Reducing Errors in Radiology

Joyce Helena Brusin, MFA

After completing this article, the reader should be able to:

- Define terms such as medical error, adverse event, and sentinel event in medical care.
- Explain how patient transfers provide opportunities for preventing errors.
- Describe how good communication practices can help avert medical errors.
- Discuss how specific approaches to medical imaging can help avoid errors in assessing and diagnosing patients in the emergency department and patients with multiple trauma.

Serious medical errors can threaten patient safety and lead to increased health care costs. Even minor medical errors can erode patient confidence and increase anxiety for medical professionals, patients, and families. Reducing errors as much as possible is best practice for radiologic technologists and makes sense financially for health care providers. Error reduction measures require effort but once instituted prove to be effective and time saving. Other industries in which errors can compromise safety, such as aviation and construction, can provide models for improved risk management and patient safety in medicine.

Medical errors that potentially can harm patients generally can be traced to one of several factors:

- Human fallibility.
- Deficiencies in the system used to accomplish health care–related tasks.
- Inadequate quality-control measures.

- The inherent complexity of modern medical technology.
- The potential complications of the disease or injury in question.

Managing risk and reducing errors requires identifying and reporting errors when they occur, examining and improving system-wide practices, moving from a workplace culture of blame to one of shared responsibility, and improving communication among physicians, other medical personnel, and patients.

Defining Medical Errors

To reduce medical errors, health care workers should understand precisely what is meant by the term medical error and how the concept relates to other concerns regarding quality patient care. The definition of a medical error historically has relied on whether an error resulted in an adverse event. Adverse events are not caused by a patient’s underlying injury or condition but are rather the unintended consequences of medical mismanagement.
Adverse events generally result in measurable disability, prolonged hospitalization, or both.2

Risk management also addresses sentinel events. A sentinel event is an unexpected occurrence that results or is at risk of resulting in death or serious physical or psychological injury. The Joint Commission, which evaluates the quality and safety of patient care in medical facilities and accredits facilities accordingly, promotes national patient safety goals and encourages institutions to report and investigate sentinel events. According to The Joint Commission, sentinel events “signal the need for immediate investigation and response.”3 The Joint Commission further asserts that “the terms ‘sentinel event’ and ‘medical error’ are not synonymous.” According to the organization, not all sentinel events originate from medical errors and “not all errors result in sentinel events.”3

Medical errors also differ from medical complications. Medical complications typically are adverse developments caused not by medical errors but by pre-existing factors such as overall patient health, lifestyle, or individual healing capacity.

Medical errors can be errors of omission—that is, something that should have been done and was not, or they can be errors of commission, which means a task or responsibility was actively mismanaged or performed incorrectly. Authors Pinto and Romano organize potential medical errors and the circumstances under which they might occur into the following categories2:

- Errors of execution (ie, failing to complete a planned action as intended).
- Errors of planning (eg, insufficient planning to achieve a particular treatment goal).
- Deviations from the standard of care.

The nature of medical imaging—the use of radiation in several modalities and imaging’s significant role in diagnosis and treatment—requires that radiologic technologists adhere to strictly defined protocols and carefully planned procedures. In such circumstances, an error can be defined as any deviation from these expected norms, regardless of whether the error results in harm to the patient or technologist.2 The potential for error is present in both diagnostic and interventional radiology.2 The potential error is present in both diagnostic and interventional radiology.2,4 Diagnostic radiology, unlike histological or microbiological diagnosis, relies on visual perception and identification of specific physical characteristics found during visual evaluation of an imaging study. Radiologists who interpret examinations rely on radiologic technologists to provide quality images so the radiologists can carefully combine a patient’s clinical history and pathology revealed in the radiological image.4,6

Errors must be identified before they can be eliminated. Author and surgeon Atul Gawande, in his book The Checklist Manifesto: How to Get Things Right, points out that few professions outside of aviation practice the sort of self-examination mandated by the National Transportation Safety Board (NTSB). NTSB examiners carefully analyze the aftermath of serious transportation-related accidents to determine cause and recommend ways to prevent similar accidents in the future.7

In 2007, the World Health Organization (WHO) launched a campaign to improve the safety of surgical procedures around the world. The campaign included a Surgical Safety Checklist. Based largely on the lists used by pilots in the aviation industry, the purpose of the list is to improve staff teamwork in the operating suite and make the use of safety processes a habit. The checklist included in the WHO campaign takes an estimated 2 minutes to implement. A 2010 report from Semel et al estimated a 10% relative reduction in complications with use of the checklist.8

The Joint Commission recommends a similar approach to accredited organizations’ self-examination of sentinel events. The Joint Commission’s standards specifically call for identifying, reporting, and evaluating sentinel events. Further, the standards require that sentinel events be investigated by using root cause analysis. Root causes are described as causes related to existing systems, which can then be redesigned to reduce risk. The Joint Commission template for root cause analysis suggests that each root cause be examined for possible corrective action. That corrective action should then be included in the health care facility’s plans for future changes or redesign.9

Health care organizations interested in reducing error rates in medical imaging and interventional radiology procedures can begin by conducting formal surveys of radiologists, medical physicists, radiologic technologists, sonographers, and others. Despite the best intentions and training, radiologic technologists might inadvertently
overlook or mishandle some activities. Instead of dismissing them as solitary missteps, radiology departments should conduct a thorough examination of when and how errors occur. Doing so can help avoid future errors, which improves patient care and the organization’s management. If a pattern of specific recurring errors is identified, managers should develop a system of education and implement changes to avoid these errors in the future.7

Causes of Errors

Patient Hand-Overs

Patient hand-overs, also called hand-offs, transfers, or sign-outs, are acknowledged as pivotal moments in the continuity of patient care. When handled inadequately, hand-overs can result in confusion, frustration, narrowly missed errors, and adverse events.8 A 2009 Institute of Medicine report on improving patient and medical resident safety suggested that patient hand-overs be approached as opportunities for learning, better communication, and enhanced teamwork.9 In the context of radiologic technology, the arrival of patients for examinations or interventional procedures and their subsequent departure from the department can be viewed as a type of patient hand-over. Each such occurrence presents radiologic technologists with opportunities to reduce or prevent errors in patient care. These opportunities include10:

- Recognizing early warning signs of possible medical complications or problems in a patient, either in the aftermath of recent treatment or in preparation for imaging procedures.
- Anticipating problems that might arise when a patient is transferred from the imaging department to the next area of clinical care.
- Recognizing and acting on opportunities to improve communication with patients and exercise teamwork skills with colleagues.

