

Geisinger Links Quality with Reimbursement: Coronary Artery Bypass Graft Surgery

Glenn D. Steele Jr., MD, PhD, President and CEO
 Albert Bothe Jr., MD, Chief Quality Officer
 Ronald Paulus, MD, MBA, Chief Technology & Innovation Officer
 Geisinger Health System

This contribution from Geisinger Health System continues the PA-PSRS Patient Safety Advisory series on leadership perspectives of patient safety. Geisinger leaders' buy-in and support helped to drive evidence-based changes in the provision of care to patients undergoing coronary artery bypass graft surgery, a process improvement that has also yielded cost benefits.

—John R. Clarke, MD, Editor

Almost two years ago, the leadership of Geisinger Health System began challenging its clinicians to further improve the quality of care being delivered to its patients in central Pennsylvania. One

of the early areas to receive attention was elective coronary artery bypass graft surgery (CABG).



Glenn D. Steele Jr., MD, PhD

Data from the Pennsylvania Health Care Cost Containment Council showed that Geisinger was already performing very well. Despite that, Geisinger's cardiac surgeons began meeting to review newly updated professional guidelines from the American Heart Association and the American College of Cardiology, which were based on well-founded studies in the medical

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Insight into Preventing Wrong-Site Surgery

Wrong-site surgery can be national news, as it was in November 2007 when Rhode Island Hospital was fined \$50,000 for doing their third wrong-side craniotomy of the year.¹ Although the frequency of wrong-site surgery has decreased in Pennsylvania, PA-PSRS continues to receive reports, despite disseminating information from our retrospective analysis of wrong-site events and near misses (see Figure 1).^{2,3} To gain further insight into the elusive and apparently intractable causes of wrong-site surgery, we have undertaken a number of initiatives. We have done site visits at volunteer facilities. We have begun collecting specific detailed information about wrong-site surgery near misses and actual events. We will be setting up a Web resource that will provide the latest information for facilities interested in decreasing their risks for experiencing wrong-site surgery.

Here, we will summarize our insights and conclusions from our site visits and give some preliminary findings from our in-depth queries of wrong-site surgery events and near misses. We intend to contribute a detailed analysis of our observations in the future. These insights and conclusions form the basis of a self-assessment checklist that

facilities can use to evaluate and monitor their programs for preventing wrong-site surgery (this checklist is available online; for information, see the Web resource sidebar on page 117).

A Synopsis of Observations of Site Verification Processes at Six Pennsylvania Facilities

We wanted to understand the variations in how the Joint Commission Universal Protocol for Preventing Wrong Site, Wrong Procedure, Wrong Person Surgery^{TM4} was interpreted and implemented and particularly how those variations might be related to the risk of wrong-site surgery. We selected hospitals from a list of hospitals licensed for more than 350 beds to avoid variations due to small numbers.

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Office Location: 539 Forum Building
Harrisburg, PA 17120

Mailing Address: P.O. Box 8410
Harrisburg, PA 17105-8410

Telephone: 717-346-0469

Facsimile: 717-346-1090

Web site: www.psa.state.pa.us

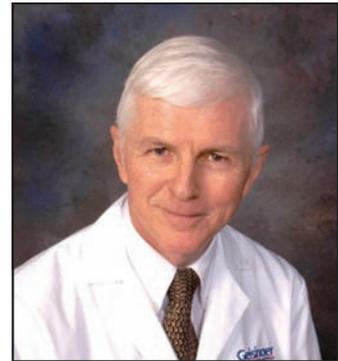
E-mail: patientsafetyauthority@state.pa.us

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literature. Over several months, the surgeons, working with Geisinger's performance improvement team, reviewed the literature and studied its existing processes. As in most institutions, they found preference-based variations in technique, equipment, and steps within the flow of patient care that each surgeon believed was best for patients. Led through the review by the chief of cardiac surgery, the seven cardiac surgeons came to agree on 40 individual steps representing evidence-based best practices that should be provided to each and every CABG patient. Because of the evidence-based nature of its care guidelines, Geisinger has termed this approach as ProvenCareSM.

The cardiac surgery workflows at the two Geisinger hospitals where CABGs were performed (Geisinger Medical Center in Danville and Geisinger Wyoming Valley in Wilkes-Barre) were redesigned or revised to help ensure that all 40 elements were reliably provided. This included new templates for use during both office visits and hospital care, standardized order sets, and real-time reminders in the electronic health record. Office staff, residents, physician assistants, and nursing staff were all brought into the work redesign since the 40 elements spanned the time from the initial office evaluation and continued through the cardiac rehabilitation stage.

In the first month of the pilot phase, the redesign team found that all 40 of the agreed-upon elements were only being provided 57% of the time. With the aid of the performance improvement team, the surgeons further imbedded some of the principles of reliability science (e.g., redundancy,



Albert Bothe Jr., MD



Ronald Paulus, MD, MBA

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Sharon L. Jacobs, RN, MS, CIC, Manager, Infection Prevention and Control, St. Clair Memorial Hospital, Pittsburgh, Pennsylvania

John Morley, MD, Medical Director, Office of Health Systems Management, New York Patient Occurrence and Tracking System

Erin Sparnon, BSE, Senior Project Officer, Health Devices System, ECRI Institute

Michael K. Urban, MD, PhD, Medical Director PACU/SDU, Hospital for Special Surgery, New York, New York

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automation, delegation) into the daily workflows. Shortly thereafter, reliability was achieved. All 40 elements were being provided 100% of the time, month after month. The initial experience with the clinical elements was recently published in the October 2007 issue of the *Annals of Surgery*.¹ Compared to a matched group of patients in the immediately preceding time period, length of stay and total hospital charges had decreased. Other metrics have also improved, although the already excellent results made it difficult to show a statistical difference in the initial time frame. Redesigning the system to reliably deliver evidence-based care has improved quality while consuming fewer resources.

Further prompted by its interest in reshaping the existing reimbursement models to explicitly recognize quality of care, Geisinger has offered a 90-day warranty for patients who undergo a ProvenCare CABG. Under most healthcare reimbursement arrangements in the United States, providers usually receive additional payments for the care of complications related to their services. Geisinger has offered a single price that covers both hospital and physician services from the preoperative phase through any additional care related to the CABG for 90 days at its facilities. Geisinger believes that by reliably providing at least the 40 elements of care, it will minimize the likelihood of any complication. If any complications of the CABG surgery were to occur, Geisinger would absorb the extra cost.

Focus groups of patients and employers find the commitment to each and every one of the 40 steps in the care process to be appealing. As Donald Berwick, MD, president of the Institute for Healthcare Improvement, commented in the *New York Times* (May 17, 2007) about ProvenCare, "Getting everything right is really, really hard." Payers and insurers find the approach intriguing. By having a single, all-inclusive price for CABGs, Geisinger reduces the variability in claims related to this particular service by offering a single charge for the entire episode of care. Furthermore, one of the 40 elements is a commitment that the surgery will only be performed on those patients who meet the nationally recognized indications, so that there is no question about the appropriateness of the procedure.

Geisinger is in the process of developing similar ProvenCare programs in other areas. Pilot projects have begun in total hip replacement surgery and in cataract surgery. Geisinger is also adapting the same principles of process reliability to the care of several chronic diseases. Geisinger believes that reliably delivering evidence-based care will ensure quality and control costs.

