Surgical checklists: a systematic review of impacts and implementation

Jonathan R Treadwell, Scott Lucas, Amy Y Tsou

Open Access

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 al3 found that surgical team training which incorporated surgical checklists along with communication strategies was associated with a significant reduction in surgical mortality. Arriaga et al4 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 lan-
guages.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 intro-
ductions, 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 check-
lists. The WHO Surgical Safety Checklist and the
Joint Commission Universal Protocol (UP) for
Preventing Wrong Site, Wrong Procedure, Wrong
Person Surgery6 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 key-
words related to checklists (‘anaesthesia checklist’,
briefing, checklist, checkout, communication, docu-
mentation, 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 rec-
ognise other surgical checklists exist; however, many
of these have only been implemented at a single insti-
tution. 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.

Table 1 Overview of the three checklists

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

SURPASS, Surgical Patient Safety System.

BENEFITS AND HARMs
Benefits
WHO checklist
The 2008 WHO Surgical Safety Checklist was tested
at eight sites around the world.3 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 pol-
cies prior to implementation of the WHO Checklist
also differed regarding the use of routine intraopera-
tive monitoring with pulse oximetry (six of eight
sites), oral confirmation of patients’ identity and surgi-
cal 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 preopera-
tively 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, involv-
ing 3955 procedures, data showed decreases in patient
mortality (from 1.5%–0.8%) and inpatient complica-
tions (from 11%–7%). No single site was driving
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 surgery13 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 colleagues15 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 checklist7–10 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 al7 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 claims10 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.20 21 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 just before incision and involve the entire OR team. The UP is not a checklist21 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 al24 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. 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. In one study, 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. 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. found that 77% of users thought the checklist improved team communication; this percentage was 70% in the study by Kearns et al. The implementation study by Conley et al. emphasised that the local champion should ‘persuasively explain why and adaptively show how to use the checklist’. Styer et al. and Bohmer et al. 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. For instance, Levy et al. 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. found that nurses were unfamiliar with the checklist because of high staffing turnover. Vogts et al. 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, especially during emergency procedures, and duplication of safety checks already routinely performed. In the study by Kearns et al., 30% felt that in emergency cases, the checklist was inconvenient. Third, developing countries often lacked regular access to resources. Yuan et al. reported that inconsistent access to antibiotics and batteries hampered checklist use in two Liberian hospitals. Likewise, Kasatpibal et al. 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. found that surgical complications decreased from 22.9% to 10%. Yuan et al. 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 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

<table>
<thead>
<tr>
<th>Author [year]</th>
<th>Description of Patient Safety Practice (PSP)</th>
<th>Study design</th>
<th>Theory or logic model</th>
<th>Description of organisation</th>
<th>Safety context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewell et al [2011]</td>
<td>2008 WHO surgical checklist, unmodified</td>
<td>Before and after study, comparing pre-training period to post-training</td>
<td>‘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’</td>
<td>A UK hospital, orthopaedic operations. 28% of operations were urgent, and 77% involved general anaesthesia</td>
<td>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</td>
</tr>
<tr>
<td>Helmio et al [2011]</td>
<td>2008 WHO surgical checklist. No specialty-related changes, but some ‘minor changes.’ Checklist included in publication; modifications did not exclude any items</td>
<td>Before and after study</td>
<td>‘The idea of the checklist is to be an add-on security tool for the defined safety standard’</td>
<td>Finland, ototorhinolaryngology head and neck surgery ORs. 747 operations in the 2-month study periods combined. All subgroups of ototorhinolaryngology head and neck surgery were included</td>
<td>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%</td>
</tr>
<tr>
<td>Conley et al [2011]</td>
<td>2008 WHO surgical checklist, unmodified</td>
<td>Case series</td>
<td>None explicitly stated</td>
<td>Five Washington State hospitals. Two hospitals had &lt;10 ORs, one had 10–20 and two had &gt;20. Two urban, two suburban and one rural</td>
<td>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’</td>
</tr>
<tr>
<td>Bell and Pontin [2010]</td>
<td>2008 WHO checklist adapted different for different surgical specialties. Checklist not included in publication</td>
<td>Case series</td>
<td>‘Without a doubt, the checklist works best when all staff members are engaged’</td>
<td>Large two-hospital trust in the UK with 10 000 staff and 850 000 patients annually</td>
<td>Nothing about pre-existing safety culture. To prepare for the checklist, they set up a Patient Safety Working Group</td>
</tr>
<tr>
<td>Sparkes and Rylah [2010]</td>
<td>2008 WHO checklist locally adapted. Checklist included in publication; modifications did not exclude any items</td>
<td>Case series</td>
<td>Discussed various ways a checklist could enhance safety, including teamwork and effective communication</td>
<td>Teaching hospital in the UK with 29 ORs in five locations performing specialised complex surgery</td>
<td>NR</td>
</tr>
<tr>
<td>Royal Bolton [2010]</td>
<td>2008 WHO checklist, unmodifed. Local adaptation of it was considered but ultimately not done</td>
<td>Case series</td>
<td>Improve patient safety by enhancing teamwork and communication</td>
<td>Trust in the UK with eight ORs</td>
<td>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’</td>
</tr>
</tbody>
</table>

