effort. PDSA cycle method for gradual implementation. Real-time feedback. Each discipline should lead a section of checklist. Provide data (process and outcome measures). Checklist adopted as hospital policy	NR	Allergies: RN added recent new allergy to record Antibiotics: not given (3), wrong antibiotic for procedure (2), surgeon changed mind about giving antibiotic after confirming procedure, antibiotic left in another room DVT: scheduled procedure typically would not have required compression boots, but patient found to have

Continued

Table 3 Continued

Author/year	Training	Study phases and checklist fidelity	Reasons for success or failure	Opinions, knowledge and behaviour	Health outcomes
		hospital policy February 2008: checklist team established (leaders from surgery, anaesthesia, nursing), project manager, administrative fellow March 2009: staggered 14-week rollout to 44 ORs. Each surgical service allotted 4 dedicated weeks of attention (week 1: communication, week 2: education, week 3: go live, week 4: follow-up). During 'go live' period, checklist team observer assigned to each surgery to educate, provide real-time feedback, answer questions			history of DVT Safety precautions: heparin drip had not been discontinued Plan for management of patient: chest radiograph after procedure for unsuccessful central line placement had been forgotten
Bittle [2011][60]	Quality division 'coaches' educated OR teams about checklist, and benefits	May 2010: 'coaches' from quality division assigned to OR to introduce checklist, first to plastics, then other specialties. Team meetings with coach, OR manager, specialty clinical nurse manager, head of surgical department and senior registrars preceded implementation. Feedback regarding checklist procedure obtained at 1 and 3 weeks	NR	Initially 'staff were anxious and somewhat apprehensive, but it is now an established step in an operation and is carried out with confidence'	Incorrect surgery site pointed out by patient Reported incidents fell from 12 to 11 compared with reporting period of previous year
Yuan et al [2012][14]	Certified registered nurse anaesthetists (CRNAs) were identified as local leaders of surgical teams. CRNAs along with surgeons, OR staff participated in 2-week training of lectures, written materials and direct guidance Large printed poster placed in ORs	Two months prior and after. All patients followed prospectively for outcomes and complications until discharge or 30 days, whichever came first	Reasons for success: checklist implementation catalysed efforts to procure equipment (ie, pulse oximeter) necessary for safety processes Reasons for failure include: lack of consistent access to crucial resources (such as antibiotics, batteries); checklist 'did little to change the entrenched hierarchy and relationship dynamics of OR staff'; lack of sustained checklist training beyond 2 weeks	'… the checklist's focus on continuous improvement helped to foster a shift in mind-set among staff who were "just used to making it to the end of the day" to building a stronger culture of safety'	Checklist associated with overall improved adherence to ≥ 4 (out of 6) safety processes, decreased surgical site infections (AOR 0.28, 95% CI 0.15 to 0.54), surgical complications (AOR 0.45, 95% CI 0.26 to 0.78) Stratified analysis revealed improved adherence limited to hospital 1 (AOR 4.06, 95% CI 2.2 to 7.6), decreased surgical site infections, surgical complications limited to hospital 2 No improvement in surgical outcomes
Kasatpibal et al [2012][34]	Circulating OR nurse participated in two meetings and 1-day data collection training session	From March 2009 to August 2009, 42.6% of operations selected for inclusion 91% of patients confirmed identity, site, procedure and gave consent. Only 19% of surgical sites marked. Anaesthesia equipment and	Compliance with marking of surgical site low because: marking materials unavailable, procedure was emergent, and 'Thai culture' in which 'Thais do not make marks on other people, especially on the head' Also, 'some surgeons assumed that	Surgical teams often did not introduce themselves during time out for cultural reasons. 'In Thai culture, people usually introduce themselves only when they first meet someone and are shy about publicising their roles' Compliance with checklist high for	NR

