Objective 9: The team will effectively communicate and exchange critical information for the safe conduct of the operation.

"The pursuit of safety … is about making the system as robust as practicable in the face of human and operational hazards" wrote James Reason, one of the pioneers of human error evaluation (*1*). Failures within a system, particularly catastrophic ones, rarely happen as a result of a single unsafe act. Rather, they are the culmination of multiple errors involving the task, team, situation and organization, which build up to a calamitous event. The factors responsible for these errors fall into seven broad categories: high workload; inadequate knowledge, ability or experience; poor human factor interface design; inadequate supervision or instruction; stressful environment; mental fatigue or boredom; and rapid change.

Human rather than technical failures are the greatest threat to complex systems. While human fallibility can be moderated, it cannot be eliminated. Complex systems such as aviation and the nuclear industry have come to accept the inevitability of human error (*2*). Such systems build in mechanisms to reduce and manage errors, in the form of technological innovations such as simulations, team training initiatives and simple reminders such as checklists.

Surgery is similarly—and perhaps even more—complex, because of the number of people involved, the acuteness of the patient's condition, the amount of information required, the urgency with which it must be processed, and the technical demands on health-care professionals. Other factors in the system, such as heavy workload, stress, fatigue, hierarchical structures and organizational factors, often contribute to an error-prone environment (*3,4*). As in other complex systems, communication among team members is essential for safe team functioning. Omission, misinterpretation and conflict arising from poor communication can result in adverse patient outcomes (*5–7*). Yet, unlike other complex systems, persons involved in current surgical practice do not regard human error as inevitable and have attempted only intermittently to build systematic safety features into care.

There is growing evidence that communication failures among team members are a common cause of medical errors and adverse events. The Joint Commission reported that in the United States communication was a root cause of nearly 70% of the thousands of adverse events reported to the organization between 1995 and 2005 (*8*). Furthermore, operating teams seem to recognize that communication breakdowns can be a fundamental barrier to safe, effective care. In one survey, two thirds of nurses and physicians cited better communications in a team as the most important element in improving safety and efficiency in the operating room (*9*).

Team culture and its effects on safety

A central element in safe surgery and the avoidance of unnecessary mishaps appears to be the empowerment of team members to raise and act on concerns about the safety of the patient or the operation. Interdisciplinary discussions to ensure adequate planning and preparation for each surgical case are an essential starting-point for effective team communication. The creation of an environment that permits and fosters such discussions depends, however, on a constructive team culture.

Three elements contribute to a team's culture: the structure of the team, the perception of team roles and team members' attitudes to safety issues. The team structure is the team's composition, hierarchy, and the distribution and coordination of work among individuals and professional groups. Operating teams include the surgeons, anaesthesia professionals, nurses and other technicians involved in the perioperative care of surgical patients. These disciplines frequently function in what has been termed 'silos': they work together, ostensibly forming a team, but the worlds of surgery, nursing and anaesthesia can be very different, and in some environments they barely interact. This professional identification and resulting segregation translate into practice patterns that function independently (and often in parallel) in the same physical space, with some overlapping duties, and that foster distinct expectations and values (*10*). These patterns constrain a team's ability to function effectively, particularly in complex, unpredictable work processes. Furthermore, operating teams tend to be strongly hierarchical, and team members are reluctant to communicate among hierarchical levels (*11*). While simple linear tasks, such as checking equipment, can be performed well in a hierarchical structure, complex tasks such as shared decision-making may be inhibited and require a less hierarchical, more collaborative approach to teamwork (*12*).

Team members can make different assumptions about how work is to be distributed and coordinated within the team. For example, surgeons and anaesthesiologists might have conflicting perceptions about who is responsible for ensuring timely administration of antibiotic prophylaxis (*13*). Ambiguity in team structure can be a product of interprofessional disagreements about how tasks should be distributed and valued (*14*). Formalization and standardization are not common in operating room teamwork, due to medicine's strongly held value of professional autonomy and its craftsman mindset, factors that promote individualism as opposed to cooperation and can act as barriers to achieving safer health care (*15*).