Continued
<table>
<thead>
<tr>
<th>Author [year]</th>
<th>Description of Patient Safety Practice (PSP) Study design</th>
<th>Theory or logic model</th>
<th>Description of organisation</th>
<th>Safety context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vats et al [2010]</td>
<td>2008 WHO surgical checklist adapted for England and Wales. Checklist included in publication; modifications did not exclude any items</td>
<td>Case series</td>
<td>‘the checklist ensures that critical tasks are carried out and that the team is adequately prepared for the operation’</td>
<td>UK academic hospital</td>
</tr>
<tr>
<td>Kearns et al [2011]</td>
<td>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</td>
<td>Before and after study</td>
<td>‘Checklists may be used to improve patient safety by ensuring that all elements of a practice are instituted for each new clinical event’</td>
<td>UK study in obstetrics ORs. Tertiary referral obstetric centre with ∼6400 deliveries per year</td>
</tr>
<tr>
<td>Norton and Rangel [2010]</td>
<td>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</td>
<td>Case series</td>
<td>Checklist can help to reduce breakdowns in communication, ineffective teamwork and lack of compliance with process measures</td>
<td>Children’s hospital in the USA performing numerous types of paediatric surgery</td>
</tr>
<tr>
<td>Styer et al [2011]</td>
<td>2008 WHO checklist modified and implemented as hospital policy. Selected modifications listed. Checklist not included in publication</td>
<td>Qualitative description</td>
<td>Implementing checklist using a PDSA cycle stepwise approach leads to smoother transition and sustained outcomes</td>
<td>Teaching hospital in the USA with 44 ORs</td>
</tr>
<tr>
<td>Bittle [2011]</td>
<td>2008 WHO checklist adapted for individual hospital. Checklist not included in publication</td>
<td>Qualitative description</td>
<td>Checklists ‘ensure there is adherence to proven standards or care’</td>
<td>Large city hospital in New Zealand</td>
</tr>
<tr>
<td>Yuan [2012]</td>
<td>2008 WHO checklist modified for local practice. Checklist included in publication</td>
<td>Before and after study</td>
<td>Checklists are an inexpensive and feasible way to potentially improve quality of surgical care in ‘resource-limited settings’</td>
<td>Two hospitals (each with 2 ORs) in Monrovia, Liberia. Hospital 1 (150-bed primary community hospital), hospital 2 (200-bed, government referral hospital)</td>
</tr>
<tr>
<td>Kasatpibal et al [2012]</td>
<td>2008 WHO checklist modified and translated. Hair removal added to checklist. Other modifications not described. Checklist not included in publication</td>
<td>Case series</td>
<td>Checklists may reduce preventable adverse surgical events, but may be difficult or inappropriate to implement in a developing country</td>
<td>University hospital in northern Thailand (1400 beds, 21 877 operations annually)</td>
</tr>
<tr>
<td>Bohmer et al [2012]</td>
<td>2008 WHO checklist modified. Checklist included in publication</td>
<td>Before and after</td>
<td>Checklists may improve staff’s perception of patient safety and job satisfaction</td>