To facilitate the accurate exchange of all clinically significant information during patient hand-overs, the Institute of Medicine report recommends that all individuals involved in the clinical care of patients take the following actions11:

- Increase face-to-face interactions that combine oral and written hand-over instructions. Face-to-face interaction supplements and improves comprehension of the written order. It facilitates emphasis of certain aspects of hand-over instructions, allows for questions and answers, and provides the opportunity to clarify information as needed.
- Use uniform terminology and language when conveying information.
- Whenever possible, convey hand-over instructions without interruption or distraction.
- Attempt to structure shift changes with slight overlap to allow for easier and more structured exchange of information.

Written and electronic sign-out systems, similar to checklists, have been developed to increase the completeness and accuracy of information conveyed during patient hand-overs. Electronic systems in particular can enhance the use of uniform terminology because multiple departments or entire facilities access the same electronic program.11 The incorporation of standardized fields in electronic documents helps ensure that important information is not omitted.10 Some programs provide greater flexibility for manually added treatment plans or for staff to anticipate tasks needed for individual patients.

Regardless of the written or electronic system used, standardizing the information conveyed during patient hand-overs improves efficiency, reduces content omission, and makes up-to-date and consistent information about patients uniformly available. Electronic sign-out systems can seem cumbersome or time consuming when first introduced. Adequate training during implementation can reduce errors that occur when the systems are used improperly.11

Including Patients in the Hand-Over Process

Encouraging patients to participate verbally in the hand-over process is a component of patient-centered care. Patients who feel empowered to participate in their own care will more readily ask questions, identify problems, or express concerns, thus reducing the likelihood of error.12 Integrating patients into their own care team begins with properly introducing the other members of the team by name and identifying their titles and roles. This is particularly important for hospital inpatients who experience many shift changes in personnel and for
patients new to an imaging facility. Staff members should remember to use a spoken vocabulary that is culturally appropriate and age appropriate for a particular patient.""

Avoiding Errors at Discharge

Although radiologic technologists do not participate directly in discharging a patient from the hospital, patients are discharged from the department, particularly following interventional procedures. Examining the discharge process as a specific type of hand-over in care affords an opportunity to identify potential intervals at which errors are more likely to occur. During hand-overs involving patient transfers to other levels of care within the same organization, or in situations in which patients are cared for by large integrated teams of medical professionals, it is particularly helpful for staff members in a variety of professional roles to receive training in the discharge process.""

Patients can perceive hand-overs in care, and particularly discharges, as confusing interruptions in the care they have been receiving. Adhering to a formally structured protocol for departmental and facility discharges is particularly important. Discharge protocols differ according to the limits and capacities of the setting where they occur, but any discharge protocol can reduce potential errors by incorporating the following suggestions"":

- Determine what information is most pertinent for maintaining quality care in the new setting.
- Determine what information is most pertinent for patient safety in the new setting.
- Use a consistent and structured protocol to transmit this information thoroughly and accurately to other health care professionals, family members, and patients.
- Use a vocabulary that is appropriate to the audience and readily understood in face-to-face discussions and written instructions.

Reliance on Technology

Although automation and computerized procedures have helped minimize the effects of human fallibility, there is a limit to technology’s ability to prevent or reduce errors. In radiology specifically, technological advances can handle tasks that once took far more time and occupied greater physical space, including mathematical calculation, information processing, image storage, and image transmission." These innovations have helped protect against errors in radiation dose, patient identification, subsequent surgery or hospitalization, and even billing.

Technology alone cannot manage the day-to-day realities of medical practice, however. Automated processes cannot address uncertainty or the individual complexity of each patient’s clinical situation. Only a human being with appropriate education and experience can handle potential crises and unexpected developments. In many ways, according to Gawande, technology further complicates clinical situations by adding “another element of complexity to the systems we depend on and [has] given us entirely new kinds of failure to contend with.”"

Worker Fatigue

Working more and sleeping less has traditionally been accepted as a mark of highly motivated individuals who possess professional dedication. Sleep research, however, has demonstrated that no one can compensate for or adapt to inadequate sleep." Chronic fatigue is inevitably the result. The connection between employee fatigue and workplace errors has prompted numerous industries, including nuclear power, transportation, mining, and aviation, to address the effects of fatigue on work performance and safety." For example, commercial airline pilots are limited to an 8-hour shift; flights of a longer duration must carry relief personnel.""

Awareness of the effects of fatigue in the health care environment increased dramatically in 2003 when the Accreditation Council for Graduate Medical Education issued new duty-hour regulations. Intended to address concerns regarding the length of time medical residents were required to be on duty in training hospitals and the subsequent errors directly attributable to fatigue, the new regulations limited residents to working no more than 80 hours per week." Fatigue and its consequences are perhaps more of a concern at hospitals and after-hours clinics, where the characteristics of shift work in a 24-hour world are more marked. However, concerns regarding workplace fatigue in the health care sector are not limited to these organizations.
In addition to limiting medical resident work hours per week, the Accreditation Council for Graduate Medical Education made several general recommendations for mitigating the effects of fatigue. Several of these recommendations are relevant to error reduction in the entire health care environment, including radiology departments:

- The educational experience intended for medical residents demands their full participation in quality improvement efforts at their respective institutions. Radiologic technologists similarly would benefit from an error reporting and investigation system that allows them to participate fully in identifying errors, as well as in planning and instituting actions to prevent them.
- In cases where fatigue is unavoidable, measures should be taken to mitigate its effects. Subsequent work schedules should allow predictable, protected, and sufficient opportunity for recovery sleep.
- Institutions should provide safe alternative transportation options for staff members who are too tired to drive home safely.

Additional suggestions to mitigate or prevent workplace fatigue are offered by the editors of the book *Principles of Risk Management and Patient Safety*. More general in nature, these recommendations are intended for adoption by a variety of health care facilities and allied health professionals:

- Educate employees on the importance of sleep to overall health and job performance. Present evidence on good sleep hygiene, the physical stages of sleep, symptoms of fatigue and sleep deprivation, and the effects of drugs and other substances on sleep.
- Discuss how environmental factors, such as lighting, ventilation, and taking regularly scheduled work breaks can increase alertness on the job.
- Examine work schedules to take into account shift length, number of consecutive working days, and start and end times for shifts. On-call or overtime expectations can be effective in reducing fatigue and work burnout. Supervisory and management personnel can place value on and actively support efforts to prevent worker fatigue.

Shift Work

Professionals who staff health care facilities after hours, at night, on rotating shifts, or who remain on call for emergencies are particularly susceptible to the effects of sleep deprivation and fatigue. Night workers in particular must remain awake and alert at a time when the body typically expects to sleep. This schedule disrupts circadian rhythms, which are affected by light and help regulate important physical functions, such as release of the hormones cortisol and melatonin. Disruption of circadian rhythms potentially affects the ability to remain awake and alert during the night, and, conversely, to sleep during the day. The chronic fatigue that often results can be exacerbated if employees have chosen to work more lucrative alternative shifts to supplement income from another job. Such a schedule means that their time off is not used for required rest, and chronic fatigue subsequently can worsen.

