Effectiveness of the Surgical Safety Checklist in Correcting Errors: A Literature Review Applying Reason's Swiss Cheese Model

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ABSTRACT

Approximately 2,700 patients are harmed by wrong-site surgery each year. The World Health Organization created the surgical safety checklist to reduce the incidence of wrong-site surgery. A project team conducted a narrative review of the literature to determine the effectiveness of the surgical safety checklist in correcting and preventing errors in the OR. Team members used Swiss cheese model of error by Reason to analyze the findings. Analysis of results indicated the effectiveness of the surgical checklist in reducing the incidence of wrong-site surgeries and other medical errors; however, checklists alone will not prevent all errors. Successful implementation requires perioperative stakeholders to understand the nature of errors, recognize the complex dynamic between systems and individuals, and create a just culture that encourages a shared vision of patient safety. *AORN J* 100 (July 2014) 65-79. © AORN, Inc, 2014. http://dx.doi.org/10.1016/j.aorn.2013.07.024

Key words: *checklists, surgical safety checklist, patient safety, OR safety, medical errors, preventable adverse events, error prevention, teamwork, just culture, Swiss cheese model.*

Although more than a decade has passed since the 1999 release of the Institute of Medicine report *To Err Is Human: Building a Safer Health System*,[1] there remains ample need for the use of standardized processes to reduce the risk of human error, thereby improving patient care. The OR is characterized by fast-paced activity, numerous distractions, a hierarchical reporting structure, advanced technology, and complex equipment, all of which can affect health care professionals, making them prone to making errors.[2] Medical errors place patients at great risk of harm.[3] Examples of errors and adverse events related to surgical procedures are wrong anatomic site, incorrect procedure, equipment failure or malfunction, administration of an antibiotic despite a noted allergy, nerve damage related to positioning, implantation of orthopedic appliances that are not appropriately sterilized, postoperative development of deep vein thrombus related to incorrect placement of sequential compression devices, and retained sponges.[4]

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In recent years, there has been a strong focus on eliminating wrong-site surgeries. Of 7,147 sentinel events reported from 1995 to 2010, The Joint Commission[5] identified 956 cases of wrong-site surgeries (13.4%), with communication breakdowns reported as the main cause of such errors. In 2008, in an attempt to reduce the risk and occurrence of wrong-site surgery, the Centers for Medicare & Medicaid Services[6] announced that it would no longer reimburse institutions for surgical errors related to wrong-site surgery or retained surgical objects. This change in reimbursement policy was driven by data indicating that 48% of all surgical complications are preventable.[7,8]

Surgical safety also is an international focus. According to the World Health Organization (WHO),[9] each year approximately 234 million major surgical procedures are performed worldwide, which is one operation for every 25 people alive. In the United States, there are more than 48 million inpatient surgical procedures[10] and more than 53 million ambulatory procedures performed annually.[11] In industrialized countries, for example, the United States, analysis of data has shown the rate of major complications associated with inpatient surgery to range from 3% to 17% and the rate of deaths to range from 0.4% to 0.8%.[7,8]

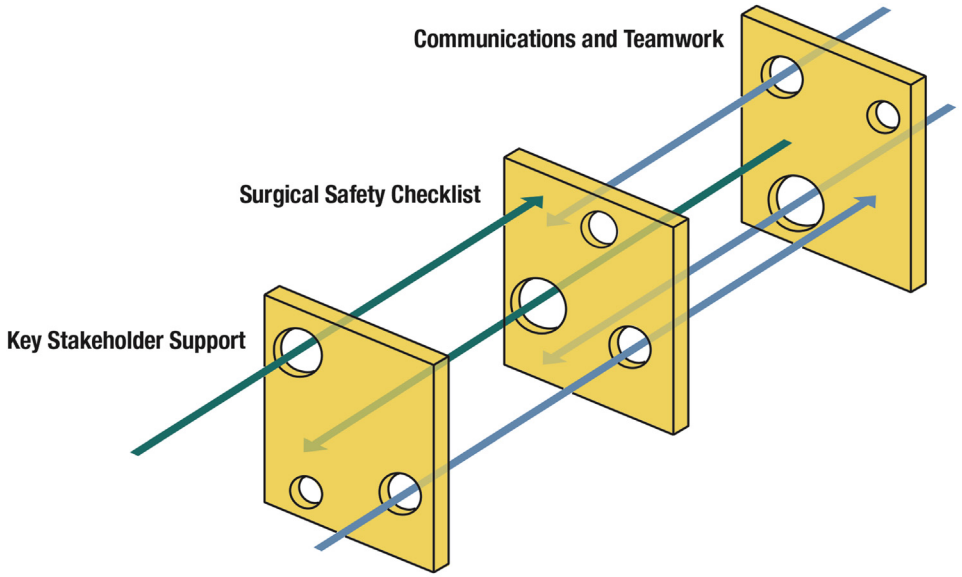
Analysis of errors by Reason[12] revealed that most accidents are rarely the result of isolated errors committed by individuals but instead are the result of multiple, smaller errors occurring in an environment with fundamental system flaws.[13] The Swiss cheese model by Reason[12] illustrates this type of occurrence but also that a system with multiple checks can prevent errors. According to the Swiss cheese metaphor, the slices of cheese are layered and each layer is a defense (eg, the surgical safety checklist) against the holes in the cheese, which represent a problem or error in the system (eg, active and latent failures). The more layers of cheese, the less likely it is that the holes will line up for an error to occur (Figure 1).[12]

The importance of systems' contributions to patient safety and adverse outcomes prompted members of a project team to apply the model by Reason[12] to a narrative review of the literature related to surgical checklists. Members of the project team included doctoral students, capstone committee members, a nurse manager, and a perioperative RN. The goal of the project was to determine the effectiveness of surgical checklists in correcting and preventing error-prone processes in the OR as well as to identify the types of errors that lead to adverse outcomes.