<td>Institute for research in Operative Medicine of the University of Witten/Herdecke</td>
</tr>
<tr>
<td>Author [year]</td>
<td>Description of Patient Safety Practice (PSP)</td>
<td>Study design</td>
<td>Theory or logic model</td>
<td>Description of organisation</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------------------</td>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fourcade et al [2012]</td>
<td>2008 WHO checklist modified. Checklist included in publication</td>
<td>Case series</td>
<td>Checklists may improve surgical outcomes, but face barriers to efficient implementation</td>
<td>18 cancer centres in France</td>
</tr>
<tr>
<td>Perez-Guisado et al [2012]</td>
<td>2008 WHO checklist. Checklist included in publication</td>
<td>Descriptive cross-sectional study of plastics, reconstructive surgical procedures</td>
<td>Checklist ‘involves new philosophy of organisation that is easier to achieve in health workers with lower hierarchy’ (ie, nurses, surgeon residents)</td>
<td>Reina Sofia Hospital (1684 surgeries)</td>
</tr>
<tr>
<td>van Klei et al [2012]</td>
<td>2008 WHO checklist modified. Checklist available in online supplementary material</td>
<td>Before and after</td>
<td>Checklists enhance teamwork and improve handovers decreased avoidable errors and complications</td>
<td>University Medical centre Utrecht (The Netherlands)</td>
</tr>
<tr>
<td>Takala et al [2011]</td>
<td>2008 WHO checklist, modified. Checklist available in appendix</td>
<td>Before and after</td>
<td>‘Checklist would improve awareness of safety-related issues and the fluency of operations as well as communication during surgery’</td>
<td>Four university teaching hospitals in Finland</td>
</tr>
<tr>
<td>Truran et al [2011]</td>
<td>2008 WHO checklist, modified. Checklist not included</td>
<td>Before and after</td>
<td>The checklist may improve compliance with venous thromboembolism prophylaxis guidelines</td>
<td>Hospitals in the UK</td>
</tr>
<tr>
<td>Vogts et al [2011]</td>
<td>2008 WHO checklist, modified. Checklist included in appendix</td>
<td>Case series</td>
<td>Checklists ‘promote communication and teamwork within the OR’</td>
<td>Auckland City Hospital, New Zealand</td>
</tr>
<tr>
<td>Askarian et al [2011]</td>
<td>2008 WHO checklist. No modifications noted, checklist not included in publication</td>
<td>Before and after</td>
<td>Checklist may improve patient safety by reducing surgical complications</td>
<td>Referral educational hospital in Shiraz, southern Iran (374 beds, 6 ORs)</td>
</tr>
<tr>
<td>Levy et al [2012]</td>
<td>2008 WHO checklist modified. Modified checklist not included in publication</td>
<td>Case series</td>
<td>Low fidelity of checklist execution may be a barrier to improving health outcomes</td>
<td>Academic tertiary care children’s hospital (Texas, USA)</td>
</tr>
<tr>
<td>Helmetro et al [2012]</td>
<td>WHO checklist (unclear if modified). Checklist not included in publication</td>
<td>Case series</td>
<td>‘This checklist has reduced complications and deaths significantly’</td>
<td>Otorhinolaryngology department in four Finnish hospitals</td>
</tr>
</tbody>
</table>