Notes

1. Casale AS, Paulus RA, Selna MJ, et al. "ProvenCareSM": a provider-driven pay-for-performance program for acute episodic cardiac surgical care. *Ann Surg* 2007 Oct;246(4):613-23.

Authority Seeks Public Comment on Notice of Infection Reporting Requirements

The Patient Safety Authority has submitted notice to Pennsylvania healthcare facilities regarding infection reporting requirements pursuant to the Medical Care Availability and Reduction of Error (MCARE) Act, Chapter 4, "Health Care-Associated Infections." The notice was published in the December 22, 2007, *Pennsylvania Bulletin* (<http://www.pabulletin.com>). The notice addresses hospital reporting requirements for healthcare-associated infections (HAIs), which were developed in consultation with the Department of Health and the Authority's HAI Advisory Panel.

Important points include the following (it is strongly suggested that the complete notice be reviewed):

- Hospitals are required to report HAIs to the Centers for Disease Control and Prevention (CDC) through its National Healthcare Safety Network (NHSN). These infections include all CDC-defined event types and specific events, which are included as Exhibit A in the notice.
- The occurrence of a CDC-defined HAI in a hospital is deemed to constitute a Serious Event, as defined by

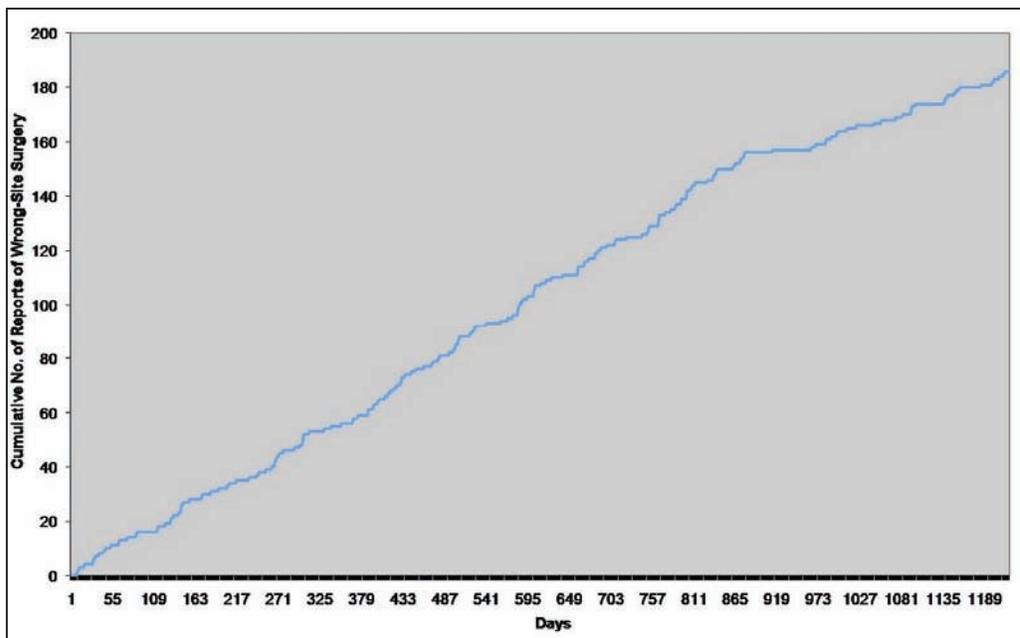
the MCARE Act, § 302. (This does not include asymptomatic bacteriuria.)

- To reduce duplicate reporting, the Authority will accept the report to CDC as meeting the Authority's requirements, provided that the facility grants group rights to the Authority in NHSN, all infection reports are filed in NHSN within 24 hours of confirmation, and the facility customizes NHSN as required in the public notice.
- Healthcare facilities will continue to report to PA-PSRS any events related to infection control and prevention that can be classified as Incidents or Infrastructure Failures.

The Authority will accept public comment about the reporting requirements for 30 calendar days following publication. Submit comments to the Authority by e-mail (patientsafetyauthority@state.pa.us). Following the public comment period, the Authority will review all comments and issue a final notice in the *Pennsylvania Bulletin*.

Insight into Preventing Wrong-Site Surgery (Continued)

Figure 1.
The Cumulative Number of Reports of Wrong-Site Surgery Events to PA-PSRS, July 2004 through December 2007



We identified hospitals that averaged more than one report of a wrong-site surgery event per year and those that had no reports of a wrong-site surgery event during the two-and-a-half-year reporting period. We adjusted for the difference in hospital sizes by calculating the number of reports of wrong-site surgery events per 100 beds.

Nine of the hospitals on our list had more than one report of a wrong-site surgery event/400 beds/year. We approached four of those hospitals that we knew were committed to patient safety despite their experiences with wrong-site surgery. They all agreed to site visits, with the requirement of confidentiality stipulated by Act 13.⁵

Two of the hospitals on the list had no reports of wrong-site surgery during the reporting period, even though they averaged more than three reports per week for other problems in their operating rooms (ORs). These hospitals also agreed to site visits, with the requirement of confidentiality stipulated by Act 13.⁵

Our PA-PSRS team, consisting of the clinical director and two nurse analysts, spent a day at each of the six hospitals. Our team also visited an ambulatory surgical facility (ASF) attached to one of the hospitals reporting multiple wrong-site surgery events. We observed one or more steps for each of 48 procedures.

See page 147 for self-assessment questions related to this article.

We were pleased with the openness and candor of everyone we spoke to during these visits. We felt that we obtained an honest picture of the activities at every facility. We are very grateful that they were willing to let us observe their practices so that everyone in the state might benefit from the observations.

In general, we noted considerable variation in how the Universal Protocol⁴ was implemented—how perioperative information was verified, how operative sites were marked, and how time outs were done—and all the other steps of taking a patient through the OR.

We describe our observations at the six hospitals in the Appendix (beginning on page 118). We not only noted considerable variation in how the Universal Protocol⁴ was implemented but also in how compliant hospitals were with their own policies. While reading the observations, consider attempting to predict which hospitals have had multiple wrong-site surgery events and which hospitals have had none. The answers are provided at the end of the article.

A Synthesis of Our Observations and Our Previous Retrospective Analysis

Wrong-site errors usually result from one of two problems: misinformation or misperception. In both our retrospective analysis³ and our observations, we noted that wrong-site surgery errors were associated with the failure to identify incorrect information in the documents related to surgery, such as the schedule,

Insight into Preventing Wrong-Site Surgery (Continued)

consent, and surgeon's history and physical examination (H&P), before the operation. Misperception can result from right/left confusion and from confirmation bias, the tendency to confirm a mental impression despite the physical facts.⁶ After reviewing the 155 actual wrong-site procedures in our retrospective analysis, we concluded that 25 resulted strictly from misinformation and 45 resulted strictly from misperception, a ratio of 1:2. The rest were mixed or ambiguous. We note that misinformation is the main source of errors that get started before the patient reaches the OR, and misperceptions typically initiate errors that start in the OR after the initial verification by the circulating nurse (see Figures 2 and 3).

The failure to identify incorrect information in documents prior to surgery can be illustrated by an edited version of a recent report to PA-PSRS:

Procedure scheduled as a right inguinal hernia repair. . . . Patient indicated his right side was the surgical side, right side was marked, and consent form was signed for the right side. The time out for a right inguinal hernia was done prior to beginning the procedure and acknowledged by everyone

in the room. After opening the right side, hernia could not be located. H&P reviewed. Surgery resumed on the left side.