SURGICAL SAFETY CHECKLISTS

In 2004, the magnitude of the wrong-site surgery problem[14] was evident from the number of sentinel events being reported. According to The Joint Commission, wrong-site surgery was the most common sentinel event reported between 2004 and 2010.[15] In response to this patient safety issue, the WHO developed and implemented a surgical safety checklist, which it updated in 2009.[16] The surgical safety checklist applies to three phases of surgery: before induction of anesthesia, before skin incision (ie, time out), and before the patient leaves the OR. Running safety checks at each phase involves all members of the surgical team, whereby the team conducts a verification process, and all members must be in agreement with one another before the procedure can continue. Team validation has been shown to reduce errors in perioperative processes.[7]

Versions of the WHO surgical checklist are in use at the global, national, and state levels to promote patient safety in the OR. The United Kingdom, for example, mandated the use of this checklist in every hospital,[17] and, in 2008, the Institute for Healthcare Improvement[18] called for all US hospitals to use the surgical safety checklist in at least one of their ORs. The Safe Surgery 2015 initiative at the Harvard School of Public Health, Boston, Massachusetts, is committed to all hospitals in the United States routinely using a version of the checklist in their ORs by 2015. This initiative has three focal points: preventing wrong-site surgery, reducing surgical-site infections, and reducing complications.[19] Additionally, in 2013, the Centers for Medicare and Medicaid Services announced that ambulatory surgery centers and hospitals



Latent Failures

The organization's information technology does not function.
The pharmacy and the OR do not interface.
The pharmacy does not retrieve medications in time for administration.
A procedure is not in place for changing or verifying gases.
Different types of gases are stored in one holder and location.
Preoperative orders are not formally written.
The RN circulator does not have access to the patient's preoperative record.
The surgical team does not address anticipation of blood loss before the procedure.
The perioperative team does not address the need for special equipment before the procedure.
Members of the nursing team are under pressure to be efficient and quick.
Confirmation of patient identity, procedure, incision site, and informed consent do not occur.
A knowledge deficit potentially exists among members of the surgical team.
Routine verification of patient allergies does not occur.
Regular testing of equipment does not occur.

Active Failures

The surgeon performs the surgery on the incorrect limb (ie, wrong-site surgery).
The surgical team identifies the wrong patient.
A member of the surgical team administers the wrong medication to the patient.
Blood is not available during the procedure when the patient needs it.
A nurse programs a piece of equipment incorrectly during the procedure.
The preoperative RN does not review the surgical schedule.
A team member places the incorrect medical gas on the laparoscopy cart.

Figure 1. Adaptation of the Swiss cheese model by James T. Reason to illustrate how the use of the surgical safety checklist may prevent active and latent failures. *Source: Reason J. Human error: models and management.* BMJ. *2000;320(7237):768-770.*

needed to report on whether their personnel used a surgical safety checklist during the previous year.[20] According to The Joint Commission, organizations are expected to assess safe patient practices and effective communication during each of the three phases of surgery identified on the checklist; annual payments to the organization may be reduced if a checklist is not used.[21]

Although the use of surgical safety checklists is becoming more common in US hospitals, various process failures continue to occur. Adoption of a checklist alone does not guarantee accuracy because errors may result because of deviations from policies and procedures. Although periodic, comprehensive audits of checklists can further help to reduce medical errors, the effectiveness of a surgical checklist

can be understood within a larger framework of errors when using the Swiss cheese model of errors by Reason.[12]

SWISS CHEESE MODEL OF ERRORS

Reason[12] reported that, in a complex system such as health care, human error is likely to occur and that expecting perfection from imperfect human beings or punishing them for their mistakes will not improve safety. The model by Reason[12] indicates that the preferred strategy is either to prevent an error from occurring or prevent the error from causing harm through the application of multiple steps that function as a safety net. High-technology systems, such as the OR, have levels of defense to catch errors or prevent them from occurring and causing harm, including the surgical safety checklist, the surgical team, and policy and procedures. As discussed, each defensive layer can be viewed as a slice of Swiss cheese. Holes are present in several defense layers, and, unintentionally, the holes can line up, allowing an error to occur. Reason[12] posits that the holes in the Swiss cheese, or defense layer, are the result of both latent and active errors. The terms *latent errors* and *active errors* are used to differentiate between system failures and individual errors, respectively.[12]

Latent Errors

Latent errors (ie, blunt-end errors) are the result of organizational system or design failures that will allow active errors to happen and cause harm. Latent errors are less apparent than active errors. For example, a pharmacy's software may not interface properly with surgical documentation software, resulting in medications that are not reviewed by the pharmacy department before administration. Other examples of latent system errors could include

- failure to institute a practice of anticipating the amount of likely blood loss before a surgical procedure begins;
- failure to review patients' allergies routinely before administering antibiotics;
- failure to perform regular testing of equipment, which then may malfunction during surgery; and
- effects of time pressures that interfere with team members' productivity, concentration, or effective room usage.

Factors that may lead to latent errors include flaws in regulatory or institutional policies and procedures, problems with leadership, the work environment, and inadequate staffing levels relative to the required tasks.[22] Addressing latent errors requires an understanding of how the system interacts with the individual; the availability of resources; and the organization's culture, policy, and procedures. Latent errors can be resolved by using strategies from system theory.[12]

Active Errors

Active errors (ie, sharp-end errors) are the result of an individual's failure and occur at the point of contact between a human and an aspect of a larger system. This type of error generally involves front-line personnel and is usually more easily identified than a latent error. Examples of active failures include

- performing surgery on the incorrect limb (ie, wrong-site surgery),
- administering the wrong medication,
- programming equipment incorrectly, and
- placing the incorrect medical gas on the laparoscopy cart.

Active errors are generally caused by mental lapses, errors in judgment, or procedural violations. According to the model by Reason,[12] addressing active errors also requires an understanding of how the system interacts with the individual. Furthermore, in determining actions to take to prevent active errors from recurring, the cause of the error first must be isolated from the error itself.[12] Active errors can be further classified into slips, lapses, and mistakes.