GI, gastrointestinal; GYN, gynaecology; NR, not reported; OR, operating room; PDSA, plan–do–study–act.
<table>
<thead>
<tr>
<th>Author/year</th>
<th>Training</th>
<th>Study phases and checklist fidelity</th>
<th>Reasons for success or failure</th>
<th>Opinions, knowledge and behaviour</th>
<th>Health outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewell et al</td>
<td>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</td>
<td>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</td>
<td>'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.'</td>
<td>77% thought it improved team communication, 68% thought it improved patient safety, 80% would want the checklist used if they were having an operation</td>
<td>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</td>
</tr>
<tr>
<td>Helmio et al</td>
<td>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</td>
<td>One-month implementation period in September 2009 (443 operations)</td>
<td>'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'</td>
<td>… 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%</td>
<td>NR</td>
</tr>
<tr>
<td>Conley et al</td>
<td>NR</td>
<td>Duration of rollout: &lt;2 months at three hospitals, &gt;6 months at two hospitals</td>
<td>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</td>
<td>Interviews conducted, but no quantitative summary of opinions provided. Three hospitals were discussed in detail</td>
<td>NR</td>
</tr>
<tr>
<td>Author/year</td>
<td>Training</td>
<td>Study phases and checklist fidelity</td>
<td>Reasons for success or failure</td>
<td>Opinions, knowledge and behaviour</td>
<td>Health outcomes</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>-------------------------------------</td>
<td>-------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Bell and Pontin [2010]&lt;sup&gt;54&lt;/sup&gt;, Bell&lt;sup&gt;57&lt;/sup&gt;</td>
<td>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</td>
<td>Piloted the checklist at one of the two hospitals first</td>
<td>‘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’</td>
<td>‘Communication and staff morale have definitely improved since the checklist was implemented’</td>
<td>NR</td>
</tr>
<tr>
<td>Sparkes and Rylah [2010]&lt;sup&gt;58&lt;/sup&gt;</td>
<td>”Extensive educational support and training”</td>
<td>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</td>
<td>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’</td>
<td>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%</td>
<td>NR</td>
</tr>
<tr>
<td>Royal Bolton [2010]&lt;sup&gt;56&lt;/sup&gt;</td>
<td>Drop-in educational sessions which involve 120 participants</td>
<td>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</td>
<td>‘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’</td>
<td>‘The feedback we received from staff was very positive. Most people were keen to introduce the checklist as quickly as possible’</td>
<td>1-month pilot identified nine potential incidents that were avoided as a result of the checklist</td>
</tr>
<tr>
<td>Vats et al [2010]&lt;sup&gt;26&lt;/sup&gt;</td>
<td>Limited time given to training</td>
<td>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</td>
<td>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</td>
<td>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</td>
<td>‘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</td>
</tr>
<tr>
<td>Author/year</td>
<td>Training</td>
<td>Study phases and checklist fidelity</td>
<td>Reasons for success or failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>-----------------------------------</td>
<td>-------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kearns et al [2011]</td>
<td>Training, humorous posters provided, and all staff empowered to remind the team to perform the checklist if it was forgotten.</td>
<td>Compliance with the preoperative part of the checklist was 61% after 3 months and 80% after 1 year.</td>
<td>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. Fiftynine operations were prompted by the checklist, with an average of 42% 4 to 6 months after its introduction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norton and Rangel [2010]</td>
<td>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.</td>
<td>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.</td>
<td>Use of the Pediatric Surgical Safety Checklist encourages multidisciplinary teamwork and has brought increased communication to our ORs and in other areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Styer et al [2011]</td>
<td>Slide presentations, educational posters in ORs, one on one sessions, frequent email updates.</td>
<td>December 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 hospital policy. PDSA cycle of Early endorsement by executive leadership. Each discipline equally involved in leading effort. Real-time feedback. Each discipline should lead a section of checklist. Formula for gradual implementation. Provide data (process and outcome measures). Checklist adopted as hospital policy. Data (process and outcome measures).</td>
<td>During sign in (site not marked), a DVT was caught one near miss (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 realized a patient needed straight catheterization, and reviewing procedure name helped nurse documentation, one specimen was incorrectly labeled).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author/year</td>
<td>Training</td>
<td>Study phases and checklist fidelity</td>
<td>Reasons for success or failure</td>
<td>Opinions, knowledge and behaviour</td>
<td>Health outcomes</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>------------------------------------</td>
<td>------------------------------</td>
<td>---------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Bittle [2011]60</td>
<td>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</td>
<td>NR</td>
<td>Initially 'staff were anxious and somewhat apprehensive, but it is now an established step in an operation and is carried out with confidence'</td>
<td>Incorrect surgery site pointed out by patient. Reported incidents fell from 12 to 11 compared with reporting period of previous year</td>
<td></td>
</tr>
<tr>
<td>Yuan et al [2012]14</td>
<td>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</td>
<td>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'</td>
<td>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</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kasatpibal et al [2012]14</td>
<td>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</td>
<td>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'</td>
<td>Compliance with checklist high for</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Author/year</td>
<td>Training</td>
<td>Study phases and checklist fidelity</td>
<td>Reasons for success or failure</td>
<td>Opinions, knowledge and behaviour</td>
<td>Health outcomes</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>-----------------------------------</td>
<td>-------------------------------</td>
<td>----------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Bohmer et al [2012]</td>
<td>NR</td>
<td>Survey administered before checklist implementation, then 12 weeks after implementation</td>
<td>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.</td>
<td>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. 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.</td>
<td>NR</td>
</tr>
<tr>
<td>Fourcade et al [2012]</td>
<td>NR</td>
<td>Training sessions, written materials and videos available from the French National Authority for Health, but use by participating centres was not reported</td>
<td>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</td>
<td>Checklist performed in 90.2% of surgeries. However, checklist was completed in only 61% of cases.</td>
<td>NR</td>
</tr>
</tbody>
</table>
Table 3  Continued