In our retrospective analysis, incorrect information was frequently conveyed when scheduling a procedure, sometimes included on the consent, and occasionally present in the H&P.³ Going back over the data in our retrospective analysis, we discovered a statistically significant correlation ($p < 0.01$) between the number of reports from a facility of OR cases scheduled incorrectly and their number of actual wrong-site surgical events. The number of reports of procedures scheduled incorrectly accounted for 5% of the prediction of the number of actual wrong-site surgical events ($R^2 = 0.05$). On average, an increase in 10 reports of procedures scheduled incorrectly with the OR was associated with an increase in one wrong-site surgical event. When incorrect information was included on the consent, we got the impression it came from someone using secondhand information, such as the OR schedule, rather than from right/left confusion by the surgeon and patient. In our retrospective analysis, we noted two reports in which two conflicting consents were obtained:

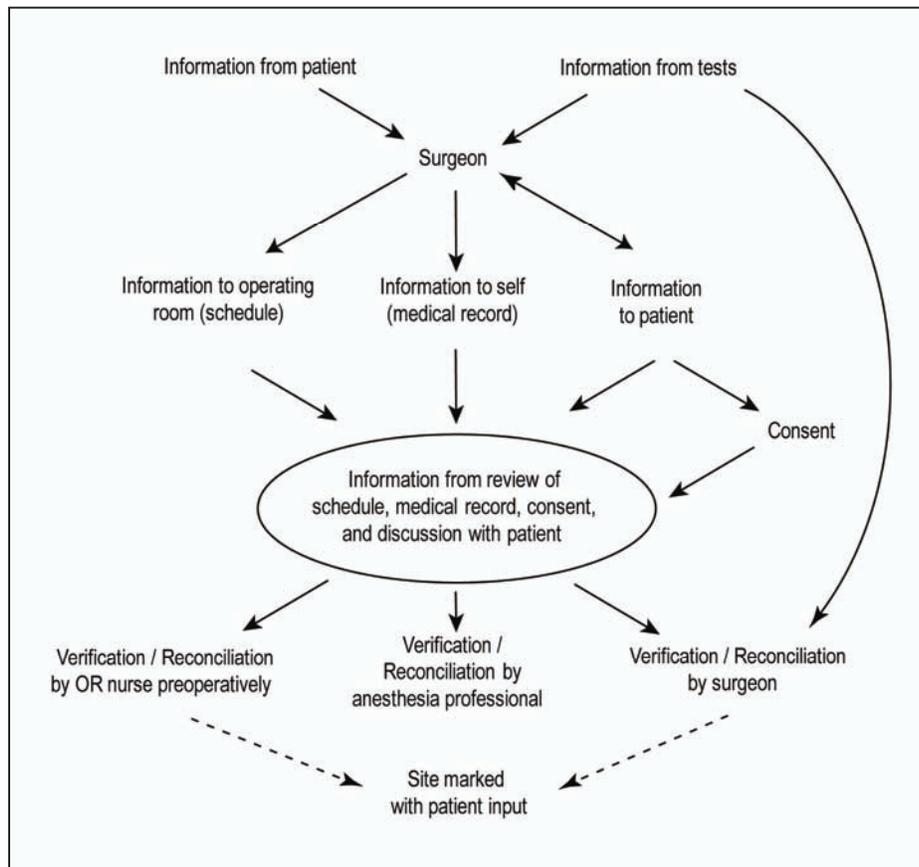


Figure 2. The Flow of Information from before the Operation Until the Site Marking.

The dashed lines indicate either option is possible.

Insight into Preventing Wrong-Site Surgery (Continued)

OR list stated right breast mass excision. Patient stated left. There were two consents. One stated right and one stated left. . . .

Two conflicting, signed and dated permits in patient chart. One stated R total hip revision; other stated L total hip revision. . . .

Both reports came from one hospital that had multiple reports of wrong-site surgery events and had no checks for inconsistencies prior to the day of surgery.

We have noted a correlation between the diligence in checking for inconsistencies in the documents and catching wrong-site errors before they occur. Hospitals that check for errors at every opportunity have more success in preventing misinformation from reaching the OR. The more independent checks, the better.

On the day of surgery, the patient frequently provides a further check to the accuracy of the documents.³ Verification of the patient's information should be done with questions that require an active expression of information, not a passive acknowledgement. As an illustration of the latter, we observed the following question: "Before I put you to sleep, we're doing your left ear, right?" When inconsistencies are noted, the surgeon must resolve them, as the patient is not correct 100% of the time.³

We noted that one facility took a proactive position by educating patients to understand that the repetitive questions about their names, procedures, and sides was done to double check against errors.

In one of the reports in our retrospective analysis,³ the patient was awake in the OR and provided useful information:

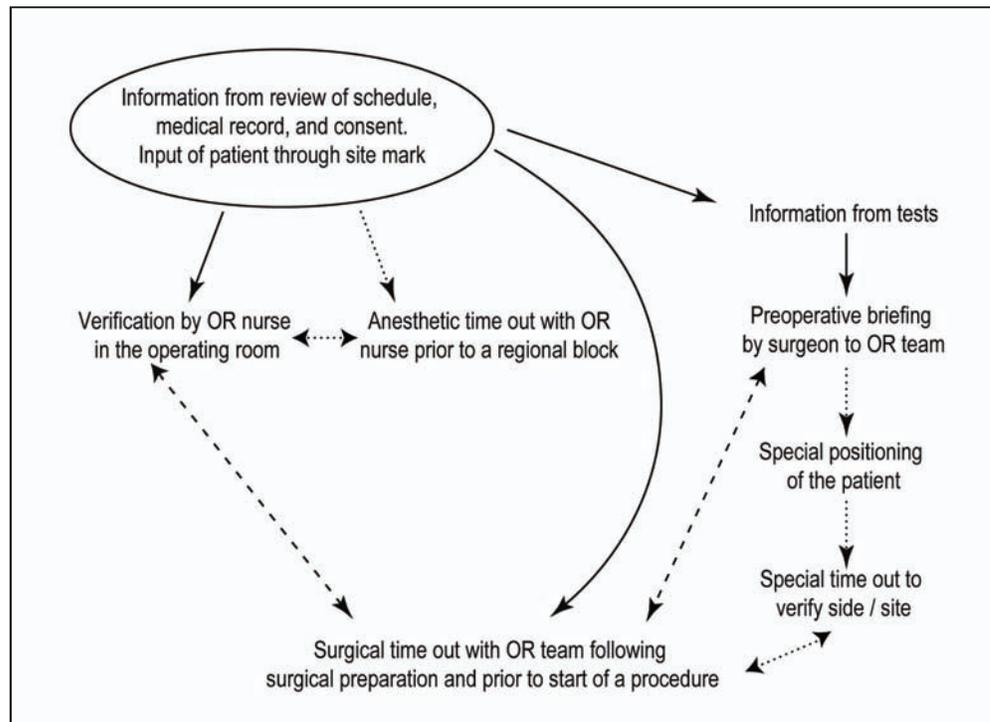
While the nurse was prepping the left leg, the patient asked if both legs would be shaved. Nurse stopped shaving and re-viewed the consent and saw the right leg was the correct side.