Slips and lapses. Reason[23] suggested that human errors involve a deviation in procedure, policy, or behavior; whereas slips and lapses can occur during rote performance of routine tasks. The

distinction between a slip and a lapse is that a slip is observable but a lapse is not.[24] Slips and lapses are generally the result of fatigue, stress, and emotional or sensory distractions.[13] Members of a health care organization can decrease the occurrence of slips and lapses by reviewing and understanding the work environment and implementing protocols and procedures. Using checklists, reducing workarounds, reducing variations in practice, and eliminating distractions are among the strategies used to decrease the occurrence of slips and lapses.[25] According to the Agency for Healthcare Research and Quality, creating a culture of safety is important because it encourages the reporting of active errors and facilitates the identification of latent errors.[22] Creating an environment in which health care professionals are not reprimanded for committing slips or lapses is vital to promoting a safe patient care environment.

Using checklists, reducing workarounds, reducing variations in practice, and eliminating distractions are among the strategies used to decrease the occurrence of slips and lapses.

Mistakes. Mistakes are often the result of wrong choices, inexperience, or procedural violations. Reducing the occurrence of mistakes generally requires additional training of the health care worker, remediation, or disciplinary action. Violations can be either deliberate (eg, a team member who refuses to participate in the time out) or unintentional (eg, forgetfulness, not paying attention to a detail). The key difference between slips or lapses and mistakes is that a mistake involves doing the wrong thing, whereas a slip or lapse involves doing the right thing incorrectly. Even though slips or lapses occur more frequently than do mistakes, health care leaders frequently treat slips or lapses as mistakes and respond by establishing an action plan to prevent mistakes.

APPLYING MODEL OF ANALYSIS BY REASON

When one uses this traditional way of analyzing patient safety and patient outcomes, the focus is on personal accountability (ie, what an individual did or did not do correctly). By comparison, the model by Reason[12] shifts the focus to systems accountability so that an event can be analyzed as a nonlinear, dynamic relationship in which the interface between behavior and the event takes place within a larger system.[26] This shift provides a broader viewpoint for determining how to prevent the error from recurring.[25]

The model by Reason indicates that all organizations are exposed to adverse events to some degree. Perioperative leaders must be both aware of this inherent exposure and able to recognize it as a nonlinear component of complex, adaptive systems. Adverse patient outcomes can be assessed by using the just culture framework. By using this framework, the incident can be explored beyond the immediate unsafe action to encompass the core assumptions of human behavior and to identify and fix the organizational conditions that contributed to the negative outcome. The just culture philosophy is one that emphasizes the value of becoming a learning organization (ie, a subculture within an organization that is composed of observing, creating, and acting[27]). Creating a just culture requires trust, which subsequently establishes and supports a culture wherein events can be reported, and errors can be examined, and conclusions reached and actions taken can be collectively understood. According to Reason,[12] a just culture is essential and must already be established within the organization to create and sustain a safety culture.

LITERATURE SEARCH: SURGICAL SAFETY CHECKLISTS

A member of the project team, the perioperative RN, conducted a search of the literature to identify studies that used a surgical safety checklist to prevent latent and active errors in the OR. The

perioperative RN gathered evidence by searching several online databases: EBSCO*host*®, CINAHL®, MEDLINE®, Ovid®, and Cochrane Reviews. She retrieved 65 articles by using the following key words: *scripting*, *checklists*, *safety*, *error prevention*, *standardized tools*, *teamwork*, *aviation*, *protocols*, *timeout*, and *guidelines*. Exclusion criteria included articles published before 2002 and studies conducted in nonsurgical settings, which left 38 articles. The project team reviewed 38 abstracts, of which 15 met all inclusion criteria (ie, published in 2002 or later, conducted in surgical settings, included search terms).

To assess the 15 evidence sources in terms of strength of design and quality, members of the project team used the evidence rating system from *The Johns Hopkins Nursing Evidence-Based Practice Model and Guidelines*.[28] Ratings used for the strength of evidence design ranged from Level I (ie, strongest) to Level V (ie, weakest), and ratings for the quality of individual sources of evidence ranged from A (ie, strong) to C (ie, low). We summarized the individual studies and works included in the literature review, the design and quality of each study, and study results (see Supplementary Table 1 at *http://www.aornjournal.org*). We also synthesized the results of the studies in our literature review (Table 1). The presentation of the studies is in the following order:

1. prevention of latent errors involving stakeholder support through the use of and adherence to a surgical safety checklist;
2. prevention of active errors involving communication and teamwork among team members in the OR through the use of and adherence to a surgical safety checklist; and
3. prevention of latent and active errors involving promotion of patient safety through the use of and adherence to a surgical safety checklist.

PREVENTION OF LATENT ERRORS: STAKEHOLDER SUPPORT

We summarized four articles (ie, one qualitative,[29] one pre-post intervention,[30] one survey,[31] and one pilot study[32]), one expert opinion,[33] and one regulatory body statement[34] in this section. All the studies received a good-quality rating (Level B). All six sources support that latent errors can be prevented by the use of a surgical safety checklist.

Conley et al[29] conducted a qualitative study (Level III B) to understand which type of organizational leadership had the greatest effect on the implementation of a surgical safety checklist. The research team conducted semistructured interviews with leaders responsible for implementation of the surgical safety checklist and with surgeons. Analysis of findings showed that implementation as a team effort was most effective, implementation by an empowering leader ranked second, and implementation by a laissez-faire leader was least effective. The team-effort approach incorporated collaboration; educational sessions; and opportunities for feedback, dialogue, and increased staff support. Surgical team members understood the rationale for implementation of the surgical checklist, recognized their own role in patient safety, and appreciated the organization's commitment to patient safety initiatives, real-time coaching, and best practices.