The attitudes of team members often reflect and reproduce the organizational culture in which they work. Surveys have shown that they often have discrepant attitudes about their ability to work as a team and about communication among disciplines. Qualitative evaluations of intensive care unit teams showed that, in contrast to physicians, nurses reported that it was difficult to speak up, disagreements were not appropriately resolved, and more input into decision-making was needed (*11*). In the operating room, the differences in attitudes between surgeons and the other team members can be substantial (*16*). It is important to understand these attitudes: research in aviation has shown that positive attitudes about teamwork are associated with error-reducing behaviour (*17*). A similar association has been found between attitude shifts and improved patient outcomes in intensive care units (*18*,*19*). Unlike personality, attitudes are amenable to change (*11*).

A culture of teamwork and communication can lead to better patient outcomes. A steep hierarchy exists in most operating rooms that affects the extent to which the teams function effectively (*12*). Professional affiliation, perception of roles, gender differences and seniority can all foster isolation and segregation, limiting interaction and interdisciplinary questioning. Evaluations of other highly reliable organizations, such as aviation, reveal that strategies such as the use of checklists, standard operating protocols and communication interventions such as team briefings and debriefings aid in task completion and

foster a culture of open communication. Such interventions standardize processes and act as reminders, so that team members need not rely solely on memory recall. In complex systems in which many people and advanced techniques are involved, appropriate procedures are needed to manage and prevent adverse events. Without such systems, problems are almost inevitable. Health care comprises an enormous diversity of tasks and goals, whereas aviation, nuclear power generation and railways are relatively homogeneous. Furthermore, the vulnerability of patients increases their liability to serious damage by unsafe acts.

Patterns of communication breakdown

Observational research in United States academic health centres revealed patterns of communication breakdown among operating teams. Breakdowns can occur during the preoperative, intraoperative and postoperative phases of surgical care and can result in death, disability or prolonged hospital stay for patients (*20*). A study of communication failures in the operating room found that they occur in approximately 30% of team exchanges (*21*). Fully one third of these breakdowns jeopardize patient safety by increasing cognitive load, interrupting routines and increasing tension. The ability to coordinate activities in the operating room varies widely among hospitals and among disciplines. Both observational data and the experience of operating room personnel indicate lack of discussion and planning, including the absence of formal systematic checks, before skin incision (*16*,*22*).

While there is some evidence of poor communication patterns in the intraoperative phase, only a few studies have addressed failures in handover of the patient postoperatively (*21*,*23*,*24*). Inadequate handover, when patients are transferred from one care site to another and during shift changes, has been found to be a safety risk (*25*,*26*). The absence of structured information flow among team members and ambiguity about responsibilities hinder effective communication throughout the perioperative period (*20*). Failure to communicate intraoperative events resulted in inappropriate monitoring of patients postoperatively, absence of enhanced vigilance for specific, predictable postoperative complications, and medication errors such as lapses or delays in administering antibiotics and anticoagulation regimens. The frequency of such omissions remains unknown. In its sentinel event investigations, the Joint Commission has made improvement of handovers among team members through standardization one of its core goals in patient safety (*27*).

Reducing communication breakdown during surgery

Pre-procedural briefings are considered critical in other highly complex fields in order to improve safety. They act by engendering shared mental models among team members (*28*). Briefings facilitate the transfer of critical information and create an atmosphere of openness in which team members feel empowered to contribute. The Joint Commission recommends use of a ‘time out’ or ‘surgical pause’ to allow the team to confirm the patient, the procedure and the site of operation before the incision (*29*). This is now a mandatory requirement in all operating rooms in the United States and has laid the foundation for trials of preoperative team briefings, in which additional safety checks are merged into the time out. Recent studies suggest that using the time just before skin incision

to review the names and roles of all team members, key checks, the operating plan, familiarity with the procedure and issues that might be encountered during the case is of significant value (*30*). In studies in single institutions, use of preoperative operating room briefings was associated with an improved safety culture, a reduction in wrong-site or wrong-procedure surgery, early reporting of equipment issues, reduced operation costs and improvements in the use of prophylactic medication (antibiotics or thromboembolism prophylaxis) in the perioperative period (*31–34*).