Our observations led us to appreciate that the mark on the operative site represents the patient's voice after he or she is sedated or anesthetized. As such, consider the following:

- The mark should be made with the involvement of the patient or surrogate. It should be made before the patient is sedated.
- The mark should be made accurately and in a way that is consistent with the facility's convention. It should be consistent with all the perioperative documents and they should all be checked prior to the marking. It should be made by someone knowledgeable

Figure 3. The Awareness of Information in the Operating Room.

The dashed lines indicate either option is possible. The dotted lines indicate a path that is only taken if indicated.



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about the procedure and the convention. It should not be ambiguous, such as an “X” that could mean “here” or “not here.”

- The mark should be made before any interventions are done, including anesthetic blocks.
- The mark should be visible from the time the patient is sedated until the final time out is done with the patient prepped and draped.

During our site visits, we heard arguments both ways about who should mark the site. Some argued that only the surgeon could mark the site accurately. Others argued that the preoperative nurses were more attentive to the process and therefore more accurate. We noted marks placed by nurses that were covered by drapes during the time outs, and we noted surgeons who neither checked the documents nor talked to the patient when marking the site. Both problems have led to wrong-site surgery.³ We believe that the question as to which person should mark the site is an open scientific question. If the preoperative nurse marks the site, the marking should be confirmed by the surgeon.

The complaint that delays occur because a surgeon must mark the site or at least visit the patient in the preoperative holding area between operations was belied by the experience in many of the hospitals we visited. The most common solution was for the surgeon to visit the first two patients before doing the first operation, then visit the third patient after the first operation, and so forth. The concern that the patient would have to be brought to the holding area earlier was not supported by perioperative staff members. They noted that rapid turnover between cases for efficiency was only useful for short procedures, so the time a patient waited for an additional case was of short duration. For longer cases with longer delays, rapid turnover was not done because it did not impact efficiency.

Problems with right/left confusion and confirmation bias in the OR can be illustrated by this edited report to PA-PSRS:

[Patient] admitted . . . for left knee [surgery]. Patient properly identified, site properly marked and brought to OR. Physician elevated right leg for procedure. Nurse prepped and draped patient. During time out, no one recognized that wrong leg had been prepared. Procedure was performed on incorrect leg.

Turning the patient prone seems to increase the chances of right/left confusion, as illustrated by this edited report to PA-PSRS:

The patient was scheduled for a left popliteal endarterectomy. The time out was done identifying the correct side. Following the procedure, it was realized that the right side was done instead of the left. The patient was placed in a prone position for the procedure.

In our retrospective analysis, we identified wrong-site regional blocks occurring because anesthesiologists did their procedures before the time outs.³ We observed that the anesthesiologists are now aware of that risk and follow policies to do a time out after the patient is marked, before starting a regional block. However, our observations at one hospital were that the time outs were not done with the formality of the time outs in the OR before starting the operation. Interestingly, this hospital had reported a wrong-site anesthesia block.

In our retrospective analysis, we noted that the most common factor associated with wrong-site surgery was the action of the surgeon in the operating room.³ In our observations, we noted a lack of engagement by some surgeons, anesthesia providers, and scrub technicians. Only nurses seemed consistently engaged in the steps of the Universal Protocol,⁴ as evidenced in the following observations:

The surgeon approached the patient's bed. There was no conversation. The surgeon used his pen to put a small “X” on the right side of the patient's neck. There was no review of the medical record.

After the nurse completed the time out, no one acknowledged it. Between 30 and 60 seconds later, the attending surgeon asked, “Are we going to do a time out?” The nurse said, “We did the time out. We already did it.” The surgeon then started the operation.

The circulating nurse started the time out, saying “Time out.” The surgeon turned to scrub tech and said, “I need a 10 [scalpel with a no. 10 blade].” The circulating nurse said, “We are doing [the name of the procedure] on [the patient's name].” The surgeon was already making the skin incision.

In June 2005, we reported that a hospital in Pennsylvania responded to a similar situation that

Insight into Preventing Wrong-Site Surgery (Continued)

resulted in wrong-site surgery by establishing a policy that blades will not be available to the surgeon until after the time out is satisfactorily completed.⁷

The surgeons seemed more engaged when they led the time outs, although the circulating nurse, not being scrubbed, has the advantage of being able to verify the information in the medical record. We note an inconsistency between how patients are queried during the verification step and how surgeons are queried during the time out step of the Universal Protocol.⁴ The patient is asked to give information (i.e., an active response). The surgeon is asked to agree with information that has been given (i.e., a passive response). Even this passive level of response was uncommon.

For a time out to be effective, the OR team members must not only be engaged, they must be prepared to speak up. During our visits, we were told of instances in which nurses spoke up, preventing wrong-site surgery, and instances when they did not speak up, even when they thought there was the possibility of wrong-site surgery occurring.

For a time out to be effective, the surgeon must also be prepared to acknowledge the concerns of OR team members. We observed a nurse object to a surgeon doing a second procedure on a patient that was not on the consent. The surgeon did not stop what he was doing to address that concern.

Anatomic confirmation of spinal levels occurs after the Universal Protocol time out. The North American Spine Society adds elements to their protocol, asking surgeons to consider an intraoperative image to verify the vertebral level and consider verification by a radiologist.⁸ We observed that surgeons operating on the spine verified the vertebral level with an image, but did not get verification from a radiologist. Surgeons have occasionally misinterpreted the images.³

In our retrospective analysis, we noted errors involving specimens.³ These errors have the potential to set patients up for wrong-site surgery in the future. Some of these errors were right/left confusions resulting from poor communication. Others were misidentification of the patient resulting from the use of labels leftover from earlier procedures in the OR. During our visits, OR nurses at several hospitals expressed concern that leftover labels were a potential source of error.

In all the hospitals we visited, we observed surgeons who were perceived by us and identified by staff as safe surgeons, unlikely to experience wrong-site surgery. In general, these surgeons reviewed all

the relevant information available, including imaging studies, and shared the information with other OR team members. They were engaged in the verification, site marking, and time out processes, sometimes referring to documents during the time out. In contrast, we know from our reports that disruptive behavior by surgeons has been associated with both wrong-site events and near misses.

Preliminary Findings from Pennsylvania

The PA-PSRS analytical team began contemporary in-depth queries of wrong-site surgery reports in August 2007. Facilities have been cooperative in providing this extra information to help us all understand the problem better. Even our preliminary data has produced useful information about the differences between near-miss events and actual wrong-site surgery events in ORs and ASFs. As of December 16, 2007, we have received the results of 16 completed in-depth queries about near-miss events and 6 about actual wrong-site surgery events from cooperating facilities. The compliance rate with our request for detailed information within 30 days of the event has been 56%.

Two-thirds of the near-miss events (8 of 12) had errors in the information communicated to the OR from the surgeon's office staff when scheduling the case. One of the six actual wrong-site surgery events had scheduling errors, a significant difference. This observation is consistent with the previous observations on our retrospective review that most scheduling errors are detected and corrected during the preoperative verification and reconciliation process.³

All of the near-miss reports indicated the use of a checklist to document the verification and reconciliation process. A checklist was used in only four of the six wrong-site surgery events, again a statistically significant difference by chi-square test. This observation suggests that the checklist may be valuable in detecting inconsistencies in the documents before they lead to wrong-site surgery.