Vats et al[30] conducted a six-month, pre-post intervention pilot study (Level III B) of implementation of an adapted version of the WHO Surgical Safety Checklist in a hospital in the United Kingdom. Health care workers used the checklist in two ORs at the same hospital in which trauma, orthopedic, general, and gynecological surgeries were performed. Researchers collected data on previous practices to compare against new data related to interventions that included having the researchers introduce the checklist by meeting one-on-one with team members, with small groups, and in large forums. Analysis of the findings suggested that, when the organization's key stakeholders (eg, surgeons, anesthesia professionals) are supportive, the surgical safety checklist will be completed thoroughly and the time out will be performed correctly. The confidence level of the OR nurse also was an important factor related to the

TABLE 1. Synthesis of Cited Works from the Literature Review

Outcomes measures	Number of studies/ evidence levels	Study (year)	Synthesis of studies
Outcomes related to the prevention of latent errors involving stakeholders by the use of and adherence to a surgical safety checklist	6 ■ 3 at Level III B ■ 3 at Level IV B	■ Butcher (2011),[1] Conley et al (2011),[2] Vats et al (2010),[3] Dellinger (2009),[4] The Joint Commission (2012),[5] Patient Safety First (2012)[6]	■ Implementation of the surgical safety checklist was more successful with the team-effort approach. The team effort used collaboration, educational sessions, and opportunities for feedback, dialogue, and increased staff support. ■ Analysis of findings suggest that when the organization's key stakeholders are supportive, the surgical safety checklist will be completed thoroughly and the time out will be performed properly. ■ The factors most important to successful implementation were having a clinical champion (76%), nursing staff support (75%), and clinicians as key stakeholders (62%), including the patient.
Outcomes related to the prevention of active errors involving communication by the use of and adherence to a surgical safety checklist	4 ■ 3 at Level II A ■ 1 at Level III B	■ Lingard et al (2008),[7] Sewell et al (2011),[8] Takala et al (2011),[9] Makary et al (2007)[10]	■ Most communication failures were experienced by only 1 team member, usually the surgeon. ■ Circulating nurses and anesthesia professionals reported significantly fewer communication failures after implementation of the surgical safety checklist. ■ The results supported the hypothesis that surgical teams with higher levels of communication and collaboration have a decreased risk of wrong-site events.
Outcomes related to the prevention of latent and active errors by the use of and adherence to a surgical safety checklist	5 ■ 2 at Level II A ■ 3 at Level III B	■ Haynes et al (2009),[11] de Vries et al (2010),[12] Askarian et al (2011),[13] Panesar et al (2011),[14] Sivathasan et al (2010)[15]	■ Decreased frequency of complications after checklist implementation. ■ The review indicated that more than 20% of wrong-site surgeries could be prevented through the use of the checklist.

(table continued)

TABLE 1. *(continued)* Synthesis of Cited Works from the Literature Review

Outcomes measures	Number of studies/ evidence levels	Study (year)	Synthesis of studies
			■ Time pressures in the OR may lead to an error because team members may have omitted certain tasks on the surgical safety checklist. ■ Results indicate that the decrease in complication rates in 6 intervention hospitals can be attributed to the use of the surgical safety checklist. ■ Implementation of the checklist was associated with concomitant reductions in the rate of patient death and complications.

1. *Butcher L. Wrong-site surgery.* Hosp Health Netw. *2011;85(11):34-37, 1.*
2. *Conley DM, Singer SJ, Edmondson L, Berry WR, Gawande AA. Effective surgical safety checklist implementation.* J Am Coll Surg. *2011;212(5):873-879.*
3. *Vats A, Vincent CA, Nagpal K, Davies RW, Darzi A, Moorthy M. Practical challenges of introducing WHO surgical safety checklist: UK pilot experience.* BMJ. *2010;340:b5433.*
4. *Dellinger EP. Implementation of the surgical care outcomes assessment program (SCOAP) and the introduction of the WHO/SCOAP surgical safety checklist. http://www.saferhealthcarenow.ca/EN/Interventions/SafeSurgery/Documents/Workshops/Plenary%20SCOAP%20Checklist%20Dr%20Dellinger.pdf. Published 2009. Accessed January 23, 2014.*
5. *Safe surgery checklist. The Joint Commission. http://www.jointcommission.org/safe_surgery_checklist/. Published July 24, 2012. Accessed January 23, 2014.*
6. *Five steps to safer surgery. In:* Implementing the Surgical Safety Checklist: The Journey So Far…. *London, UK: Patient Safety First; 2012:2.*
7. *Lingard L, Regehr G, Orser B, et al. Evaluation of a preoperative checklist and team briefings among surgeons, nurses, and anesthesiologists to reduce failures in communication.* Arch Surg. *2008;143(1):12-17.*
8. *Sewell M, Adebibe M, Jayakumar P, et al. Use of the WHO surgical safety checklist in trauma and orthopaedic patients.* Int Orthop. *2011;35(6):897-901.*
9. *Takala RS, Pauniaho SL, Kotkansalo A, et al. A pilot study of the implementation of the WHO surgical checklist in Finland: improvements in activities and communication.* Acta Anaesthesiol Scand. *2011;55(10):1206-1214.*
10. *Makary MA, Mukherjee A, Sexton JB, et al. Operating room briefings and wrong-site surgery.* J Am Coll Surg. *2007;204(2):236-243.*
11. *Haynes AB, Weiser TG, Berry WR, et al. A surgical safety checklist to reduce morbidity and mortality in a global population.* N Engl J Med. *2009;360(5):491-499.*
12. *de Vries EN, Prins HA, Crolla RM, et al. Effect of a comprehensive surgical safety system on patient outcomes.* N Engl J Med. *2010;363(20):1928-1937.*
13. *Askarian M, Kouchak F, Palenik CJ. Effect of surgical safety checklists on postoperative morbidity and mortality rates, Shiraz, Faghihy Hospital, a 1-year study.* Qual Manag Health Care. *2011;20(4):293-297.*
14. *Panesar SS, Noble DJ, Mirza SB, et al. Can the surgical checklist reduce the risk of wrong site surgery in orthopaedics?—can the checklist help? Supporting evidence from analysis of a national patient incident reporting system.* J Orthop Surg Res. *2011;6:18.*
15. *Sivathasan N, Rakowski KR, Robertson BF, Vijayarajan L. The World Health Organization's "Surgical Safety Checklist": should evidence-based initiatives be enforced in hospital policy?* JRSM Short Rep. *2010;1(5):40.*

successful use of the checklist. The OR nurses viewed the hierarchical reporting structure, which can be deeply rooted in many ORs, as a barrier to implementation of the surgical safety checklist. Compliance with the use of the surgical safety checklist during the pilot test ranged from 42% to 80%.