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Training</th>
<th>Study phases and checklist fidelity</th>
<th>Reasons for success or failure</th>
<th>Opinions, knowledge and behaviour</th>
<th>Health outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perez-Guisado et al [2012]²²</td>
<td>NR</td>
<td>January–December 2010 Responsibility for sections of checklist was divided between nurses, anaesthetists and surgeons</td>
<td>checklists fail to improve patient safety</td>
<td>Nurses achieved 99% implementation, but surgeons and anaesthetists only completed checklists 79% and 72% of time, respectively</td>
<td>NR</td>
</tr>
<tr>
<td>van Klei et al [2012]³³</td>
<td>Information provided in regular meetings to OR staff. Posters placed in all ORs and electronic systems</td>
<td>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</td>
<td>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</td>
<td>Checklist fully completed in 39% of all patients. Median number of items documented was 16</td>
<td>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</td>
</tr>
<tr>
<td>Takala et al [2011]³³</td>
<td>‘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</td>
<td>NR</td>
<td>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&lt;0.001) and gave prescriptions and instructions to post-anaesthesia care unit more often</td>
<td>Implementation led to discovery of systematic error in timing of prophylactic antibiotics administration</td>
<td></td>
</tr>
<tr>
<td>Truran et al [2011]³⁴</td>
<td>NR</td>
<td>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</td>
<td>NR</td>
<td>Non-compliance with guidelines for venous thromboembolism prophylaxis decreased after checklist from 6.9% to 2.1%</td>
<td>NR</td>
</tr>
<tr>
<td>Vogts et al [2011]³²</td>
<td>NR</td>
<td>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</td>
<td>Compliance with ‘sign in’ and ‘time out’ sections of checklist was high. However, ‘sign out’ was only observed in 2/100 cases</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Askarian et al [2011]³¹</td>
<td>Checklist presented to OR head Educational packages containing checklist and guidelines were distributed to surgeons, assistants,</td>
<td>Included all elective general surgeries 3 months prior to checklist, followed by 3 months after implementation (144 patients)</td>
<td>Obtaining information for time out and sign out sections of checklist improved after checklist implemented</td>
<td>Surgical complications (before discharge) decreased from 22.9% to 10% after checklist implementation Surgical site infections decreased</td>
<td>NR</td>
</tr>
<tr>
<td>Author/year</td>
<td>Training</td>
<td>Study phases and checklist fidelity</td>
<td>Reasons for success or failure</td>
<td>Opinions, knowledge and behaviour</td>
<td>Health outcomes</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>-------------------------------------</td>
<td>--------------------------------</td>
<td>----------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Levy et al [2012]¹¹</td>
<td>Anaesthetists and nurses, checklist presented to OR teams</td>
<td>All OR team members except physicians viewed a computer-based training presentation one time, large poster of checklist placed in every OR</td>
<td>Direct observation of randomly selected non-emergent surgeries over 7-week period</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Helmio et al [2012]¹⁵</td>
<td>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</td>
<td>Checklist implemented in September 2010. All surgeries (7148) between September 2010 and August 2011 included Survey administered October 2011</td>
<td>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'</td>
<td>Checkpoint 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'</td>
<td>Checkpoint 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'</td>
</tr>
</tbody>
</table>