The surgeon responded to a specific concern that a member of the OR team voiced about possible wrong-site surgery in all 11 replies about near-miss events, but only in 1 of 4 replies about wrong-site surgery events. This statistically significant difference suggests that reluctance to either express or acknowledge concerns may contribute to a situation becoming a wrong-site surgery rather than a near miss. The following report provides an example:

Patient for left inguinal hernia repair via laparoscopy. The documentation and

Insight into Preventing Wrong-Site Surgery (Continued)

marked site was on the left. Procedure requires opposite of side of repair to be prepped, and the surgeon directed the nurse to [prep the left]. The surgeon was questioned about the site and [said] to proceed with that side. The surgeon completed the procedure and when completed went to document on the chart and recognized the right side had been done, not the left. The patient was immediately prepped for the left inguinal hernia repair.

We are optimistic that the ongoing cooperation of facilities in providing in-depth information about wrong-site surgery events and near misses will reveal more clues about processes that are successful in preventing wrong-site surgery.

Conclusion

Based on our retrospective analyses, observations, and preliminary, contemporary comparisons, we believe that the opportunities for wrong-site surgery are minimized when all salient information is in agreement. For elective surgery, reconciliation of all the important information, such as the OR schedule, the consent, the H&P, and definitive diagnostic studies, can occur before the day of surgery. We also believe that confusion is minimized when all members of the OR team assume a personal responsibility to have firsthand knowledge that the correct patient is getting the correct procedure at the correct location. The mark on the operative site is the patient's voice, continuing to speak after sedation or induction of anesthesia. We have concluded that the time out is commonly perceived as the opportunity to make sure that the correct procedure was being done on the correct patient. It is not; it is the *final* opportunity of many that began when the patient was scheduled for surgery. Many steps of preparing the patient for an operation and performing an operation can lead down the path of wrong-site surgery. Preventing wrong-site surgery may require attention at every step of the process, not just the three advocated by the Universal Protocol.

We will continue to analyze the wrong-site surgery events and near misses. In the meantime, we encourage hospitals and ASFs—that wish to have the success of the Hospitals C and E described in the Appendix—to assess their program for preventing wrong-site surgery using the aforementioned self-assessment checklist. We encourage you to share your assessments and the success or failure of your efforts to improve your wrong-site surgery programs with us. We welcome interest from facilities outside Pennsylvania as well as in Pennsylvania.

Web Resource for Wrong-Site Surgery

Those interested in preventing wrong-site surgery can get the following information from the Pennsylvania Patient Safety Authority Web site (<http://www.psa.state.pa.us>):

- A stand-alone copy of a self-assessment checklist for programs to prevent wrong-site surgery
- A graph of cumulative wrong-site surgery events in Pennsylvania, updated quarterly
- Stand-alone copies of figures discussing the flow and awareness of information in the operating room
- The ongoing comparative results of detailed reports of wrong-site surgery and near misses, updated quarterly
- Access to all *Advisory* articles on wrong-site surgery and information on articles in other publications authored by the PA-PSRS team
- The previously released "Doing the 'Right' Things to Correct Wrong-Site Surgery" video
- A contact link to discuss with the PA-PSRS team your assessments, successes, failures, other experiences, opinions, and questions

Notes

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Insight into Preventing Wrong-Site Surgery (Continued)

Appendix: Hospital A

Scheduling	Surgeon office personnel fax requests using a standard form that includes the procedure and diagnosis. If the site, side, or digit is missing, the scheduler in the operating room (OR) calls the office for the information. Preadmission testing (PAT) requests that the consent be sent when scheduling the case, but this happens 50% of the time. Compliance is compromised by staff turnover in surgeons' offices. PAT educates office staff on scheduling procedure.
Consent	Consents are obtained "before the day of surgery if possible." About half are sent with the request to schedule surgery. Surgical subordinates usually obtain delinquent consents.
Verification and Reconciliation	<p>If both are present, the scheduler in the OR reconciles the scheduled procedure and the consent. In the admission area, the preoperative nurse verifies the patient's name, date of birth, and allergies with active queries of the patient and a check of the armband. The patient's understanding is also verified against the consent, the OR schedule, and the history and physical examination. Discrepancies are resolved by the surgeon.</p> <p>For inpatients, an OR checklist is completed on the inpatient unit and verified by the preoperative nurse. If it is incomplete, the preoperative nurse completes it. The rare discrepancy about the procedure or consent is resolved by the preoperative nurse.</p>
Site Marking	The admitting preoperative nurse marks the site with a "YES" with verification by the patient. For inpatients, site markings are done by the patients if possible. Otherwise, they are done by the preoperative holding area nurses. A permanent marker is used.
Anesthetic Induction Area	Not applicable.
OR and Time Out	There are two time outs. The time outs are led by the circulating nurse. The first time out is supposedly, but not always, done before anesthesia is given. All members of the operating team are supposed to participate, but usually just the circulating nurse and anesthesia providers take part. The second time out is just before the incision. If there is a second procedure, a third time out is done before that procedure.
Verification of Spinal Level	Not observed.
Specimen Management	Not observed.
Other Observations	None.
Impression	<p>OR team members did their jobs, but did not communicate much with each other. There were examples of a lack of situational awareness (e.g., ordering antibiotics that the patient was allergic to). Except for the leader, team members were usually not engaged in the time outs. Observed comments include the following:</p> <p>Anesthesiologist asked the preoperative nurse, "What's the holdup?" The patient said, "She's dotting the i's and crossing the t's." The preoperative nurse said, "Thank goodness someone is in my corner."</p> <p>As the scrub technician was setting up the equipment after the first time out, he said, "What side are we doing?" The circulating nurse said, "Right." The scrub technician later said to an equipment representative, "I think we are doing the right here; I'm not sure."</p> <p>After the nurse completed the time out, no one acknowledged it. Between 30 and 60 seconds later, the attending surgeon asked, "Are we going to do a time out?" The nurse said, "We did the time out. We already did it." The surgeon then started the operation.</p>

Insight into Preventing Wrong-Site Surgery (Continued)