In the workplace, effects of fatigue caused by chronic sleep deprivation can take the form of reduced cognitive ability, short-term memory lapses, moodiness, clumsiness, lack of motivation, and lapses in attention and vigilance. Reductions in cognitive ability in particular have been the subject of numerous studies. Among the cognitive skills and functions negatively affected by fatigue are the ability to multitask and the ability to integrate new information, both of which can have significant effects in the health care arena. Unusually long shifts and staffing shortages also contribute to fatigue in many health care settings.

Chronic staffing shortages in the nursing field have had a dramatic effect on fatigue in the workplace. Registered nurses often are required to work more than a standard shift length (exceeding 12 hours), forego work breaks, work extra shifts, and regularly be on call during their time off. For nurses, the likelihood of making an error increases with hours worked per week, overtime hours, and increased shift duration. Medication errors account for many documented errors, but mistakes in performing procedures, maintaining patient records or medical charts, and conducting medical transcription also have been noted. Because staffing shortages also can affect the work schedules and hours demanded of radiologic technologists, recognizing and addressing potential errors attributable to fatigue is similarly important.
For employees who work rotating shifts, assign work shifts that rotate forward to facilitate circadian rhythms.

Use scheduling software to determine whether work schedules for employees allow for adequate rest. Fatigue Avoidance Scheduling Tool software is an example; it was originally developed for the U.S. Air Force (Fatigue Science).

Safety Culture
The 2009 Institute of Medicine report on medical resident safety stressed the importance of implementing a safety culture that extends across hospital settings. The report noted that “[b]usinesses in particularly risky industries that could have a catastrophic impact on the public, such as military operations, commercial airlines, and nuclear power generation, were among the first to adopt the continual processes needed to achieve high-reliability operations while producing minimal errors.”11 The report’s authors also stressed the importance of implementing organizational and system strategies that use adverse event and error reporting systems as opportunities to further medical education and training.11

Radiologic technologists practice radiation safety on a daily basis to protect their patients and themselves from the potential radiation exposure risk associated with some medical imaging examinations. Maintaining a culture of safety throughout the patient care continuum and all settings requires a broadening of what the Institute of Medicine report called “continual processes.”11

Individuals and workplaces might define a culture of safety differently, but the following foundational qualities generally are found in organizations that successfully reduce errors while maintaining and improving workplace and patient safety11,17:

- Organizational values and behavioral norms place a high priority on safety.
- Sufficient resources and incentives are in place to implement the commitment to safety.
- Staff members communicate openly, regardless of job hierarchy, particularly in safety-related scenarios.
- Employees acknowledge and openly report errors that occur.

Management responds to errors as opportunities for organizational learning.

Any tendencies to blame individuals for errors are discouraged.

The Institute of Medicine report further stressed that organizations interested in reducing medical errors should replace a system focused on blaming for errors with a system focused on sharing responsibility for reducing and preventing errors.11

Checklists
Once medical errors have been reported, their root causes identified, and changes put in place, the next challenge is to disseminate information and educate staff members. Publications, bulletins, e-mail messages, and similar efforts can be lost in the mass of information typically encountered by health care professionals. Peer-reviewed articles and error reduction studies also risk being lost among the many articles and pieces of information that radiologic technologists and other health care professionals receive.

Gawande offered a lesson from the safety-conscious airline industry. Aviation safety experts take the results of intensive studies produced by the NTSB and create checklists to address and prevent the problems uncovered. Pilots are not required to read massive, densely worded manuscripts issued in response to every new finding. Instead, they receive and test a simple list of steps to prevent the error.7 The intensity of work and demands on employees’ time in most health care settings make similar simplification and distillation essential to error reduction efforts, and a properly developed and implemented checklist can provide similar results.

Although the idea of a preventive checklist to address potential medical errors might seem new, such a list has existed for decades and consistently is used in clinical encounters. According to Gawande, vital signs such as pulse, body temperature, respiratory rate, and blood pressure that hospital staff members record for patients provide a perfect example of a safety checklist. Recording vital signs has taught clinicians that missing one of these signs can harm a patient and that reliable and consistent recording of vital signs helps monitor patients’ overall health.7
All safety checklists should be kept short, and the exact length depends on the context. In aviation, for example, emergency checklists might take only 20 seconds to complete simply because that is all the time available. In medicine, checklists short enough to be truly useful might take from 30 to 90 seconds to complete, depending on their purpose. Completing a checklist any longer than 90 seconds introduces opportunity for distractions and can lead to taking shortcuts or missing steps, which defeats its purpose.

In addition to length recommendations, suggestions for developing a checklist include:

- Focusing on the most urgent items or steps that might be simple but easily forgotten and can cause the most harm if skipped.
- Incorporating steps that address frequent errors uncovered through research such as an employee survey.
- Intentionally omitting items that staff and supervisors know are never forgotten. This helps shorten the list and increases its potential for truly reducing error.
- Keeping the wording simple but exact.
- Maintaining the language and terminology used in the medical profession.
- Ensuring that the checklist is no longer than one page.
- Keeping the checklist appearance simple, without colorful illustrations or other distractions.
- Ensuring that the text is large enough and clear enough to read easily.

Implementing Checklists

The surgical checklist first developed by Gawande and his team was introduced slowly and systematically into the pilot hospitals that adopted it. A similar systematic approach might ease the implementation of error reduction methods in other organizations and in medical imaging departments or outpatient imaging centers:

- Introduce new checklists or other risk management strategies in a series of presentations. Include all imaging professionals concerned with the quality and reliability of imaging equipment, procedures, and outcomes. Avoid using impersonal channels such as e-mail or memos to communicate error reduction protocols.
- Acknowledge errors that have been identified in staff surveys and describe how the measures being implemented will help prevent or reduce those specific errors.
- Limit the introduction of checklists to a single department, section, clinic, or shift. Introducing checklists incrementally facilitates problem-solving and revision before organization-wide or facility-wide implementation.
- Secure a commitment from senior staff members and management. Gawande emphasized the importance of involving people who can implement new efforts to reduce errors, especially those that originate from systemic problems.