Continued

Table 3 Continued

Author/year	Training	Study phases and checklist fidelity	Reasons for success or failure	Opinions, knowledge and behaviour	Health outcomes
		medication checked in 90% of cases. Pulse oximeter applied in 95% of cases. Allergies, difficulty airway, aspiration risk and risk of >500 mL blood loss assessed in 100% of cases	wrong-site surgery would not occur because they had not experienced it themselves' Compliance with hair removal procedures was hampered by lack of familiarity with proper procedure, lack of equipment and requests from surgeons	life-threatening issues (drug allergies, difficult airways, profuse blood loss) and confirmation of patient's name, incision and procedure. Notably, standards for these measures are already current hospital policy Compliance was low for surgical site marking and appropriate hair removal	
Bohmer et al [2012][30]	NR	Survey administered before checklist implementation, then 12 weeks after implementation	All participating specialties were involved in formulation of the questionnaire The checklist was modified for 'local conditions' based on feedback from staff Checklist introduced by department heads, demonstrating leadership Baseline findings and improvement after introduction of the checklist were presented to staff	OR staff felt that communication culture in OR was improved, and checklist facilitated information about intraoperative complications. The authors observed there was more discussion of critical events between surgeons/anaesthesiologists	NR
Fourcade et al [2012][27]	NR Training sessions, written materials and videos available from the French National Authority for Health, but use by participating centres was not reported	11–29 January 2010. Random sample of 80 records from medical record per centre were analysed Excluded topical anaesthesia, IR, GI endoscopy and CVC placement Subsequent interviews with staff and surgeons via semi-structured interviews and email surveys	Barriers to success: 1. Many elements of checklist already exist so checklist creates duplication 2. Poor communication between surgeon/anaesthetist 3. Completing checklist took too much time, staff did perceive benefit 4. Some items confusing because they did not fit in with customary OR practices (or seemed inappropriately timed) 5. High staff turnover, new staff unfamiliar with checklist. 6. If OR staff not actively engaged during checklist, nurses felt concerned about 'legal implications of signing the checklist as they might be held accountable for errors' 7. Some felt questions were repetitive, might frighten patients about to undergo anaesthesia 8. In 5 centres, box for checklist could be checked if safety check not performed for time constraints. Some staff worried this would make	Checklist performed in 90.2% of surgeries. However, checklist was completed in only 61% of cases	NR

Table 3 Continued

Author/year	Training	Study phases and checklist fidelity	Reasons for success or failure	Opinions, knowledge and behaviour	Health outcomes
			checklists fail to improve patient safety		
Perez-Guisado et al [2012][62]	NR	January–December 2010 Responsibility for sections of checklist was divided between nurses, anaesthetists and surgeons	Local 10-question checklist already in place, containing 8 items from WHO checklist	Nurses achieved 99% implementation, but surgeons and anaesthetists only completed checklists 79% and 72% of time, respectively	NR
van Klei et al [2012][33]	Information provided in regular meetings to OR staff. Posters placed in all ORs and electronic systems	1 January 2007–30 September 2010 Checklist implemented 1 April 2009 Monthly compliance reports provided to team managers. OR circulating nurses designated in charge of checklist completion	Checklist completion may be necessary for improved health outcomes Checklist may be less likely to be completed in patients undergoing emergency surgery who are at higher risk of mortality. This raises methodological questions of how to adjust for patient severity	Checklist fully completed in 39% of all patients. Median number of items documented was 16	After implementation, 30-day in-house mortality decreased from 3.13% to 2.85%. Checklist associated with decreased odds of 30-day mortality (AOR 0.85; 95% CI 0.73 to 0.98) Incomplete checklist did not have a significant effect on mortality
Takala et al [2011][63]	'Brief instructions on the use of the checklist were on the checklist backside. Written guidelines on how to use the checklist were also available. Instructions were given in order to avoid variation in the use of the checklist in different hospitals and operating theatres'	Study initiated in 2009 Nurses, anaesthetists and surgeons surveyed regarding OR practices Then, the checklist was implemented over 2–4 weeks Finally, survey of OR practices repeated 4–6 weeks after checklist implementation	NR	Nurses, anaesthetists and surgeons reported increased confirmation of patient identity and awareness of names/roles of team members Surgeons reported improvements in discussions of critical events with anaesthesiologist (34.7–46.2%, p<0.001) and gave prescriptions and instructions to post-anaesthesia care unit more often	Implementation led to discovery of systematic error in timing of prophylactic antibiotics administration
Truran et al [2011][64]	NR	Checklist introduced April 2009 Study evaluated compliance with NICE venous thromboembolism prophylaxis guidelines for 3-week period prior to checklist implementation, and 6 months afterwards	NR	Non-compliance with guidelines for venous thromboembolism prophylaxis decreased after checklist from 6.9% to 2.1%	NR
Vogts et al [2011][32]	NR	November–December 2010 Medical student observed 100 procedures, documented compliance	Authors suggest compliance with 'sign out' section is low because the timing is 'not linked to a specific event in patient management' and nurses tasked with performing this section have many competing responsibilities at the end of procedure	Compliance with 'sign in' and 'time out' sections of checklist was high. However, 'sign out' was only observed in 2/100 cases	NR
Askarian et al [2011][35]	Checklist presented to OR head Educational packages containing checklist and guidelines were distributed to surgeons, assistants,	Included all elective general surgeries 3 months prior to checklist, followed by 3 months after implementation (144 patients)	NR	Obtaining information for time out and sign out sections of checklist improved after checklist implemented	Surgical complications (before discharge) decreased from 22.9% to 10% after checklist implementation Surgical site infections decreased