Appendix: Hospital B

Scheduling	Surgeon office personnel schedule operations using a form on the hospital's intranet that includes demographic information and the procedure. There is a separate field for side and body part. If the side is not filled in, the scheduler in the operating room (OR) calls the surgeon's office for the information. After scheduling a case and prior to the day of surgery, the surgeon's office faxes a list of the patients and procedures, including sides, in the order in which the surgeon wants to do them. This list is entered into a computer to create an electronic version of the daily OR schedule. The patient side must be known to enter a procedure. If the information on the list does not match the information on the original scheduling forms, the surgeon's office is called for clarification. If the order of cases is changed the day of surgery, the changes are noted on the electronic OR schedule, which is displayed throughout the OR. However, some changes have occurred without being reflected in the electronic OR schedule.
Consent	The consents are usually obtained in the surgeons' offices; if not, they are obtained the day of surgery. Many attending surgeons forward their consents to the hospital, but some carry them to the hospital the day of surgery.
Verification and Reconciliation	The preoperative nurse verifies the patient's name, date of birth, medical record number, procedure, and allergies with the identification armband. Four pieces of information are used for verification: the schedule, consent, history and physical examination (H&P), and the patient. The anesthesia provider and the attending surgeon also separately see the patient in the preoperative holding area. Surgeons who run two rooms see two patients before doing the first operation, and then see the third patient before doing the second operation, and so forth.
Site Marking	After meeting the requirements for verification, the nurse marks the site with a "Yes." If all four pieces of information used for verification are not available, such as when the surgeon is in the process of delivering the consent and H&P, the site can be marked on the basis of two of the four. If the minimum of two pieces of information is not available, the surgeon marks the site in the OR. Surgeons in some specialties mark the sites themselves for specific reasons. Operative sites for structures without sides, digits, or levels are not marked. Breasts are marked over the clavicle to avoid misleading surgeons about the exact location of a biopsy. Marks should be visible after the patient is prepped and draped.
Anesthetic Induction Area	The anesthesiologist does a time out before doing a regional block.
OR and Time Out	The anesthesiologist leads the time out after the patient is draped. The time out includes checking the patient's wristband and reading the procedure from the consent. It includes the patient's name, procedure, allergies, antibiotic status, and equipment availability. Information is verified with the medical record.
Verification of Spinal Level	Not observed.
Specimen Management	The specimen is labeled and a duplicate label is placed in the specimen book along with the name of the person delivering the specimen, the date, and the time. The person transporting the specimen for pathology is supposed to check the specimen label against the entry in the book and sign the book. The name of the patient's attending physician on the label may not be the name of the operating surgeon, so the results may initially go to someone other than the surgeon. The facility is considering a specimen time out, too. Currently, there is little input by the operating surgeon into the identification of the specimen. Supervisors have also witnessed situations in which plates or labels that were left over from a previous operation were used to label the specimen during another operation. This situation is related to the extensive computerized checklist that the circulating nurse must complete. The time needed sometimes extends beyond the patient's departure, leading to mixing of information with the incoming patient.
Other Observations	The schedulers in the OR meet with the office schedulers once or twice a year to discuss problems. The OR director checks 10 verifications and observes 10 time outs per week to monitor compliance with the Joint Commission Universal Protocol.
Impression	The occasional last minute addition of the consent and H&P to the medical record had the potential to compromise the verification process. Observed comments include the following: "As things get more ingrained, they also become treated more as a routine." "The more that's done in the doctor's office, the less chance for error."

Insight into Preventing Wrong-Site Surgery (Continued)

Appendix: Hospital C

Scheduling	Surgeon office personnel send requests for cases to be scheduled by telephone, fax, or e-mail. The diagnosis and procedure must match. The request must be specific about the site. If there are any inconsistencies or deficiencies, the operating room (OR) scheduler will call to clarify. Later, the office sends the consent, history and physical examination, and orders to a central hospital department for verification and reconciliation with the schedule. If any information is missing or inconsistent, the surgeon's office is called. The department begins to double check three days before surgery, following up daily if needed. The department documents the information on a checklist. "Almost 100%" of scheduled operations have full documentation verified the day before surgery or earlier.
Consent	The consent for elective surgery must be sent by the surgeon's office no later than the day before surgery.
Verification and Reconciliation	The preoperative nurse checks the medical record prior to speaking with the patient. The nurse verifies the patient's name and date of birth when applying the identification armband. The procedure and site are verified with the patient, the consent, and the medical record using a standard preoperative verification form. All questions to the patient require an active response, not a passive acknowledgement. If there are any discrepancies, the surgeon verifies the correct information before the patient goes to the OR. The anesthesia provider sees the patient and independently verifies the information.
Site Marking	Site markings are reserved for procedures with laterality. The nurse marks near the operative site with a "YES" using a permanent marker after verification and with the involvement of the patient.
Anesthetic Induction Area	Not applicable.
OR and Time Out	In the OR, the circulating nurse verifies the information using the preoperative checklist. The images are accessed only within the OR rooms, almost always in the PACS and almost always by the nurses. The nurses are educated in how to access the images, but without specific reference to double-checking patient ID, side, or date. The images were present for all operations observed. The person who leads the time out immediately before the incision may either be the surgeon or the circulating nurse.
Verification of Spinal Level	Surgeons routinely identify spinal levels by imaging, rather than by counting from a landmark. Some surgeons use a percutaneous needle to mark the vertebra before making the incision. Others put a marker on an exposed vertebra. The confirmations are done by the surgeons, but not verified by radiologists.
Specimen Management	All specimens are listed on a form. There are also separate forms for each specimen. The labels are checked by the circulating nurse. The surgeon identifies the original sites of the specimens. The scrub technician repeats the information about the specimen's origin when handing off each specimen to the circulating nurse. The circulating nurse verifies each specimen cup label with the scrub technician. Each specimen is placed in a bag with its form. Usually, an OR aide takes the specimens to pathology and reports their origin. The pathology technician verifies the specimen labels with the OR aide, then enters the information about the specimens into the department computer to generate a unique identifier for each specimen. The pathology tech writes the identification numbers on the specimen forms. Both the OR aide and the pathology tech sign the forms, and the OR aide takes a copy of each back to the OR.
Other Observations	Surgeons did not run two rooms in this hospital. There was a level of tolerance for variation in physician practices. The OR supervisors will do root cause analyses on wrong-site surgery near misses and discuss them during OR staff meetings. They also do 15 to 20 random observations each month to monitor compliance.
Impression	<p>The members of the OR team talked to the patient, talked to each other, engaged in time outs, and were attentive in general. Observed comments includes the following:</p> <p>The OR did a case a few weeks earlier during which a nurse appropriately questioned a surgeon "whose personality would make him the least likely to be challenged" and succeeded in preventing a wrong-site surgery. "You think it would never happen, but it almost did."</p> <p>The circulating nurse said, "I never trust the consent. I look for confirming information."</p> <p>The surgeon entered the room and began viewing the computed tomography (CT) scans. One of the nurses performed a time out. The surgeon did not look up from viewing the CTs. The nurse performing the time out asked the surgeon if he agreed, and he said, "Agree to what?" When the nurse replied that a time out had been done, the surgeon said, "I'm canceling the time out. I decide when the time out happens." The time out was planned to be done by the surgeon immediately prior to the incision.</p>

Insight into Preventing Wrong-Site Surgery (Continued)