An example of how checklists can be introduced and supported by senior staff members took place at a hospital in which the director of surgery created a one-of-a-kind visual reminder and trigger for checklist completion. He designed a metal tent stenciled with the words “Cleared for Takeoff” for the nurses to place over the scalpel as they were laying out the surgical instruments. Only when the items on the operating room checklist had been completed would the nurse lift the metal tent and provide the scalpel to the surgeon. In the ensuing months, the director of surgery measured how surgeries had changed since the introduction of the metal tent. After 3 months, 89% of appendicitis patients received the correct preoperative antibiotic at the appropriate time. Ten months after the introduction of the metal tent, the percentage had improved to 100%. The habitual use of the list was credited for the improvement, as was the fact that team members other than the surgeon, namely the nurses, could delay an operation until the necessary steps and checks had been completed.

Instituting error reduction measures, including checklists, can be met with resistance. One type of criticism is the time, effort, and risks required when implementing checklists. Some members of the staff might fear that checklists increase rigidity and discourage innovation and independent thinking and response. Although there are costs associated with implementing safety checklists, Semel et al compared these costs to the relative reduction in costs of complications from errors and concluded that...
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the WHO Surgical Safety Checklist was effective and ultimately could save hospitals money. Another way to counter resistance is to explore how error reduction measures can save time. Anticipating a potential problem and proactively working to prevent it can prevent future errors, saving time in the long run. Another factor to consider is the fact that the implementation and use of checklists requires collaboration within and between departments.

When Gawande and his colleagues published the results of their pilot program in 2009, they included results from an anonymous survey conducted at the close of the trial period. The results revealed that although many individuals on surgical teams, including surgeons, nurses, and anesthesiologists, had been skeptical about the usefulness of the pilot checklist at the beginning of the study period, by the end of the 3-month trial period, 80% of them reported the list was easy to use, did not take long to complete, and improved the safety of care.

Types of Checklists

Checklists serve as assurance that staff members will forget no step in a particular process, but they do not work well unless implemented within a culture of safety. Error reduction checklists fall into 2 categories: a read-do list or a do-confirm list. A read-do list requires that a staff member or team reads the list and checks each item off as it is completed. A do-confirm list allows greater flexibility in how and in what order tasks are completed; users of this type of list complete tasks and then pause at key points in the procedure to confirm that everything necessary has been done and nothing has been overlooked.

An advantage of a do-confirm checklist is that it provides for brief pauses during a procedure. The increased complexity of medical care, increased demand for medical services, shortage of medical personnel, and other limitations can inadvertently discourage even brief pauses to assess the progress of a particular procedure. Establishing set pause points, as they are known in aviation safety, can provide a useful structure and establish a protocol to discourage errors and mishandling.

Pauses should occur at intervals at which a significant part of the procedure has just finished or is about to begin. For example, Gawande’s surgical team instituted specific pauses at 3 key intervals in their surgical checklist:

- Before the patient received anesthesia.
- After the anesthesia had taken effect but before the surgeon made an incision.
- After surgery, just before the patient was moved to recovery.

The pauses were used to check for recommended antibiotics, patient allergies, and equipment readiness, among other important concerns.

Pause points in medical imaging examinations or interventional procedures would depend on the specific examination or procedure. Although many procedures, such as commonly performed interventional procedures in cardiology, might already have established pause points, an increased awareness among both management and patient care personnel of the importance of these in reducing and preventing errors can encourage their use. Pause points are an excellent example of an error reduction effort that might appear to consume time but that actually helps save time and improves efficiency and safety.

Radiologic technologists might set up a checklist system to ensure they first ask a patient about recent injuries or chronic discomfort that might be exacerbated by positioning during an imaging procedure. It is imperative that technologists do not hesitate to pause and clarify any part of an imaging order that seems inconsistent with or contrary to the patient’s medical condition (eg, a badly swollen right ankle with an order for a left ankle radiograph). Despite the increasing complexity of diagnostic procedures and medical technology, errors continue to originate from simple and often easily overlooked factors. In some cases, the items listed on checklists might seem routine or rudimentary, but surgical teams who have used checklists confirm that the double checks afforded by lists removed the possibility of easily avoidable errors.

Communication

Poor communication has been found to be a contributing factor in approximately 30% of adverse medical outcomes studied. Even in cases where a medical error does not result in an adverse outcome, failures in communication contribute to frustration and confusion.

Communication
for both patients and those caring for them. Patients can lose trust in the health care system and in their provider if they note errors in simple tasks or are given contradictory information regarding their condition and care. These concerns make good communication a key component of effective risk management. Communication from referring physicians can lead to errors or repeat examinations. Radiologic technologists and radiologists need complete and accurate clinical information about patients to complete timely and accurate examinations, and radiologists need detailed clinical history to complete their image interpretations.

Improved communication should not, however, be understood as mere collegiality. In fact, health care professionals’ practice of ensuring they know one another’s name and precise role in any clinical encounter introduces a structure and discipline into communication with both colleagues and patients. Paying consistent attention to communication improves the quality of attention dedicated to the task at hand, whether a radiologic technologist is confirming instructions from a radiologist or attending in a systematic manner to technique factors.

In medical imaging, improving communication to reduce errors also accomplishes improved communication with patients and their families. Taking time to confirm the name of the patient, along with the identity and role of others accompanying a patient, improves efficiency and can prevent errors caused by mistaken assumptions or misunderstandings. Asking patients whether they understand what is about to happen or have any questions or concerns regarding an examination or procedure can help to uncover mistakes in patient identity or the anticipated imaging examination.

Technology has increased the complexity of some medical imaging modalities and techniques. Likewise, increasing specialization in medicine has inadvertently encouraged some individuals to confine themselves to narrow domains of highly specialized skill, often to the detriment of a team’s efforts and patient-centered care. In addition to discouraging effective teamwork, such narrow specialization can create what Gawande called silent disengagement, a situation where team members observe problems or potential errors but choose not to reveal or correct the errors because the problem falls outside their area of specialization.

Imaging technology historically has required attention to detail. New imaging technologies ease some burdens and heighten expectations. The increased number of choices necessary and options available simply leaves more room for error. In addition, technologists can choose to specialize, as in mammography or through assignment to the emergency department of a large urban hospital. The most pressing concerns in either setting might differ widely, but good communication regarding patient status, immediate needs, and potential complications or consequences of errors is essential in both.

Making professional introductions routine can be more crucial in a large metropolitan hospital than in a small outpatient clinic, where staff members are more likely to know one another well, yet the principle behind the practice remains the same. When nurses on a surgical team, for example, were given an opportunity to introduce themselves by name and discuss any potential concerns they might have regarding the upcoming surgery, they were more likely to offer comments and observations than if a short time for introductions and comments had not been set aside.