Continued

Table 3 Continued

Author/year	Training	Study phases and checklist fidelity	Reasons for success or failure	Opinions, knowledge and behaviour	Health outcomes
	anaesthetists and nurses Checklist presented to OR teams				
Levy et al [2012][31]	All OR team members except physicians viewed a computer-based training presentation one time Large poster of checklist placed in every OR	Direct observation of randomly selected non-emergent surgeries over 7-week period	Inadequate education during implementation led to confusion regarding practical execution of checklist. (Unclear if physicians received any training) Checklist poster in OR lacked practical instructions for how checklist should be executed, including which team members questions are directed towards Checklist was not adapted for paediatric patients and may have been less relevant	Although electronic medical record reported 100% compliance, only 4/172 cases completed more than 7 out of 13 checkpoints Small post-study survey of OR staff revealed confusion about proper timing of 'time-out' and team member responsible for ensuring checklist execution	NR
Helmio et al [2012][15]	OR staff heard three informative lectures before participating in WHO pilot study Specific guidelines on use of checklist were available in the OR Brief instructions appeared on the back of the checklist	Checklist implemented in September 2010. All surgeries (7148) between September 2010 and August 2011 included Survey administered October 2011	Nurses reported 'some senior otolaryngologists had negative attitudes towards the checklist' 'Active leadership, regular audits and feedback are important for successful implementation and maintenance of a checklist'	Checklist completion rates were: sign in 62.3%, time out 61.1%, sign out 53.6% 76% of OR team agreed checklist improved OR safety, 68% agreed it improved error prevention, 93% would want checklist used during their own surgery Disregard for checklist use was revealed in the open responses: 'answers are dismissive', 'it is noisy and staff is not concentrating on the checks' … One senior otolaryngologist wrote, 'Time out has never been performed in my operations'. In addition, there was confusion about who should lead each check section and when to do checks: 'I have never received the information on how to use the checklist' Positive comments included 'the checklist is beneficial', 'it should always be used' and 'nowadays no operation should be varied out without the checklist'	NR

AOR, adjusted odds ratio; NICE, National Institute for Health and Clinical Excellence; NR, not reported; OR, operating room; PDSA, plan–do–study–act.

EDUCATION AND COMPLIANCE

Regarding checklist training, 10 sites mentioned educational sessions, seven used posters in the OR, two mentioned a hospital-wide publicity campaign, two mentioned that training was provided (however no details were given), and eight either failed to mention training or stated that only limited training was provided. Six studies mentioned a pilot testing period; these pilot tests lasted 1–3 months and often resulted in minor modifications to the checklist.

Nine studies reported the degree of compliance with the checklist; one simply reported 97% compliance, and two others reported improvement over time (from approximately 60% to 80% in one study, and from 85% to 95% in another study). Notably, while compliance with checklist use was high, the checklists were often left incomplete. Fourcade et al[27] reported checklist use in 90.2% of surgeries, but completion in only 61%. Similarly, Levy et al[31] found that although checklist compliance was 100% in the electronic medical record, only 4 of 172 checklists completed more than 7 out of 13 required checklist items. Kasatpibal et al[34] reported that staff had high compliance with checklist items which had already been standard hospital policy, but low compliance for checklist items not routinely practiced.