Appendix: Hospital D

Scheduling	Offices and surgeons request cases to be scheduled by telephone or fax, or in person using handwritten entries on preprinted cards. The information in the cards includes the patient's name, procedure, diagnosis, surgeon, and time. The side or spinal level is entered under comments. The handwritten information is entered into three electronic systems. If a deficiency or discrepancy is identified, the surgeon's office is called. Office personnel "occasionally" call back. The schedulers "need complete information" to include the procedure in the surgeon's block time on the OR schedule. The original card remains part of the medical record. Verification is done using both the card and the schedule.
Consent	The consent is usually obtained in the surgeon's office. It may be obtained by the surgeon or someone else in the preadmission testing or the admitting/holding area. The preoperative nurse can obtain a consent if the surgeon has spoken to the patient.
Verification and Reconciliation	<p>A hospital service makes sure that the consent, history and physical examination (H&P), orders, and lab values are present and in agreement by at least the day before elective surgery. If any deficiency or discrepancy is identified, the surgeon's office is called.</p> <p>The admitting area receives the consent, H&P, orders, and lab values the day before any elective procedure and verifies the information with the operating room (OR) schedule. An anesthesia provider sees the patient for the first time on the day of surgery. Patients cannot be taken to the OR until they are seen by the anesthesia providers. No sedation is given prior to either a regional block in the induction area or the OR itself. Different nurses said they used different documents for verification, from the patient's name, date of birth, and procedure to the consent, H&P, OR schedule, and x-ray. Any discrepancies are resolved by the surgeon. Some, but not all, surgeons see the patient in the admitting/holding area. The circulating nurse may repeat the verification in the admitting/holding area before taking the patient to the OR.</p>
Site Marking	Sides are marked with "YES" on the correct side, right or left. Spinal levels are also marked as cervical, thoracic, or lumbar near the area of incision. The preoperative nurses mark the operative sites with input from the patients. At the request of the surgeons, they place the mark within the operative field, but not over the site of the incision. Our observations were that they were not always successful in their attempts to make their marks within the operative field. Some surgeons do the site marking themselves in the admitting/holding area, either in lieu of or in addition to any marking by the nurse.
Anesthetic Induction Area	Anesthesiologists conduct a time out before doing a regional block in the induction area, but it appears to be more of verification, with little reference to documentation. The blocks are done after the patient is marked.
OR and Time Out	There are two time outs. The first is when the circulating nurse, the anesthesia provider, and the attending surgeon are first together with the patient in the OR, before anesthesia is administered. This time out is similar to the initial verification by the circulating nurse, upon entering the OR, at other hospitals. The second is after the patient is prepped and draped. Each room has a white board with space for the patient's name, the type of procedure, and the names of the OR team members for that procedure. The white boards were filled out inconsistently: some sparsely, some completely.
Verification of Spinal Level	All procedures on cervical vertebrae are preceded by a needle localization of the vertebral level. Needle localization is not done uniformly for procedures on lumbar vertebrae.
Specimen Management	The surgeons are only nominally involved in the specimen handling process. Labels left in the OR from a previous operation were the most frequent source of labeling errors.
Other Observations	<p>The OR supervisor has noted failures of empowerment, such as reluctance of a new nurse to speak up and intimidation by a surgeon that serves to discourage a time out.</p> <p>Surgeons did not run two rooms in this hospital. Everyone, including aides and transport orderlies, has been taught to identify patients correctly with two identifiers (i.e., name and date of birth) using the armband for verification.</p>
Impression	<p>The members of the OR team appeared to work together. The distinction between "verification" and "time out" was blurred. Observed comments include the following:</p> <p>"If I am not around to hear patient say the side, I [always] check the consent."</p> <p>The certified registered nurse anesthetist (CRNA) looked at the patient's armband and said, "Your armband says [the patient's name]?" The patient said, "Right." The CRNA said, "You're [gives patient's age]?" The patient said, "Right." The anesthesiologist asked, "How are you doing today? Right leg?" The CRNA said, "Right." The anesthesiologist then proceeded with the block.</p> <p>The circulating nurse started the time out saying, "Time out." The surgeon turned to scrub tech and said, "I need a 10 [scalpel with a no. 10 blade]." The circulating nurse said, "We are doing [the name of the procedure] on [the patient's name]." The surgeon was already making the skin incision. The circulating nurse asked, "Do you agree?" When the surgeon who was operating did not respond, she repeated, "Do you agree?" The surgeon responded to the second query and said, "Yes, I agree. All in favor?" (Editor's note: The last comment was said in jest.)</p>

Insight into Preventing Wrong-Site Surgery (Continued)

Appendix: Hospital E

Scheduling	Surgeon office personnel communicate requests by phone, fax, or e-mail. One person in the scheduling office enters the reservation onto the computerized operating room (OR) schedule. The reservation should include the patient's name, date of birth, surgeon, procedure and site, but does not have to be complete for the operation to be scheduled. The side and site is entered in a comment field. If the side/site is not provided, a notation is made for the side/site to be verified later. The surgeon's office must also call the hospital registration office to have the patient entered in the hospital system.
Consent	The surgeons must obtain the consents. They usually obtain consent in their offices. The preadmission testing (PAT) nurse checks the consents.
Verification and Reconciliation	<p>The PAT nurse coordinates the patient preadmission testing and generates a medical record. The PAT nurse ideally sees the patient at least one week prior to surgery. The PAT nurse reviews the OR schedules one week in advance of the scheduled surgery and contacts any patients who have not gone through the preadmission testing process. The PAT nurse also will call to obtain information from any off-site preadmission tests. The PAT visit starts with a visit to the registration office, where the patient's identity is verified with a picture ID, if possible. The registration staff also verifies the procedure and side/site and the surgeon with the OR schedule. During the PAT visit, the PAT nurse verifies the patient's name, surgeon, procedure and side/site on the OR schedule with the patient. If there are any discrepancies, the surgeon's office is notified. The PAT nurse also gives the patient an overview of the process/procedure. Two days before surgery, all of the patient's information goes to the anesthesia office for review. Generally, a certified registered nurse anesthetist (CRNA) reviews the information and checks for any pending or missing information. The information is sent back to the PAT office. The day before surgery, the registration office prints the OR schedule generated by the scheduling office and verifies the registration information with the OR. The secretary in the PAT office checks the list of patients for surgery the following day, sent by the registration office. She notes any missing information on a stamped form on the front of each patient's medical record and enters the notations of missing information on a log. The medical records are then sent to the admitting/holding area. The PAT secretary reviews the log with the registration office in preparation for the next days' OR schedule. The registration office will again call the surgeon's office if there is a discrepancy in the admission/registration paperwork and the OR schedule.</p> <p>On the day of outpatient surgery, the hospital registration staff verify the patient's identification, with the date of birth and a picture if possible, and attach the armband. The preoperative nurses verify the patient's name, date of birth, consent, history and physical examination, and schedule against the patient's responses. Discrepancies are resolved by the surgeon. An anesthesia provider sees the patient and reviews the medical record. The surgeons or their surgical assistants must see the patient in the preoperative holding area and mark the operative site. If the consent is not acceptable, the surgeon must get the consent before marking the site. The circulating nurse and/or CRNA from the operating team verifies the patient immediately prior to transporting him or her to the OR.</p>
Site Marking	The surgeons or their surgical assistants must initial the operative site in the preoperative holding area. This can only be done if the consent has been signed. The patient cannot be sedated or taken to the OR unless the site is marked. The CRNA is the monitor for the site markings. The OR nursing supervisor feels strongly that marking the site is the responsibility of the surgeons, not the nurses. Most, but not all, of the site markings were visible after the patients were prepped and draped.
Anesthetic Induction Area	Not applicable.
OR and Time Out	The verification checklist is signed by the circulating nurse and the surgeon preoperatively, although the surgeon sometimes signs it post-operatively. Some time outs were led by circulating nurse, some by surgeons, and some by CRNAs. The time out includes the patient's name, the procedure, antibiotic status, and implants.
Verification of Spinal Level	Not observed.
Specimen Management	They have had problems with labels leftover from previous cases being available during the next cases. They have also had problems with breast biopsies of areas identified by needle localization being sent directly to pathology rather than to radiology to confirm the presence of the calcium. They feel they could do better about asking the surgeons the exact locations of the specimens removed.
Other Observations	The chief of surgery appeared to believe that the hospital's procedures to prevent wrong-site surgery were unnecessary and slowed the OR schedule. Other surgeons complained of too much paperwork. Some surgeons run two rooms, but they must mark the operative site and be in the OR before anesthesia is given. The orthopedic and anesthesia programs are very supportive of the procedures to prevent wrong-site surgery. The OR and preoperative staff are very experienced and have had lots of education. The nurses are not afraid to question the surgeons. The hospital's preoperative patient education program includes information on preventing wrong-site surgery. OR supervisors do informal site verification monitoring monthly.
Impression	<p>The surgeons were no more interested in procedures to prevent wrong-site surgery than surgeons elsewhere. They were knowledgeable about their patients and familiar with their records. Most marked the sites perfunctorily. The anesthesia personnel were more involved than elsewhere. Overall, the team had situational awareness (e.g., everyone was aware of an elevated PTT). The hospital had numerous (about seven) checks in the verification and reconciliation process, so that it was rare that a patient came to the holding area with a deficiency or discrepancy in any documents. Observed comments include the following:</p> <p>"If there is an issue, we want everyone aware."</p>