Talking to radiology team members and the patient about examination or procedure expectations, including the expected length of time and any risk factors the patient might have for potential complications, can increase the quality of patient care and prevent errors due to mistaken assumptions. In addition, knowing that one’s participation and opinion are valued can increase the sense of responsibility a team member has for the success of an examination or procedure. In effect, encouraging participation produces the opposite result of that produced by Gawande’s concept of silent disengagement. Reports have shown that using checklists helps surgical staff communicate and work together better as a team.

 Failures in Communication

Failures in communication might occur between individuals, but poor communication across an entire workplace offers an example of how medical errors can originate from system-wide deficiencies. Besides its significance in affecting patient and technologist safety, poor communication influences workplace efficiency,
relationships among coworkers, and use of valuable resources. Practicing effective communication begins with understanding how communication can be undermined.

To be effective, communication must be thorough, detailed, and clear. Just as medical errors originate in a variety of contexts and take various forms, communication failures can be categorized in the following ways:

- Failure of content – critical information is omitted from the content of either written or verbal communications or is conveyed inaccurately.
- Failure of occasion – information is provided too late to be useful.
- Failure of audience – key individuals are left out of discussions or not provided with information.
- Failure of purpose – issues to be decided are left unresolved; that is, the communication has not fulfilled its purpose.
- Failure of process – communication is handled improperly or inadequately. For example, in-person consultations do not occur, handwritten notes are illegible, terminology used is confusing, or personnel in charge are unprepared.

Anyone who has worked a number of years in radiology or another health care field can probably recall examples of each of these types of communication failures. However, despite definitions of good communication in health care, medical errors continue to result from a lack of communication. Although communication takes place between or among individuals, good communication depends on systemic practices within the workplace to foster an environment in which it can reliably occur.

In a 2011 book on risk management and safety, DeVito examined 7 system-level factors that contribute to communication failure in the health care environment:  

- The presence of workplace hierarchies.
- A culture that discourages communication.
- Differences in or lack of education and training.
- Insufficient staffing.
- Lack of team integration and stability.
- Lack of standardized training in communication.
- Limits on duty hours and the subsequent increase in transfers of patient care.

Hierarchies might be one of the biggest contributors to poor communication in the medical workplace. In many industries, a clear chain of command allows those working on the lower links of the chain to approach superiors with problems or concerns. In contrast, in some medical settings superiors might prefer not to be approached with the concerns or questions of coworkers or colleagues with less authority. This tendency might appear more pronounced within particular work pairings, especially in teaching hospitals.

In academic settings, medical residents and other personnel might be reluctant to approach attending physicians with questions or concerns that could reveal an error or lack of knowledge. The staff member might be hesitant to approach the physician, even in cases in which he or she has too little initial information about a particular patient.

Timely and efficient exchange of information can be compromised during transfers of patients from the emergency department to inpatient units, especially in academic settings. Residents, nurses, and other staff members often hesitate to question physicians. Hierarchical structures might also encourage communication through written materials or electronic health records, which delays the exchange of important information that could reverse an error.

The exclusive use of written orders and the absence of face-to-face communication might allow for better documentation but is a form of impersonal communication that does not offer a context for discussing the specific concerns of a patient’s case in any detail.

Use of electronic health records and an increasing reliance on electronic communication decreases personal communication between radiologic technologists and radiologists. Communication that used to take place when technologists and radiologists interacted during delivery or hanging of radiographs now occurs through electronic notes that accompany digital images. Written orders and communication do not allow radiologic technologists, nurses, and other staff members to ask questions or clarify issues that occur to them as they begin caring for the patient.

In addition, personal communication incorporates nonverbal communication, a significant factor in effective communication. For example, nonverbal communication can signal to an observer how receptive a superior might be to hearing unexpected information.
Regardless of an individual’s official status, his or her body language also can influence how coworkers respond to his or her concerns. Among the most important nonverbal communicators are:

- The presence or absence of eye contact.
- The length of a gaze.
- Tone of voice.
- Body posture.
- Facial expression.

Face-to-face communication allows opportunities for questions and answers, clarification of written instructions, and emphasizing certain instructions. The effect of hierarchies on communication is not limited to communication between coworkers and superiors. There also could be implied hierarchies between health care providers and their patients. The risk of medical error can increase when patients feel powerless or uninvolved in the decision-making process. Without active involvement, they might hesitate to offer information that could prevent complications or errors. The use of medical terminology instead of commonly understood terms exacerbates the hierarchical relationship.

A major principle of patient-centered care is to improve communication among health care providers and between providers and their patients and patients’ family members. The improved communication is designed to involve patients and family members in their care and to improve patient outcomes and safety. For example, patients who are involved in care might be more likely to adhere to recommendations for preventive care or medication regimens. Improved communication and collaboration between providers reduces errors and can improve care, such as in the patient-centered medical home concept. Minimizing hierarchical effects on communication and improving collaboration begins with cultivating a work culture that encourages a sense of shared responsibility.

Health care practitioners often believe that they should be able to handle a situation on their own, without requesting assistance or advice. In such a cultural context, errors inevitably are viewed as personal failures and potentially occur unreported and unaddressed. Personal accountability examines the individual who is to blame for an error, as opposed to a process or systemic issue that might have led to the error. Looking for fault for an error can lead to a culture of blame in the workplace, rather than a sense of shared responsibility and open communication.

Examining and improving the performance of groups, as opposed to individuals, helps to implement changes system-wide and ensures compliance from everyone in the organization. A culture of shared responsibility and system-wide change also ensures that improvements do not diminish or disappear when individual personnel leave a workplace.

Organizations also can benefit from encouraging the growth and expression of strong leadership skills among all levels of employees. A positive workplace culture encourages individuals to come forward with and discuss concerns, seek solutions to problems, and publicly support constructive change.

Recognizing how educational preparation of health care practitioners affects workplace interactions also is important in decreasing medical errors. The educational preparation of physicians such as radiologists, for example, stresses accuracy but also conciseness. Radiologic technologists learn about the technical aspects of conducting examinations but rely on radiologist and manager feedback for ongoing education about image quality and how to minimize radiation exposure to patients. Technology can interfere with many of the traditional feedback mechanisms.

Although complex and sophisticated technology is a defining feature of diagnostic medical imaging in particular, the educational preparation of radiologic technologists also emphasizes patient-centered care. Patients’ immediate and pressing physiological needs, their safety and comfort, and their personal concerns take precedence over the requirements of the imaging procedure. Radiologic technologists who habitually observe and inquire about a patient’s needs and concerns before and during imaging procedures are more likely to earn a patient’s trust. Patients who trust the technologist performing their procedure are, in turn, more likely to communicate effectively regarding their care and to alert the technologist to any potential problem or complication.