In 2010, the National Patient Safety Agency surveyed 167 acute care hospitals in England and Wales to assess the extent to which they had fulfilled the requirements of WHO Surgical Safety Checklist implementation.[31] Of the 161 hospitals that responded, 77% reported an increase in teamwork, 68% reported improved safety, and 41% identified more near misses. Respondents indicated that most important to implementation was having a clinical champion (76%), nursing staff support (75%), and clinicians as key stakeholders (62%).

This large survey (Level IV B) supports the need for buy-in from key stakeholders in successful implementation of a surgical safety checklist.

Butcher[32] reported findings from eight hospitals and ambulatory surgery centers that participated in the pilot phase of the Center for Transforming Healthcare project. The purpose of this pilot study (Level III B) was to identify the root causes of wrong-site surgery. The study identified variations from the surgical safety checklist as the root cause of most errors. At the organizational level, Butcher[32] identified the following issues as the causes of shortcuts and failures:

- senior leadership not being fully engaged;
- patient safety not being an organizational priority;
- staff members not feeling empowered or supported;
- policy changes not being shared at all staff levels; and
- pressures being put on staff members to improve efficiency, thus causing shortcuts and variations from proper practice.

Dellinger[33] reported supportive findings (Level IV B) in his expert opinion review of the implementation of the surgical safety checklist at the University of Washington Medical Center, Seattle. Implementation began with 13 general surgeons. Dellinger[33] found that implementation required promotion, support, and role modeling behaviors by a well-respected team comprising nursing leaders, anesthesia professionals, and surgeons.

Less attention has been paid to the role of the patient as a stakeholder in the surgical safety checklist. However, as noted by The Joint Commission (Level IV B),[34] the patient also has an active role in site verification, patient identification, verification of the procedure being performed, and confirmation of any allergies.

To summarize, four articles,[29-32] one expert opinion,[33] and one regulatory body statement[34] all consistently support that latent errors can be prevented by the use of a surgical safety checklist. Analysis of these findings indicate that, when key stakeholders within an organization are supportive of the surgical safety checklist, team members will complete the checklist thoroughly and properly, and also indicate that implementation efforts related to the surgical safety checklist were more successful with a team approach, including collaboration, educational sessions, and opportunities for feedback, dialogue, and increased team member support.

PREVENTION OF ACTIVE ERRORS: COMMUNICATION AND TEAMWORK

In this section, we summarize four studies[2,35-37] that used quasi-experimental design or nonexperimental design. Each article received quality ratings of Level A or B. All four sources indicate that active errors related to breakdowns in communication can be prevented by the use of a surgical safety checklist.

Lingard et al[2] (Level II A) examined whether implementation of a surgical safety checklist accompanied by structured OR briefings affected team communications and reduced communication failures by providing the opportunity for problem identification and resolution. This 13-month quasi-experimental study was conducted by using a prospective design with a pre-post intervention survey tool in a general OR at a Canadian academic tertiary center. The sample was composed of nurses, surgeons, surgical residents, anesthesia professionals, and anesthesia care residents. The intervention was a structured team briefing by using a surgical safety checklist. Trained observers used a validation scale (ie, an information-exchange recording form) to observe failures in communication and their consequences. Examples of failures included late, inaccurate, unresolved, and exclusive communication. During the study period, there were 295 surgical safety checklist briefings for observance, along with 172 procedures, 86 of which occurred before the intervention and the rest of which

occurred after. Communication failures declined from a mean of 3.95 (standard deviation [SD] 3.20) to 1.31 (SD 1.53) per surgical procedure after the intervention ($P < .001$). Analysis of the results of this study suggest a causal relationship between communication and safety, supporting the hypothesis that the use of a surgical safety checklist combined with surgical team briefings reduces the number of communication failures and promotes team communication.

In a quasi-experimental study (Level II A) conducted in the United States, Sewell et al[35] explored the relationship among the surgical checklist, team communications, and teamwork. The researchers performed a prospective audit of checklist use in elective and emergent orthopedic procedures before and after an educational intervention at a single-site hospital. The intervention included posting the surgical safety checklist in the ORs, viewing a compulsory training video, and holding group discussions of the common reasons for errors in the OR and how the surgical safety checklist could assist with preventing adverse events. The research team highlighted how the use of a surgical safety checklist could promote a shift in OR culture by flattening the hierarchical reporting structure, enhancing teamwork, and emphasizing that all members of the team are responsible for patient safety. Researchers collected preintervention data on 480 orthopedic surgical patients, and postintervention data on 485 patients. In addition, the researchers asked 100 surgical team members four questions about their perceptions of the surgical safety checklist before and after the educational intervention. The intervention significantly increased use of the surgical safety checklist, from 7.9% to 96.9% of the time; and 76% of the personnel who researchers surveyed reported that communications among team members had improved.

One quasi-experimental study suggests a causal relationship between communication and safety, supporting the hypothesis that the use of a surgical safety checklist combined with surgical team briefings reduces the number of communication failures and promotes team communication.

In an international quasi-experimental study (Level II A), Takala et al[36] studied the effect of the surgical safety checklist on improved team communications and improved safety by preventing errors from occurring. In this prospective pilot study at four hospitals in Finland, the researchers conducted a pre-post–test design by using a structured, multiple-choice questionnaire to gather data from surgeons, anesthesia professionals, and the circulating nurses in the OR during a six-week period. Researchers collected data before and after implementation of the surgical safety checklist. The circulating nurses reported better communications after implementation of the surgical safety checklist. The circulating nurses noted that, when applying the surgical safety checklist, the identity of the patient was confirmed more often, 94.2% of the time after implementation compared with 81.6% before ($P < .001$). Knowledge of the surgical site improved significantly, increasing from 90.5% before implementation to 95.3% after implementation ($P < .001$). The anesthesia professionals also reported awareness of the names and roles of the team members improved after implementation as well as better communications among team members and increased discussion of critical events with surgeons (42.6% after compared with 22.0% before; $P < .001$). The surgeons reported that the entire team's awareness regarding the surgical procedure improved significantly after implementation of the surgical safety checklist; however, they did not report any change in quality of communication among the team. There is evidence that the majority of communication failures were experienced by only one team member, usually the surgeon, who was often unable to recognize

the concerns or problems of other team members. The circulating nurses reported significantly fewer communication failures after implementation of the surgical safety checklist (3% after compared with 23% before; $P < .001$) as did the anesthesia professionals (6% after compared with 13% before; $P < .05$).