SURPASS checklist

Our searches identified no attempts to use the SURPASS checklist outside the Netherlands. The website (http://www.surpass-checklist.nl/home.jsf?lang=en) describes a web version of the checklist (called SURPASS Digital), which allows one to modify the checklist, although the designers of SURPASS strongly discourage it (http://www.surpass-checklist.nl/content.jsf?pageId=FAQ&lang=en).

Wrong-site surgery checklists

We identified four sites describing checklists based on the Joint Commission's UP (table 4). The Swiss study[37] focused on verifying patient identity and surgical site. Compared with the first 3 months of implementation, the next 3 months saw better compliance in checking patient identity and proportion of surgical site checks performed. Barriers to implementation included surgeons saying they already knew the patients or the surgical site was obvious, and the failure to include the input of all surgical services in developing the protocol.

The Swedish study[38] involved two hospitals, each of which had a recent wrong-site surgery incident, and a root-cause analysis suggested that a time-out procedure might help. A time-out checklist was implemented, and 1 year later, a questionnaire showed that 93% of team members believed the checklist contributed to patient safety.

The English study[39] was conducted at a children's hospital in which staff had incorporated an eight-item correct-site surgery checklist into an existing surgical checklist. Comparing 2008 with 2006, correct completion was improved for four of the eight checklist items.

The North Carolina study[37] implemented a checklist to prevent wrong-site surgery that was tailored to the hospital's preferences and procedures. Staff commented favourably that they no longer had to remember everything on a cumbersome form.

No implementation advice was found on the Joint Commission website or in other published documents. In August 2010, the Joint Commission conducted an online survey of over 2100 people.[40] The website reports high agreement that organisations can fully implement the UP, its three steps are appropriate, and that 'there is benefit' in using it in the OR, ambulatory surgery and hospital units performing invasive procedures (but the rates of agreement of benefit were lower for ambulatory clinics and physician offices). The need to modify policies and procedures varied greatly across respondents, and no differences were found between different types of respondents (eg, type of hospital, bed size).

COSTS

Costs of implementing a checklist mostly involve checklist development and/or modification, formal staff notification, training and additional OR time. In 2010, Semel et al[41] performed a hypothetical decision analysis of checklist introduction. The cost was estimated using the 'opportunity cost of the work that would have otherwise been performed by the three department checklist champions and the implementation coordinator', which was an estimated $12 635 in 2008 dollars; per-use cost was only $11. But the cost of a major surgical complication was estimated at $13 372. In the base case, checklist introduction saved money.

Regarding time, Sewell et al[24] reported that 20% of staff thought the WHO checklist caused an unnecessary time delay. However, in 2011, Taylor et al[16] reported that the WHO checklist took only about 2 min on average.

ADOPTION AND DIFFUSION

On 15 May 2013, the WHO's Surgical Safety Web Map (http://maps.cga.harvard.edu:8080/Hospital/) indicated that as of 26 March 2012, 4132 hospitals had expressed interest in using the checklist and 1790 of these hospitals have used the checklist in at least one operating theatre.

Many professional organisations have recommended adoption of the WHO checklist. These include the Institute for Healthcare Improvement (http://www.ihi.org), the National Patient Safety Agency in the UK (http://www.nrls.npsa.nhs.uk),[42 43] the Canadian Patient Safety Institute,[44 45] the Washington State Surgical Care and Outcome Assessment Program[46] (http://www.scoap.

Table 4 Studies of wrong-site-surgery checklists implementing the Universal Protocol