Staffing shortages can lead to disruptive employee fatigue and consequent medical errors, along with decreasing levels of communication. Staffing shortages...
can adversely affect the quality and length or number of patient care team meetings, which can result in the goals for a particular patient’s care being communicated inadequately. Staffing procedures also can lead to communication difficulties, particularly to a lack of clinical team integration. Integrating work teams improves communication among workers and informal education as health care professionals observe how peers perform equivalent duties.

**Standardized Communication Training**

Patient transfers are daily occurrences in hospitals and other health care facilities, yet little formal training is available in how to consistently and effectively communicate patient needs during transfers and handovers. In addition, staff fatigue at the end of a long shift can compromise the quality and extent of discussion regarding a patient’s care. Standardized instructions in how to communicate effectively—regardless of staffing, shift changes, coworker or supervisor hostility, or other personnel concerns—can help reduce errors that originate during patient transfer.

Standardized instructions in communication also can address differences in interpersonal dynamics. Assertiveness training might prove especially helpful for employees.

Standardized protocols for briefing coworkers or supervisors usually are structured to include examining the situation, summarizing its history, and anticipating what might happen next. An example is the situational debriefing model, originally developed by the U.S. Navy and abbreviated SBAR, which stands for situation, background, assessment, and recommendation. Standardized communication or briefing protocols developed by government agencies in other industries, such as aviation, can be used in health care to structure discussions that are least likely to omit important details or, conversely, to include so much information that pertinent details are lost.

DeVito suggested that even in situations in which workplace hierarchies and staffing shortages make open communication difficult, an agreed-upon phrase representing what DeVito called critical language can help avoid a crisis. If employees are trained to use a phrase such as “we have a serious problem; stop and listen to me,” whenever they observe a critical error or situation developing, any staff member within a strict hierarchical environment can help avert a potentially serious error. Critical language offers a straightforward tool for immediate use, even as leaders implement system-wide changes.

Gawande described a situation he witnessed during a surgical procedure at a Jordanian hospital in which a female nurse overcame cultural and hierarchical norms to point out a breech in protocol to a male surgeon. The surgeon had contaminated his surgical gloves when adjusting the operating lights. The nurse pointed out the problem and, despite the surgeon’s initial dismissal of her concerns, persisted in her demands that he change his gloves. He eventually did so, and only then did the procedure continue.

**Reducing Errors in Emergency Departments**

Emergency department imaging is especially complex for radiologic technologists. The nature of many patients’ conditions and the urgency associated with turnaround times for examinations and physician interpretation requires that technologists be prepared and technically accurate. In addition, technologists might be working independently during evening hours, with radiologists performing after-hours interpretation via teleradiology coverage. Technologists might need to make rapid decisions autonomously and acquire the best images possible to facilitate a timely emergency diagnosis.

Professionals in the aviation industry are known for facing rapid decisions regarding unexpected events. The emergency checklists used by airline pilots begin with a simple and straightforward admonition: “Fly the airplane.” Before and while completing checklists and other emergency measures, pilots must ensure that they continue flying the plane. This admonition echoes medicine’s traditional instruction to “first, do no harm.” It also is reminiscent of the “ABCDE” approach (airway, breathing, circulation, disability, exposure) used by emergency responders and personnel to assess, treat, and stabilize patients. Ideally, from such basics can evolve a firm foundation from which to avoid and reduce error in a rapidly evolving emergency situation.
Conventional radiography and ultrasonography provide less resolution than other modalities and are inherently limited in their field of view. This can lead to errors in diagnosis and the downgrading of injuries in emergency department patients. For example, ultrasonography’s sensitivity and specificity might be adequate for initial assessment of blunt abdominal trauma but inadequate for injuries involving some internal organs and skeletal injury. CT is considered superior to focused assessment with sonography for trauma in definitive diagnosis.

Radiography of Extremity Trauma

Radiographic images of the extremities often are acquired after initial CT imaging has been completed. Conventional radiography remains the first-line imaging modality for suspected osseous injuries. Protocols for trauma radiography specify that 2 radiographs at 90° angles be obtained of all extremities and that these include both joint spaces on one or more images of all long bones.

Multiple Trauma

Personnel in emergency departments must frequently work with patients who have sustained multiple traumatic injuries. Handling multiple trauma presents specific challenges and more potential for medical errors than most other clinical situations. Errors can occur even in specially designated trauma centers. Medical imaging is essential to correctly diagnose patients who have multiple trauma. Emergency department physicians preliminarily assess trauma patients for the possibility of vertebral fracture immediately after assessing their cardiac and respiratory status because the danger of paralysis is so pronounced in patients with multiple trauma.

Today most trauma, especially multiple trauma, is evaluated with computed tomography (CT). Radiologic science instructors offer the following tips for adopting routine radiographic procedures for use in emergency situations. Ready ing equipment and preparing for procedures in advance can free valuable time for addressing emergency situations once patients arrive. The following suggestions can provide a framework for developing an emergency department checklist.

Before a patient arrives:
- Obtain as much information as possible about the incoming patient and his or her injuries.
- Based on this information, prepare equipment for expected imaging examinations (eg, cassettes and markers).
- Prepare required protective equipment (ie, lead aprons, gloves, gowns).

Once a patient arrives:
- Assist the trauma team in assessing the patient.
- Introduce yourself to the patient before beginning the examination.
- If possible, explain what images you plan to acquire.
- Ask the patient about his or her mobility, and, if possible, obtain the patient’s assistance in positioning.
- To prevent worsening the patient’s injury, seek assistance from nurses or physicians when moving and positioning the patient.
- Provide radiation protection to any individuals required to stay in the room during imaging.
- Use appropriate shielding on the patient.

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Reducing Errors in Radiology

Projections. Imaging in 2 planes might not reveal non-displaced fractures of the forearm or elbow.32,34

Fractures of the calcaneus sometimes occur as work-related injuries among middle-aged and younger men. Missed diagnosis of a fractured calcaneus can lead to prolonged pain and disability, along with associated soft tissue injury. Where a calcaneal injury is suspected, an axial projection should be acquired along with anteroposterior and lateral projections of the foot. Lateral projections usually are best for displaying the calcaneus because they allow assessment of the posterior facet position and the loss of calcaneal height.32

Most diagnoses missed on radiography are fractures. Avoiding misdiagnoses in the emergency department requires proper examination of the patient. This suggests that physicians must take great care in requesting the specific radiographic projections they require to aid in diagnosis. For example, when assessing finger injuries, physicians should request radiographs of the fingers rather than of the hands. Specific requests ensure that radiographers obtain the most useful images possible. Misdiagnoses that result from no radiographs being obtained usually are because of poorly localized injuries or the presence of other significant or painful injuries that draw attention away from the fractured extremity.32

**Torso and Spine Injuries**

Possible injuries to the vertebral column are of immediate concern in assessing patients with multiple trauma. Although spinal injuries from trauma are more common at the craniocervical junction, an identified injury in any segment of the spine should prompt suspicion of similar injuries in other vertebral locations.39 Standard radiographic evaluation of the traumatic cervical spine usually comprises at least 3 projections: anteroposterior, cross-table lateral, and open-mouth odontoid. However, studies found these standard projections to be inadequate in identifying half of the fractures ultimately detected32,35,36.