Preoperative checks vary in content according to the centre. They usually include checks to confirm use of infection prophylaxis and the availability of critical equipment and resources. In an observational study of 10 surgical procedures, about 15 resources were added per procedure after the beginning of the operation (*24*). Equipment problems are more likely to disrupt workflow, delay case progression and lead to deterioration in the dynamics among team members than compromise patient safety. In a survey of operating room team members, respondents felt that nearly 10% of errors in operating rooms were related to equipment problems (*35*). The American College of Surgeons Closed Claims Study showed that the errors in 5% of claims were equipment-related (*36*). Equipment-related issues not only delay case progression but cause surgeons to adjust their technique and the procedure to work around equipment problems (*24*). Although this phenomenon has not been studied in detail, such adaptation could result in technical errors. The Kaiser-Permanente organization (United States) found that preoperative briefings that included a check on whether the equipment required or expected for the procedure was available resulted in reduced equipment problems and an increase in staff morale (*33*). Training for and implementing the briefing required minimal resources.

Preoperative briefings or checks can also include discussion of modifications to routine operating plans, specific concerns about the patient and the availability of necessary imaging for the operation. The Australian Incident Monitoring Study found that nearly 25% of clinical incidents resulted from poor preoperative information, assessment and preparation (*37*). Imaging can provide independent confirmation of the site for operation, when it is available (*38*). In cases of bilaterality, multiple body parts (e.g. fingers) or multiple levels (e.g. spinal surgery), the American College of Surgeons has proposed that imaging should be prominently displayed in the operating room (*39*). Images can also be important in cases in which intraoperative decisions about the extent of surgical resection are made. Such decisions often depend on a combination of surgical and radiographic evaluation of size and anatomical location of the diseased area (e.g. soft tissue and solid organ tumours).

In general, preoperative briefing sessions are a means of timely information transfer among team members. The intensity and nature of the work in an operating room may mean that team members will have to be prompted to use a checklist or briefing (*28*). While some may see the briefings as an interruption, most surgeons, anaesthesiologists, nurses and technicians who have participated in this type of study reported that the benefits outweighed the inconvenience (*34,40–42*).

Post-procedure debriefings consist of a pause at the conclusion of an operation to give the team an opportunity to review what was done, any critical events during the case and the management plans for recovery. Debriefings have been tested at various centres to see whether they improve the reliability of care (*41*).

Incorporation of safety checks into debriefings could form the basis for a safety intervention. The combination of team briefings and debriefings significantly improved the perceived collaboration of operating room personnel (*30*). Although their effect on patient outcomes is less clear, an established recovery plan highlights any concerns about recovery.

Use of checklists to improve safety and communication

Checklists counteract human failures of omission. Omissions are most likely occur when there is information overload, multiple steps in a process, repeated steps and planned departures from routine procedures. Interruptions and distractions are also causal factors in errors of omission (*43*,*44*).

Checklists are routinely used in high-reliability organizations such as aviation and the nuclear power industry. In aviation, their use is mandatory for every stage of a flight, and failure to use a checklist is considered a violation of flight protocol and a flight error (*45*). Checklists have been used in a number of health-care specialties, such as intensive care and anaesthesia. Their use in health care has met with some scepticism, for practical and cultural reasons. It would be difficult to standardize treatment for the considerable variety of patients, and standardization would not take into consideration differences in clinical presentation and demographics and comorbid conditions. Resistance to their use stems from the perception that they undermine the professional autonomy of clinicians (*45*).

In order to appreciate the limitations of checklists in the clinical setting, it is crucial to assess their value objectively. 'Checklist fatigue' can result from the use of multiple checklists (*45*), and use of checklists can actually lead to errors if they are seen as extraneous and unimportant. If multiple checks are performed by multiple providers, a person may declare that an item has been checked even when it has not, thus perpetuating errors. Exhaustive checklists can slow the process of care and may alienate the users. This may foster negative attitudes and defeat the purpose of a checklist, which is to create a safety climate.

Even a checklist with simple items that clinicians consider routine and clearly defined can have merit. In an attempt to reduce central venous catheter infections, Pronovost et al. (46) instituted a checklist in over 100 intensive care units in the State of Michigan, United States. Simple checks ensured that providers washed their hands before the procedure; wore gloves, a gown, a hat and a mask; properly prepared the skin at the insertion site; draped the patient and maintained a sterile field; and evaluated the patient daily to determine whether the catheter was needed. They found a dramatic decrease in the rate of catheter-related infections when teams adhered to these simple measures, providing a model for how a simple checklist can induce clinicians to adhere to known safety measures in their daily practice.