Author/year	Description of PSP	Study design	Theory or logic model	Description of organisation	Safety context	Implementation details
Garnerin et al [2008][37]	Verification protocol for checking patient identity and the site of surgery	Case series	'… the prevention of wrong patients and wrong site surgery, not to mention accountability, demanded an intervention aimed at improving the way both patient identity and site of surgery checks were performed, while acquiring the ability to identify and correct deficiencies'	Swiss anaesthesiology service located within a 1200-bed university hospital	Prior to introduction of the checklist, all patients were required to wear ID bracelets, and the operative site had to be signed by the surgeon. Anaesthesiologists were made aware that they were being monitored	Verification protocol developed by an interdisciplinary team. It required patients to state their identity, comparing the statement to the ID bracelet, OR schedule, and medical record. Similar types of checks for correct site of surgery. Nine consecutive months of data were obtained (October 2003–June 2004), and later 3 subsequent months (October 2004, March 2005 and October 2005) Compared with the first 3 months of implementation, the next 3 months saw better compliance in checking patient identify (63% up to 81%), complete compliance with identity checks (10% up to 38%), proportion of surgical site checks performed (77% up to 93%), and complete compliance with surgical site checks (32% up to 52%). Compliance was stable in subsequent periods Authors attributed the improvements to increased use of wristbands upon admission into the and the use of three different sources for verification Barriers included surgeons saying they already knew that patients or the surgical site was obvious, and the failure to develop the protocol with the input of all surgical services
Nilsson et al [2010][38]	Preoperative 'time-out' checklist	Questionnaire after implementation	None explicitly stated	Two Swedish hospitals, bed sizes not reported	In the autumn of 2007, there were two incidents of wrong-side surgery at these hospitals, and a root-causes analysis suggested that a time-out procedure might help. The checklist was pre-approved by the heads of the operating and anaesthesia departments	Implementation began in December 2007. The checklist was a shared responsibility of the OR team. One year later, a questionnaire was sent to all 704 surgeons, anaesthesiologists, operation nurses, anaesthetic nurses, and nurse assistants, soliciting their opinions about the new time-out checklist. Of the 331 responders, 93% felt that the checklist contributed to increased patient safety (either 'without a doubt' or 'probably'). When asked about eight specific components of the time-out checklists, the percentage of respondents who felt the component was 'very important' varied widely, from a low of

Table 4 Continued

Author/year	Description of PSP	Study design	Theory or logic model	Description of organisation	Safety context	Implementation details
						14% for the introduction of team members to highs of over 80% for patient identity, correct procedure, and correct side. Regarding the sign-out, 91% felt that the item involving the count of surgical instruments and sponges was very important
Owers et al [2010][39]	Correct site surgery checklist incorporated into an existing surgical checklist	Case series	None explicitly stated	English children's hospital, bed size not reported	A surgical checklist already existed at this facility; they added a correct site surgery component	Five people were required to sign the documentation: marking surgeon, operating surgeon, ward nurse, scrub nurse and anaesthetist. Two audit cycles: once in 2006 (sooner after implementation) and once in 2008 (2 years later). Comparing 2008 with 2006, correct completion of the eight items was not at all improved for four items (ward nurse signed, operating surgeon signed, scrub nurse signed, and operating department practitioner signed) but was improved for the other four (mark site documented, no mark required documented, entries legible, and marking surgeon signed).'The lack of documentation, of course, may not reflect that the new guidance and processes are not being followed, but rather that the documentation is regarded as a low priority part of the process'
Anonymous 2007[65]	Checklist to implement the Universal Protocol, tailored to this hospital's preferences and procedures	Case series	Stated that the checklist provides cues for staff when preparing for a procedure	Hospital in North Carolina, bed size not reported	Before this checklist, they were using a 'cumbersome form' to document their compliance with the Universal Protocol	Original checklist in 2005, minor revisions for 2006. Demonstrated the checklist during educational staff meetings, and new staff were given a primer. Staff gave positive comments that they no longer had to remember everything. The completed checklist is kept as part of the medical record

OR, operating room.

org), the South Carolina Hospital Association,[44] the Spanish Ministry of Health and Spanish Association of Surgeons,[47] and the countries of France,[44] Ireland,[48] Jordan[48] and the Netherlands.[33] Furthermore, several organisations in Australia and New Zealand have developed modified versions of the WHO checklist: the Royal Australasian College of Surgeons, the Australian and New Zealand College of Anaesthetists, the Royal Australian and New Zealand College of Obstetricians and Gynecologists, the Australian College of Operating Room Nurses, and the Australian Commission for Safety and Quality in Health Care.[49]

Sivathasan and colleagues[50] conducted telephone interviews with 238 hospitals in the UK. Almost all (99%) of the hospitals had heard of the checklist, and its use was already compulsory in 65% of them. In hospitals where it was not required, 81% used it voluntarily and 75% planned to make it mandatory in the future. Notably, some ORs reported partial use of the checklist, that is, intentionally skipping items or skipping the entire checklist because of time constraints.