In a nonexperimental study (Level III B) conducted at a large academic medical center in Baltimore, Maryland, Makary et al[37] investigated OR briefings conducted in conjunction with the surgical safety checklist and their effect on communications. The five-month study was carried out in a general OR with nurses, anesthesia professionals, and surgeons. The researchers used a pre-post—test design, administering a survey before and after the introduction and initiation of OR briefings in combination with the use of a surgical safety checklist. Analysis of survey results indicated that collaboration between the anesthesia professional and the surgical team yielded the highest gain. The results also supported the hypothesis that surgical teams with higher levels of communication and collaboration have a decreased risk of wrong-site surgery.

In summary, four studies[2,35-37] demonstrate that effective communication affects patient safety by preventing active errors in the OR. Team briefings have a vital role in the successful implementation of the surgical safety checklist. In addition, researchers identified obstacles to effective communication among team members; most communication failures reported were experienced by only one team member, usually the surgeon, therefore impeding accurate and effective communication among team members. Sources of communication breakdowns among surgical team members are a vital issue that warrants further exploration.

PREVENTION OF LATENT AND ACTIVE ERRORS: PROMOTION OF THE SAFETY CHECKLIST

The following is a summary of five studies[7,17,38-40] that indicate that both active and latent errors can be prevented by the promotion and use of a surgical safety checklist. Each study used quasi-experimental or nonexperimental designs, and all received strong or good-quality ratings.

Haynes et al[7] in a large international study (Level II A) examined the effect of the WHO Surgical Safety Checklist on complications by using a sample of 3,955 patients ages 16 or older who were scheduled to undergo noncardiac surgery. The researchers investigated complication rates and deaths within 30 days after surgery. The results at the eight participating hospitals showed substantial improvement in process measures, including

- appropriate antibiotic selection,
- airway evaluation,
- increased use of the pulse oximeter,
- additional IV catheter insertions based on anticipated blood loss,
- oral confirmation of the patient's identity (eg, confirmation of the surgical site), and
- completion of the sponge count.

There was a significant reduction in mortality, from 1.5% before implementation to 0.8% ($P = .003$) after implementation of the checklist. Inpatient complications also declined, from 11.0% before implementation to 7.0% ($P < .001$) after implementation of the checklist.

To examine how adherence to surgical safety checklist processes was related to complications and mortality, de Vries et al[38] conducted a pre-post intervention prospective study (Level II A) in six hospitals in the Netherlands, five of which did not receive the intervention and served as a control group. For this international study, the researchers collected data from October 2007 until March 2009, comparing outcomes of 3,760 patients before implementation of the checklist with outcomes of 3,820 patients after its implementation. The baseline data that the researchers collected during a three-month time frame were from adult patients who had general surgery and were discharged from the hospitals. Implementation of the surgical safety

checklist was completed during a nine-month period, after which researchers collected post-intervention data for another three months. Based on random sampling, researchers entered 1,146 of 4,387 surgical procedures (26%) that used the surgical safety checklist into an online data repository to measure compliance and complication rates. They calculated compliance rates in terms of the percentage of items marked on the surgical safety checklist as being completed and found a median of 80%. They determined complication rates by comparing the differences between two groups: those patients for whom the number of items marked on the checklist was above the median and those for whom the number marked was below the median. The complication rate per 100 patients decreased from 27.3 (95% confidence interval [CI], 25.9-28.7) to 16.7 (95% CI, 15.6-17.9). In-house mortality decreased from 1.5% before implementation of the checklist to 0.8% after implementation. Patient outcomes did not change in the five control hospitals. Analysis of the results indicates that the decrease in complication rates in the six intervention hospitals can be attributed to the use of the surgical safety checklist. In addition, they suggest that complication rates decrease further when 80% or more of the items on the checklist are marked as being completed.

Sivathasan et al[17] conducted a telephone survey (Level III B) of 421 private and public hospitals in the United Kingdom to determine whether their ORs were using the WHO checklist. Researchers administered the survey before the compulsory implementation of the WHO checklist took effect. Managers at hospitals where the checklist was used reported that, because of time pressures in the OR, team members may have omitted certain tasks on the surgical safety checklist, resulting in errors.

Managers at hospitals where the checklist was used reported that, because of time pressures in the OR, team members may have omitted certain tasks on the surgical safety checklist, resulting in errors.

Several researchers have investigated the effect of surgical safety checklists on patient safety. Askarian et al,[39] in a six-month interventional study (Level III B), examined the effects of the surgical checklist in reducing surgical complications. Conducted in a teaching hospital in Iran, the study involved a convenience sample (ie, a nonprobability sampling) of 144 participants. The hospital had six ORs. The researchers found that the two most vital phases of the surgical safety checklist were the time out, occurring just before incision, and the sign-out, occurring as the patient prepared to go to the recovery room. The researchers noted a 57% decrease in surgical complications with the use of the checklist. The most common documented complication before implementation of the surgical safety checklist was postoperative surgical-site infections: 10.4% before the intervention compared with 5.3% after the intervention; however, this was not statistically significant ($P > .05$). Hospital personnel addressed this problem by adhering to the checklist guidelines related to the timing of the prophylactic antibiotic before the surgical incision. The study also noted an increase in personnel's awareness of and compliance with the validation process related to the surgical checklist. For example, instruments used for the surgical procedure met the checklist sterility parameters, thereby contributing to the reduction in postoperative surgical-site infections. The researchers attributed the decrease in surgical complications primarily to the cooperation between the surgeon and the anesthesia professional.

Panesar et al[40] conducted another international study (Level III B) to investigate how surgical safety checklists have been used as a structured communication tool. The researchers retrospectively

reviewed data on orthopedic surgeries performed in the United Kingdom in 2008 that resulted in harm or death to the patient. The data search identified 316 instances of problems, including 133 in which wrong-site surgeries were actually performed. The researchers examined whether a checklist could have decreased the number of wrong-site surgery events. The incidents of interest were

- wrong site marked on the consent form,
- wrong patient,
- wrong-site prostheses,
- wrong site marked on the patient,
- wrong site blocked,
- wrong-site surgery, and
- wrong site marked on the checklist.