Record-keeping

Accurate record-keeping is integral to providing high-quality care (*47*,*48*). Although there is little experimental evidence of its value, broad experience has established its importance for maintaining adequate communications in professional practice (*49*,*50*). Good record-keeping is regarded as a mark of an organized, safe practitioner. Medical records exist for the benefit of the patient

and for reference by future health-care providers. The General Medical Council of the United Kingdom specifies that doctors should "keep clear, accurate, legible and contemporaneous patient records which report the relevant clinical findings, the decisions made, the information given to patients and any drugs or other treatment prescribed." It also states that doctors should "keep colleagues well informed when sharing the care of patients" (*51*). As surgical care is provided by a multidisciplinary team, often working in a variety of settings and locations, the accuracy and clarity of written records ensures that information that affects care is readily available to all the personnel involved. Patient records allow all team members to reconstruct events and enable them to plan further treatment or interventions on the basis of full information about clinical history and events. Good record-keeping is an accepted component of surgical care and an important means of promoting high-quality health care.

In order to improve communication, team members must communicate before, during and after a procedure. Preparation for a complex case should ideally begin before the day of surgery in order to ensure the preparedness of the team for any critical event. Conscientious use of a checklist before induction of anaesthesia, before skin incision and before the patient is removed from the operating room can facilitate communication and focus all team members on the critical steps that will prevent harm and improve safety.

Recommendations

Highly recommended:

- Before skin incision, the surgeon should ensure that team members, in particular nurses, anaesthesia professionals, and surgical assistants are aware of the critical steps of the procedure to be performed, the risk for heavy blood loss, any special equipment needed (such as instruments, implants, intraoperative imaging, frozen section pathology) and any likely deviation from routine practice. The nurse(s) should inform the team members about any critical safety concerns and the lack of availability or preparation of any special equipment. The anaesthesia professional should inform the team about any critical safety concerns, in particular any difficulty in preparing for resuscitation after heavy blood loss or patient comorbidities that add risk to the anaesthesia.
- In cases of bilaterality, multiple body parts (e.g. fingers or toes) and multiple levels (e.g. spine) or when intraoperative decisions on the extent of surgical resection are to be made in conjunction with radiographic imaging, the team should confirm that the necessary imaging is available and displayed in the operating room.
- Before removing the drapes at the end of the operation, the surgeon should inform team members of any alterations that were made to the procedure performed, any problems that may occur in the postoperative period and essential postoperative plans (which might include antibiotics, venous thromboembolism prophylaxis, oral intake or drain and wound care). The anaesthesia professional should summarize the clinical condition of the patient during the operation and any other instructions needed to ensure a safe recovery. The nurse should notify the team of any additional concerns recognized during the operation or for recovery.

- An accurate, complete, signed surgical record should be maintained. All patient records should be:

  clear: the patient clearly identified by his or her name and hospital number on each page, written legibly or typed and each entry signed, dated and timed;

  objective: opinions should be based on recorded facts;

  contemporary: notes should be written as soon as possible after an event;

  tamper-proof: attempts to amend records should be immediately apparent; if computerized systems are used, they should record the date and author of any notes and track any amendments;

  original: records should not be altered or amended once an entry is complete. If a mistake is noticed, amendments or corrections may be added and clearly identified as such. If a change is made to the record, it should be signed and dated, and a note should explain why the change was made.

- Information recorded by the surgeon in the operation note should include, at a minimum, the name of the main procedure performed and any secondary procedures, the names of any assistants, the details of the procedure and the intraoperative blood loss. The information recorded by the anaesthetist should include, at a minimum, intraoperative vital sign parameters recorded at regular intervals, medications and fluids administered intraoperatively and any intraoperative events or periods of patient instability. The information recorded by the nursing team should include, at a minimum, sponge, needle, sharps and instrument counts, the names and positions of the personnel performing the counts, instruments and sponges specifically left inside the patient, any action taken in the event of a count discrepancy, and, if no count was performed, the reasons for not conducting a count. The complete operation record should therefore include the names of all team members involved.

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