In June 2009, the journal *OR Manager* received online data from 136 subscribers regarding use of the WHO checklist.[51] Nearly half (48.5%) reported implementing the checklist and 64% said the checklist had improved safety in the OR. However, 11% of respondents stated that the checklist was not well accepted by surgeons and another 63% said surgeons did accept it but 'with reservations.' Nurses were found to have a somewhat greater degree of acceptance.

A 2009 UK survey of 12 oral and maxillofacial consultants found that all were aware of the WHO checklist, but only 5 of 12 were actually using it.[52] Ten of 12 expressed the belief that it would improve patient safety, but 4 of 12 said it would not improve team communication.

Regarding the UP, accredited hospitals are required to comply. Therefore the 'diffusion' of the UP is large, by mandate. However, as stated earlier, the UP is not a checklist. We found no published information on how many hospitals actually use a checklist in their efforts to comply.

DISCUSSION

Several prominent authorities in the field of patient safety have promoted checklists in an attempt to prevent mistakes related to surgery. Our report demonstrates that checklists have been widely adopted, not only in Western countries, but in diverse contexts throughout the world. Notably, we found evidence that checklists are associated with improved health outcomes, including decreased surgical complications and surgical site infections. Association, however, does not imply causation. Thus, we note three important caveats. First, checklists are often implemented as part of a multifaceted strategy to improve care, which may render it difficult to determine whether improvements should be attributed to checklists alone or to other changes such as improved communication and shifts in OR culture. Second, reporting bias may have played a role. Eleven out of 21 implementation studies did not report health outcomes, potentially due to an absence of clear improvements after checklist implementation. Third, the reported results do not mean that all surgical checklists are beneficial; other surgical checklists containing different items may or may not be beneficial.

Many surgical staff have reported favourable attitudes towards checklist implementation. However, numerous implementation issues remain, including how to modify a given checklist to a specific hospital setting or specific surgical staff. Our report found that barriers to effective implementation include confusion regarding practical aspects of checklist use, dealing with challenges to efficient workflow, obtaining regular access to resources and the beliefs and attitudes of participating staff, particularly surgeons. One recurrent theme in the literature on surgical checklists is the explicit encouragement of a *team-based approach*. The AHRQ continues to investigate factors supportive of effective checklist implementation with the 2010–2013 project entitled, 'Factors associated with effective implementation of a surgical safety checklist'.[53] This project will elucidate how teamwork may contribute to the impact of the checklist.

The WHO checklist's wide adoption and dissemination suggests it may serve as a model for policymakers seeking to develop safety strategies in the future. This checklist was explicitly designed to be modified for widely varying contexts and executed in a short time frame to maintain feasibility. The WHO website instructs hospitals: 'Do not hesitate to customise the checklist for your setting as necessary, but do not remove safety steps just because you are unable to accomplish them' and emphasises that 'It should take no more than a minute to complete each section of the checklist' (ie, 3 min in total).[54] The pilot study reported that, at various sites, introduction of the checklist took only 1 week to 1 month.[5] Checklist implementation is relatively inexpensive, with some hospitals simply printing posters to be hung on OR walls. These practical characteristics of the WHO checklist may have significantly promoted its uptake and use. Notably, the WHO approach markedly differs from that stated by creators of the SURPASS checklist, who strongly discouraged its adaption. Although SURPASS is more comprehensive, it has not been widely implemented, potentially due to the resource intensive effort required to track patients throughout a surgical hospitalisation.

In conclusion, the WHO checklist, the SURPASS checklist and checklists implementing the Joint Commission UP represent promising initiatives with suggestive evidence for improving patient safety. Future research may clarify the unique nature of their contribution and provide insights for effective implementation.

Key summary points

▶ Surgical checklists such as the WHO Surgical Safety Checklist and Surgical Patient Safety System (SURPASS) checklist offer a promising intervention for decreasing patient morbidity and mortality due to surgical operations.

▶ The WHO Surgical Safety Checklist has been successfully adapted for implementation in a wide variety of settings, including all surgical specialties, academic and community hospitals, and industrialised and developing countries.

▶ Surgical safety checklists were associated with increased detection of potential safety hazards, decreased surgical complications and improved communication among operating room staff. Other factors independent of checklists, such as concurrent safety improvements, may also explain these improvements.

▶ Key components of successful checklist implementation include enlisting support from institutional leaders, training staff on using the checklist, adapting the checklist to incorporate staff feedback and avoiding the duplication of information already routinely collected.

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