In 2009, the American College of Radiology recommended that multidetector computed tomography (MDCT) with multiplanar reconstruction be the method of choice for imaging suspected spinal trauma, especially in patients who show clinical indicators of risk for cervical fracture.37 These clinical indications include32:

- A confused or altered mental state.
- Tenderness at the posterior midline cervical spine.
- Focal neurologic deficit.
- Neck pain on range of motion.
- Any other painful injury that might distract the patient from cervical spine pain.

Incorrect classification of lumbar spine fractures is more likely in patients who are overweight or obese or in patients who have multiple trauma with coexisting abdominal injuries. This is especially true if patients have injuries to the hollow viscera, the mesentery, solid organs, and large blood vessels. Lumbar spine injuries also are more likely to be missed when injury has resulted in abdominal bleeding, which can increase diagnostic errors by as much as 45%.39

In thoracic trauma patients, a traditional chest radiograph results in underestimation of pneumothorax 50% of the time. Injuries to the sternum also are frequently underestimated, but accompanying pain usually prompts additional diagnostic examinations to determine the cause. When a patient has multiple trauma, costal fractures might remain undetected for several days.
Pediatric patients with multiple trauma cause special concern. Among those with already identified skeletal and solid visceral organ injury, coexisting injury to the area of the ureteropelvic junction is missed in some 50% of cases initially evaluated with radiography and ultrasonography.  

**Use of Multidetector Computed Tomography**

MDCT offers emergency departments detailed imaging studies that can uncover subtle signs of injury, often before other clinical signs are evident or patients experience symptoms. Speed of acquisition is an additional advantage of MDCT; new equipment allowing rapid whole-body scans expands the diagnostic advantages of MDCT to more emergency department and multiple trauma patients. Newer multidetector equipment can display the exact location of vascular injury, along with the nature and characteristics of the injury. Characterizing vascular injury contributes to decisions regarding whether patients are managed with an endovascular approach or with traditional surgery (see Figure 2). In addition to hemodynamically stable patients, patients who are slightly unstable clinically and patients with borderline status now can benefit from the advantages of MDCT imaging.

MDCT is an example of increasingly complex medical technology that, despite its benefits and advantages, can lead to heightened expectations. Although contrast-enhanced MDCT is highly sensitive and specific for evaluating injury in patients with multiple trauma, the technology requires attention to protocols and acquired skills specific to MDCT; error reduction and prevention remain concerns. Most errors in the use of MDCT are preventable.

Figure 2. A. Blunt cerebrovascular occlusion in a 51-year-old man who was involved in a motorcycle accident. The axial multiplanar reconstruction image (A) in 3-mm-thick slices shows the absence of contrast material within the right vertebral artery (arrow) and the coexistence of a C4 lateral mass fracture (arrowhead) involving the right vertebral channel. The same findings (arrows and arrowhead) are clearly detectable on the sagittal multiplanar reconstruction image (B), on which the presence of contrast material is detectable within the right vertebral artery upstream and downstream from the occlusion. C.-D. Multidetector computed tomography images of a 28-year-old man who was involved in a bicycle accident. The axial multiplanar reconstruction image (C) in 3-mm slices shows multiple skull base fractures (arrows) involving the clivus and no contrast material within the basilar artery (arrowhead). Midfacial fractures also were present. The sagittal maximum intensity projection reconstruction (D) (4-mm thickness) confirms a focal absence of contrast material within the lumen of the basilar artery (arrow). Reprinted with permission from Bonatti M, Vezzali N, Ferro F, Manfredi R, Oberhofer N, Bonatti G. Blunt cerebrovascular injury: diagnosis at whole-body MDCT for multi-trauma. Insights Imaging. 2013;4(3):347-355.
MDCT can be traced to lack of experience on the part of the radiologist and incorrect patient management.\textsuperscript{29} For example, massive pneumothorax is a frequent cause of death after deceleration trauma, and the interpreting physician should search for monolateral or bilateral pneumothorax in the scout projection at the start of the MDCT trauma examination.\textsuperscript{29,39}

Patients must be prepared and managed appropriately following established protocols for body scans of patients with multiple trauma.\textsuperscript{29,40} According to radiologists familiar with patient management during contrast-enhanced MDCT, reducing or preventing common errors begins with strict collaboration among the trauma team.\textsuperscript{29}

Important considerations for MDCT teams in successful patient management and error reduction include\textsuperscript{29,39}:

- Ensuring correct venous access for contrast administration and sufficient flow rate for the detection and correct identification of vascular injuries.
- Delaying use of an oral contrast medium until the absence of enteromesenteric lesions is confirmed.
- Using sedation only as needed for patients who cannot cooperate.
- Positioning patients correctly to image anatomy with as few artifacts as possible.
- Characterizing vascular injury to assist in deciding whether patients will be managed with an endovascular approach or with traditional surgery.
- Using the precontrast phase of contrast-enhanced MDCT to detect a small blood clot or enteromesenteric injury, which can help characterize underlying injuries that can be difficult to see in the contrast-enhanced phase.
- Recognizing that respiration artifacts can be a source of interpretation error.

The craniocervical region is a frequent site of spinal injury and the region associated with 2 frequent errors in imaging that can result in increased morbidity and mortality in multiple trauma patients\textsuperscript{29}:

- The first common error is understaging of injury in the supraaortic trunks. This can be prevented by extending the arterial chest-abdominal phase to the neck. The frequency of traumatic vascular injury in this region, along with the threat of associated morbidity and mortality, is significant enough to warrant this extension.
- The second is missing underlying vascular damage due to intraparenchymal hematomas of the brain. Intraparenchymal hematoma in a patient with multiple trauma can indicate either an arteriovenous malformation or the spontaneous bleeding of an intracranial aneurysm. In such cases, integrating the precontrast study of the skull with CT angiography or magnetic resonance angiography can offer the best possibilities for evaluation.