By using a 5-point Likert scale (from 1 = "very unlikely to occur if a checklist had been used" to 5 = "very likely to occur if a checklist had been used"), the researchers ranked the incidents. Analysis of their findings suggest that the surgical safety checklist could have prevented 28 of the 133 wrong-site surgeries. Additional analysis indicated that communication failures were associated with inefficiency, team member tension, waste of resources, shortcuts, and procedural errors. The researchers concluded that structured, formal communication methods such as checklists can improve teamwork and promote reliable delivery of care for the surgical patient.

In summary, the evidence reviewed from five studies[7,17,38-40] of either strong or good-quality grading demonstrates that the use of a surgical safety checklist improves patient safety in the OR. Analysis of the evidence shows that patient safety is improved by preventing active and latent errors from occurring.

DISCUSSION

Reason[27] noted two important concepts about errors: they are recurring and react to the situation, not to the individual. The human condition cannot be altered; however, the environment in which the human functions can be controlled to reduce variability. The surgical safety checklist is a tool that may be applicable when designing a high-reliability system with a focus on error-prone situations instead of on the individual. The surgical safety checklist, with proper execution, will almost always achieve a fail-safe situation. When using the surgical safety checklist, the surgical team cannot perform components of the time out improperly. The Swiss cheese model demonstrates how the surgical safety checklist could be a safety net against errors.

CONCLUSION

Wrong-site surgery is prevalent and harmful to patients. The Swiss cheese model by Reason[12] identifies this patient safety issue and provides a framework for identifying the problematic processes that lead to errors, including active and latent failures. The surgical safety checklist has been a successful intervention (ie, a slice of cheese) that reduces the recurrence of errors in the OR. This narrative review highlights the importance of using a surgical safety checklist and suggests that fundamental requirements for successful implementation include engagement of key stakeholders, a culture of trust, a shared vision for safety, and active communication. Broad implementation of a surgical safety checklist can prevent errors, thereby avoiding adverse events and helping to ensure patient safety.

SUPPLEMENTARY DATA

The supplementary table associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.aorn.2013.07.024. AORN

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SUPPLEMENTARY TABLE 1. Descriptions and Evidence Levels of Cited Works

Study (year)	Study purpose and design	Sample and setting methods	Results	Evidence level
Askarian et al (2011)[1]	■ 6-month interventional study to examine the effects of the surgical safety checklist in reducing surgical complications	■ Nonprobability convenience sample of 144 participants ■ Conducted at a teaching hospital in Iran with 6 ORs	■ 57% decrease in frequency of surgical complications after the surgical safety checklist was implemented	III B
Butcher (2011)[2]	■ 9-month pilot study to identify the root causes of wrong-site surgery in the OR	■ Nonprobability convenience sample ■ Conducted in 8 US hospitals and ambulatory surgery centers ■ Partnership between The Joint Commission Center for Transforming Healthcare and 8 hospitals and ambulatory surgery centers that performed more than 130,000 annual procedures	■ Identified variations from the surgical safety checklist as the root cause of errors: ■ lack of site verification when multiple procedures were performed, ■ ineffective hand over, ■ primary documentation was not used to verify the patient and site, ■ the site marking washed off during prepping or was not visible after draping, ■ the time out was not performed at the correct time, ■ the time out was performed without full participation, ■ the time out was not performed when multiple procedures have multiple providers, ■ senior leaders were not fully engaged, ■ inconsistent organizational focus on patient safety, ■ passive personnel, ■ personnel who are not empowered to speak up, ■ policy changes made without staff involvement, ■ the added stress of maintaining a high procedure volume and the pressure to perform a task quickly	III B

SUPPLEMENTARY TABLE 1. *(continued)* Descriptions and Evidence Levels of Cited Works

Study (year)	Study purpose and design	Sample and setting methods	Results	Evidence level
Conley et al (2011)[3]	■ Qualitative research project to identify factors in organizational leadership that have the greatest effect on implementation of the surgical safety checklist	■ Nonprobability purposive sample ■ Conducted at 5 hospitals in Washington state	■ Showed implementation of the surgical safety checklist was more successful with the team-effort approach, including ■ collaboration; ■ educational sessions; ■ opportunities for feedback, dialogue, and increased staff member support	III B
Dellinger (2009)[4]	■ Expert opinion review of implementation of the surgical safety checklist at a facility	■ Nonprobability convenience sample. ■ Conducted at the University of Washington Medical Center, Seattle	■ Showed implementation of the surgical safety checklist required promotion, support, and role modeling of behaviors by a well-respected team composed of nursing leaders, anesthesia professionals, and surgeons	IV B
de Vries et al (2010)[5]	■ Prospective study using a pre-post intervention design to compare outcomes of 3,760 patients before implementation of the surgical safety checklist with those of 3,820 patients after implementation	■ Random sample of checklists from participating hospitals in the Netherlands ■ Conducted at 6 intervention hospitals and 5 control hospitals in the Netherlands	■ Decrease in the complication rate per 100 patients, from 27.3 (95% CI, 25.9-28.7) to 16.7 (95% CI, 15.6-17.9) ■ Decrease in in-house mortality, from 1.5% to 0.8% ■ Decrease in complication rates in the 6 intervention hospitals was attributed to the use of the surgical safety checklist	II A
Haynes et al (2009)[6]	■ Before-and-after quasi-experimental study to examine the effect of the World Health Organization (WHO) Surgical Safety Checklist on complications ■ Hospital participants in the WHO Safe Surgery Saves Lives Program ■ Patients included a range of economic groups and populations ■ 3,733 patients met the inclusion criteria before implementation of the Surgical Safety Checklist ■ 3,955 patients met the inclusion criteria after checklist implementation	■ Nonprobability convenience sample ■ Conducted in 8 hospitals and cities (Toronto, Canada; New Delhi, India; Amman, Jordan; Auckland, New Zealand; Manila, Philippines; Ifakara, Tanzania; London, England; and Seattle, Washington) ■ Carried out from October 2007 to September 2008	■ Implementation of the checklist was associated with concomitant reductions in the rate of patient death and complications ■ Significant reduction in mortality, from 1.5% to 0.8% ■ Decline in inpatient complications, from 11.0% to 7.0%	II A