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 reported checklist use in 90.2% of surgeries, but completion in only 61%. Similarly, Levy et al 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. Kasapibal et al 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&clang=en).

Wrong-site surgery checklists

We identified four sites describing checklists based on the Joint Commission’s UP (table 4). The Swiss study 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 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 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 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. 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 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 reported that 20% of staff thought the WHO checklist caused an unnecessary time delay. However, in 2011, Taylor et al 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), the Canadian Patient Safety Institute, the Washington State Surgical Care and Outcome Assessment Program (http://www.scoap.
<table>
<thead>
<tr>
<th>Author/year</th>
<th>Description of PSP</th>
<th>Study design</th>
<th>Theory or logic model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garnerin et al [2008]</td>
<td>Verification protocol for checking patient identity and the site of surgery</td>
<td>Case series</td>
<td>&quot;...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.&quot;</td>
</tr>
</tbody>
</table>

**Description of organisation**

- Swiss anaesthesiology service located within a 1200-bed university hospital

**Safety context**

- 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.

**Implementation details**

- 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 to 38%, proportion of surgical site checks to complete compliance (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 OR, and the use of three different sources for verification.**

- None explicitly stated

<table>
<thead>
<tr>
<th>Nilsson et al [2010]</th>
<th>Preoperative 'time-out' checklist</th>
<th>Questionnaire</th>
<th>None explicitly stated</th>
</tr>
</thead>
</table>

**Description of organisation**

- Two Swedish hospitals, bed sizes not reported

**Safety context**

- 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 details**

- 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, operating 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 checklist, the percentage of respondents who felt the component was very important varied widely, from a low of 25% for complete identification of surgical site to a high of 93% for completion of the checklist.

**Authors attributed the improvements to increased use of wristbands upon admission into the OR and the use of three different sources for verification.**

- None explicitly stated
Table 4  Continued

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Description of PSP</th>
<th>Study design</th>
<th>Theory or logic model</th>
<th>Description of organisation</th>
<th>Safety context</th>
<th>Implementation details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owers et al [2010]&lt;sup&gt;35&lt;/sup&gt;</td>
<td>Correct site surgery checklist incorporated into an existing surgical checklist</td>
<td>Case series</td>
<td>None explicitly stated</td>
<td>English children’s hospital, bed size not reported</td>
<td>A surgical checklist already existed at this facility; they added a correct site surgery component</td>
<td>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. 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’</td>
</tr>
<tr>
<td>Anonymous 2007&lt;sup&gt;35&lt;/sup&gt;</td>
<td>Checklist to implement the Universal Protocol, tailored to this hospital’s preferences and procedures</td>
<td>Case series</td>
<td>Stated that the checklist provides cues for staff when preparing for a procedure</td>
<td>Hospital in North Carolina, bed size not reported</td>
<td>Before this checklist, they were using a ‘cumbersome form’ to document their compliance with the Universal Protocol</td>
<td>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</td>
</tr>
</tbody>
</table>

OR, operating room.
Surgeons, the South Carolina Hospital Association, the Spanish Ministry of Health and Spanish Association of Surgeons, and the countries of France, Ireland, Jordan and the Netherlands. 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.

Sivathasan and colleagues 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. 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. 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.’ 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). The pilot study reported that, at various sites, introduction of the checklist took only 1 week to 1 month. 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.

Acknowledgements The authors wish to thank Allison Gross, MS, MLS for performing literature searches, and Karen Schoelles, MD, SM and Paul Shekelle, MD, MPH, PhD for project oversight.

Contributors JRT contributed to planning the review, reviewing abstracts, extracting data, writing text and editing text. SL contributed to planning the review, reviewing abstracts, extracting data, writing text and editing text. AT contributed to extracting data, writing text and editing text.

Disclaimer All statements expressed in this work are those of the authors and should not in any way be construed as official opinions or positions of the ECRI Institute, AHRQ, or the US Department of Health and Human Services.

Funding This work was supported by funding from the Agency for Healthcare Research and Quality (AHRQ), US Department of Health and Human Services (Contract No HHSA-290-2007-100622). AHRQ reviewed contract deliverables to ensure adherence to contract requirements and quality, and a copyright release was obtained from AHRQ prior to submission of this manuscript.

Competing interests The authors declare no competing financial interests exist.

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 3.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/3.0/

REFERENCES

16 Taylor B, Slater A, Reznick R. The surgical safety checklist effects are sustained, and team culture is strengthened. Surgeon 2010;8:1–4.
51 Patterson P. In survey, about half of ORs are using the WHO checklist. OR Manager 2009;25:1, 6–8.