Many trauma patients with multiple injuries undergo urinary catheterization, which can disguise even large bladder lacerations. If bladder lacerations are suspected, the first or subsequent contrast-enhanced MDCT examinations should involve using the catheter to fill the bladder with iodinated contrast medium. This helps to identify even the smallest trauma-caused lacerations, which might otherwise remain undetected.\textsuperscript{29}

Multiple trauma is an evolving condition that requires highly coordinated monitoring and care. Although radiology professionals play a critical role in initial examination, reducing the occurrence of errors in trauma care is the responsibility of the entire trauma team. Awareness of fundamental concerns, knowledge gained by experience, and adherence to imaging protocols are essential to a successful diagnosis of trauma patients.\textsuperscript{29}

**Conclusion**

Awareness of the potential harm to patients from errors and the need to remain vigilant in following institutional policies and procedures improves patient safety, outcomes, and trust. As technology continues to improve medical imaging capabilities and work flow, radiologic technologists must continually improve their skills to ensure quality diagnostic imaging for their patients. Improved communication, concise checklists, structured protocols, and increased attention to the effects of fatigue can help reduce errors in the medical imaging workplace.

Joyce Helena Brusin, MFA, works as an essayist and freelance medical writer and editor in Missoula, Montana.
She previously has written Radiologic Technology Directed Readings about radiation protection, digital mammography, osteogenesis imperfecta, bone densitometry, ergonomics, and the role of cultural competence in addressing health disparities.

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References


Reducing Errors in Radiology

1. Which of the following is not a contributing factor to medical errors?
   a. human fallibility
   b. system-wide deficiencies
   c. the complex nature of modern medical technology
   d. the size of the hospital or outpatient center

2. Which of the following statements is true regarding adverse events?
   a. Adverse events are caused by unintended consequences of medical mismanagement.
   b. Adverse events are the consequences of a patient’s underlying condition.
   c. Patients seldom have measurable disability from adverse events.
   d. Adverse events seldom result in hospitalization.

3. According to The Joint Commission, a sentinel event signals the need for:
   a. formation of a team to address potential long-term solutions.
   b. firing of the responsible employee or employees.
   c. immediate investigation and response.
   d. legal action.

4. Medical complications are caused solely by medical errors.
   a. true
   b. false

5. An error of commission occurs:
   a. when a necessary task is not done.
   b. when a task or responsibility is mismanaged or done incorrectly.
   c. most often in emergency medicine.
   d. when a staff member forgets to transfer a patient.
6. Which of the following is an example of root cause analysis examination?
   a. how systems can be redesigned to prevent or reduce risk
   b. determining which individual is to blame for an error
   c. what causes staffing shortages
   d. how to eliminate workplace hierarchies

7. As patients arrive for and depart from radiologic imaging procedures, radiologic technologists can help prevent medical errors by:
   1. anticipating problems that might arise.
   2. recognizing early signs of developing medical complications.
   3. acting on opportunities to improve communication with patients.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

8. Patient hand-over instructions are best conveyed:
   a. through written instructions only.
   b. through oral instructions only.
   c. through a combination of written and face-to-face communication.
   d. in the presence of family members.

9. Electronic sign-out systems offer all of the following advantages except:
   a. they enhance the use of uniform terminology.
   b. multiple departments or entire facilities can access them.
   c. patients can individualize their own care plan.
   d. they contain standardized fields that make it harder to omit important information.

10. Which of the following statements is true about chronic sleep deprivation?
    a. Sleep deprivation is not a problem for individuals who are accustomed to it.
    b. The problem can be addressed with caffeine or other stimulants.
    c. It increases the ability to multitask.
    d. Sleep deprivation causes lapses in short-term memory and attention span.

11. In situations where fatigue is unavoidable, managers should:
    a. allow for sufficient and protected opportunities for recovery sleep.
    b. allow for recovery sleep on the job.
    c. schedule overlapping shifts.
    d. provide compensatory time in the next week’s schedule.

12. How do managers respond to medical errors in a workplace culture of safety?
    a. by identifying and firing the employee responsible
    b. as opportunities for organizational learning
    c. by discouraging employees from reporting errors
    d. by taking individual responsibility for correcting all errors

13. Which of the following statements are true regarding an ideal checklist for preventing medical errors?
    1. the list should take 30 to 90 seconds to complete.
    2. the list should include all urgent items.
    3. the list should include at least 2 illustrations.
    a. 1 and 2
    b. 1 and 3
    c. 2 and 3
    d. 1, 2, and 3

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14. A study of the World Health Organization Surgical Safety Checklist revealed that the safety checklists:
   a. can be too time-consuming and costly to use widely.
   b. are inexpensive and quick to implement.
   c. involve costs to implement but are effective in saving money by reducing complications from errors.
   d. are completely ineffective.

15. A read-do checklist requires users to:
   a. read each item and check it off as it is completed.
   b. complete tasks and then pause to confirm that everything necessary has been done.
   c. complete longer items with more detailed instructions.
   d. complete shorter items with less detailed instructions.

16. Established pause points during an examination or procedure usually occur when:
   a. staff members are retrieving necessary supplies.
   b. a staff member takes a phone call.
   c. it is noted that previous errors have occurred.
   d. a significant part of the examination or procedure has just finished or is about to begin.

17. Poor communication has been found to be a contributing factor in approximately ______% of adverse medical outcomes.
   a. 5
   b. 10
   c. 30
   d. 50

18. Reports have shown that use of ______ helps surgical staff communicate and work together better as a team.
   a. regular staff meetings
   b. 360° evaluations
   c. error reporting software programs
   d. checklists

19. In poor communication, failure of content means that:
   a. the communication takes place too late to be useful.
   b. key people are left out of the discussion.
   c. key issues are not resolved.
   d. essential information is omitted from the communication.

20. Radiologic technologists and radiologists communicate in person less often today because of:
   a. increasing emphasis on hierarchies in all health systems.
   b. increasing use of electronic communication accompanying digital images.
   c. intervention of supervisors.
   d. poor communication and safety cultures.

21. A major principle of patient-centered care is to improve communication among health care providers and between providers and their patients and patients’ family members.
   a. true
   b. false

22. Which of the following statements is not true regarding standardized instructions in communication?
   a. Standardized instructions help reduce errors.
   b. Standardized protocols should not summarize history of the situation.
   c. Interpersonal dynamics can be addressed by standardized instructions.
   d. Protocols developed in other industries can be transferred to health care.

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23. Emergency department imaging is made more complex for radiologic technologists by the:
   1. urgency associated with turnaround times.
   2. nature of patients’ conditions.
   3. potential to work independently and without a radiologist present.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

24. Which imaging modality is used to image most emergency department multiple trauma?
   a. digital radiography
   b. ultrasonography
   c. computed tomography
   d. magnetic resonance imaging

25. ______ is a frequent cause of death after deceleration trauma.
   a. Stroke
   b. Pneumothorax
   c. Myocardial infarction
   d. Spleen rupture