(table continued)

SUPPLEMENTARY TABLE 1. *(continued)* Descriptions and Evidence Levels of Cited Works

Study (year)	Study purpose and design	Sample and setting methods	Results	Evidence level
The Joint Commission (2012)[7]	■ Regulatory agency recommendation to designate the patient as an active participant in some safety checks associated with the surgical safety checklist		■ The patient has a role in communications related to site verification, patient identification, verification of the procedure being performed, and confirmation of any allergies ■ The patient is a stakeholder	IV B
Lingard et al (2008)[8]	■ 13-month quasi-experimental study to examine whether implementation of a surgical safety checklist accompanied by structured OR briefings affected team communications and, more specifically, whether it reduced communication failures ■ Prospective design with a pre-post intervention survey tool and thorough observation of 172 procedures	■ Nonprobability purposive sample of general surgeons, surgical residents, OR nurses, anesthesia professionals, and anesthesia professional residents at an academic tertiary center in Canada	■ Showed support for the hypothesis that a surgical safety checklist combined with surgical team briefings reduces the number of communication failures and promotes team communication ■ Offered evidence of a causal relationship between communication and safety ■ Decline in communication failures from a mean of 3.95 (SD 3.20) to 1.31 (SD 1.53) per surgical procedure after the intervention ($P < .001$)	II A
Makary et al (2007)[9]	■ 5-month nonexperimental study to investigate OR briefings conducted in conjunction with the surgical safety checklist and their effect on communications ■ Pre-post design for which a survey was administered before and after introduction and initiation of OR briefings in combination with the use of a surgical safety checklist	■ Survey with high response rate was sought; no sampling ■ Conducted at a large academic medical center in Baltimore, Maryland	■ Supported the hypothesis that surgical teams with higher levels of communication and collaboration have a decreased risk of wrong-site surgery ■ Showed briefings reduced the risk of wrong-site surgery and improved collaboration among the team (F [6,390] = 10.15, $P < .001$), as reported by surveyed health care professionals ■ 11 surgeons implemented the briefings after 2 months of collecting baseline data	III B
Panesar et al (2011)[10]	■ Retrospective study of orthopedic procedures to identify patient safety issues (eg, wrong-site surgery)	■ Stratified sample from a database (ie, The National Reporting and Learning Service)	■ Suggested that more than 20% of wrong-site surgeries could have been prevented through the use of the surgical safety checklist	III B

SUPPLEMENTARY TABLE 1. *(continued)* Descriptions and Evidence Levels of Cited Works

Study (year)	Study purpose and design	Sample and setting methods	Results	Evidence level
		■ Reviewed data from hospitals in the United Kingdom for procedures performed in 2008 ■ 316 procedures met the inclusion criteria		
Patient Safety First (2012)[11]	■ The National Patient Safety Agency surveyed 167 acute care hospitals to verify their fulfillment of the requirements of the WHO Surgical Safety Checklist	■ Nonprobability purposive sample ■ Total respondents = 161 ■ Conducted in England and Wales	■ Respondents indicated that factors most important to successful implementation were having a clinical champion (76%), nursing staff support (75%), and clinicians as key stakeholders (62%)	IV B
Sewell et al (2011)[12]	■ Quasi-experimental study to examine the relationship among the surgical checklist, team communications, and teamwork ■ Prospective audit of checklist use in elective and emergent orthopedic procedures before and after an intervention at a single-site hospital ■ Data collected on 480 patients before an educational intervention and on 485 patients after the intervention ■ Educational program designed to promote the use of a surgical safety checklist	■ Nonprobability convenience sample ■ Conducted at a single-site hospital in the United States	■ Before the educational intervention, the researchers found proper use of the surgical safety checklist 7.9% of the time; after the intervention, they found proper use 96.9% of the time ■ 76% of personnel thought the surgical safety checklist improved team communications	II A
Sivathasan et al (2010)[13]	■ Telephone survey of 421 private and public hospitals to determine whether ORs were using the WHO Surgical Safety Checklist ■ Conducted before compulsory implementation of the WHO Surgical Safety Checklist took effect	■ Nonprobability convenience sample ■ Surveyed 421 private and public hospitals in the United Kingdom	■ Because of time pressures in the OR, personnel may have omitted certain tasks on the surgical safety checklist, sometimes leading to an error ■ Only two-thirds of respondents reported their hospital uses the surgical safety checklist	III B
Takala et al (2011)[14]	■ International, quasi-experimental, 6-week prospective pilot study to investigate the effectiveness of the surgical safety checklist	■ Nonprobability convenience sample of volunteer participants ■ Conducted at 4 university teaching hospitals in Finland	■ Most communication failures were experienced by only 1 team member, usually the surgeon	II A

(table continued)

SUPPLEMENTARY TABLE 1. *(continued)* Descriptions and Evidence Levels of Cited Works

Study (year)	Study purpose and design	Sample and setting methods	Results	Evidence level

	■ Pre-post intervention design
	■ 1,748 procedures: 901 questionnaires before the use of a surgical safety checklist, 847 after
			■ Decrease in communication failures after implementation of the surgical safety checklist:
			  ■ Circulating RNs: from 23% to 3% ($P < .001$)
			  ■ Anesthesia professionals: from 13% to 6% ($P < .05$)
			  ■ Surgeons: from 9% to 10% (not significant)
			■ Increase in the confirmation of the patient's identity, from 94.2% to 81.6% ($P < .001$)	

Vats et al (2010)[15]	■ 6-month, pre-post intervention pilot study of the implementation of an adapted version of the WHO Surgical Safety Checklist	■ Nonprobability convenience sample ■ Observed 729 procedures ■ Conducted in 2 ORs in 1 hospital in the United Kingdom	■ Support from stakeholders linked to thorough completion of the surgical safety checklist and correct performance of the time out ■ The range in compliance with the use of the surgical safety checklist was 42% to 80%	III B

CI = confidence interval; SD = standard deviation.

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