Insight into Preventing Wrong-Site Surgery (Continued)

Appendix: Hospital F

Scheduling	Scheduling for ambulatory and hospital patients is done electronically from the surgeons' offices. There is no quality control of the process. Errors are not identified until the day of surgery.
Consent	The consent should be obtained in the surgeon's office. The offices are encouraged to scan the consents and send them to preadmission testing (PAT). Sometimes the consent is obtained in the admitting/holding area. The patient cannot leave the admitting/holding area without a valid consent.
Verification and Reconciliation	<p>The PAT nurse practitioners check that the consents and history and physical examination (H&P) are done and do preoperative testing. Patients in the ambulatory surgical facility get pamphlets explaining the time out process, in response to concerns that the patients did not understand why the OR staff did what they did.</p> <p>A trained desk clerk checks to make sure all necessary documents are present for patients on the next day's hospital and ambulatory OR schedules. However, the clerk does not check for or reconcile any discrepancies.</p> <p>The admitting nurse verifies the patient's name with two identifiers and applies an armband. The nurse verifies the consent, schedule, and H&P with the patient and checks for recent illnesses. Any discrepancies must be resolved by the surgeon before the patient leaves the admitting area. The preoperative nurse also verifies the patient's name with two identifiers and checks the consent, schedule, and H&P for discrepancies. The surgeon marks the operative site if not done already. The preoperative nurse and the certified registered nurse anesthetist have a preoperative briefing to verify the reconciliation and the site marking. This briefing catches one to two discrepancies or deficiencies per week.</p>
Site Marking	The attending surgeon must mark the site with his or her initials, in consultation with the patient and medical record, before a patient can enter the OR. The site can be marked in the surgeon's office, the inpatient units, or the preoperative/holding area. The site must be marked prior to any regional block. The markings must be visible when the patient is prepped and draped. If both sides are being done, neither side is marked. The anesthesia department monitors the site markings.
Anesthetic Induction Area	Regional blocks are done in the preoperative holding area. The anesthesiologist conducts a time out with the patient and a "regional anesthesia nurse."
OR and Time Out	The surgeon leads the time out. The circulating nurse records the time out. The anesthesia department monitors the time out. The time out is a more detailed preoperative briefing. Most surgeons do the time out from memory, but some use a checklist. There is no problem getting members of the OR team to focus on the time out. The operation does not start without acknowledgement of the time out. Everyone can speak up. There is not supposed to be any change in OR team members between the time out and the start of the procedure. If there is a second procedure, a second time out is done before that procedure.
Verification of Spinal Level	The surgeon verified the vertebral level by radiograph, marking it with a needle after exposing it. Confirmation was done by the surgeon, but not verified by a radiologist.
Specimen Management	Not observed.
Other Observations	The OR team members communicate with each other. Some surgeons run two rooms, although the attending surgeon must mark the site before a patient can enter the OR. When running two rooms, the staff tries to do all the left-sided procedures in one room and right-sided procedures in the other room when possible. Sometimes the H&P that is in the system from a previous procedure is accessed by mistake.
Impression	<p>Inaccuracies during the scheduling of procedures were perceived as an area of weakness in the system by the facility's staff. The OR team members were attentive to the surgeon-led preoperative briefings/time outs. Observed comments include the following:</p> <p>"If it's not on the consent, it's not going to happen in the OR."</p> <p>After completing a procedure on the right ear, the surgeon did an examination under anesthesia of the left ear. When the nurse said that the examination was not part of the procedure, the surgeon said, "Actually, I always examine both ears. [The patient] is signed up for bilateral [procedures] if necessary." The schedule (and consent according to the OR supervisor) clearly said "right ear [procedure]" only.</p> <p>"I need permission to put you to sleep. The risk is not zero, but it's not prevalent, either. Before I put you to sleep, we're doing your left ear, right?"</p> <p>The anesthesia provider was relieved by another. A complete handoff was done, and the first provider stayed for the time out.</p> <p>"There is some reluctance to speak up."</p> <p>"This is ridiculous," said the attending surgeon. "You're wasting my time! This [discectomy and vertebral fusion with a bone graft] is only going to take 20 minutes." Someone said to the surgeon, "That was preop. The next patient has [a contact allergy]." The surgeon responded, "What does that mean for me? Is that going to slow me down?" Five minutes after making the skin incision, the surgeon asked "What time did we start this case?" When informed that it was five minutes ago, he said, "It's turned into a marathon already." Two minutes later, having exposed the vertebra and identified it with a needle, he asked, "Where's my x-ray? Did [the radiography technician] come back yet?" Later he said, "Can you pull that x-ray up? What's going on? It's not done yet. Can you call up? There it is." The surgeon confirmed the vertebral level. As the observers left the OR room, a nurse said, "He's always that way."</p>

Prompt Identification and Effective Communication of Status May Reduce MRSA Infections

More than 1,700 reports related to methicillin-resistant *Staphylococcus aureus* (MRSA), including 14 deaths, have been submitted to PA-PSRS since its inception through October 2007. Less than 10% of MRSA reports indicated the facility performed a MRSA screening upon a patient's admission. Approximately 13% of reports submitted to PA-PSRS indicated that a patient's MRSA status, either an infection or colonization, was not communicated to healthcare workers. Failure to adequately identify and/or communicate patients' MRSA statuses can perpetuate infection and transmission to other patients and healthcare workers.

The sometimes devastating effect of an invasive MRSA infection is demonstrated in the following PA-PSRS report.

Patient readmitted mid-July with recurrent MRSA bacteremia from an infected [intravenous (IV)] site during previous admission. When patient was discharged, [after this previous admission] blood cultures had been negative, and patient was discharged on IV antibiotics. Patient was readmitted with recurrent MRSA bacteremia and developed paralysis of lower extremities related to septic thrombophlebitis of the spinal cord with compression.

Staphylococcus aureus is a common bacteria residing on the skin and nasal passages, and it can cause infection when it gains access to the body through an open cut in the skin.^{1,2} MRSA is a type of *Staphylococcus aureus* that is resistant to certain antibiotics, including methicillin, oxacillin, penicillin, and amoxicillin.³ MRSA bacterial strains include healthcare-associated MRSA (i.e., MRSA acquired in healthcare facilities) and community-associated MRSA (i.e., MRSA acquired in the community, usually associated with skin infections such as abscesses).^{1,3}

Among multidrug-resistant organisms (MDROs), MRSA is identified as a target organism because methods implemented to reduce MRSA may be applicable to limiting transmission of other MDROs.⁴ Despite the efforts of healthcare facilities aimed at reducing infection, MRSA infections continue to cause harm to patients. Although elimination of MRSA from healthcare facilities is a complex

process, a comprehensive infection control program may decrease its prevalence and incidence. A comprehensive program includes the following: screening patients for colonization and infection (i.e., active surveillance), strict adherence to isolation precautions for colonized and or infected patients, development and implementation of hand hygiene protocols, and improvement in the decontamination of medical equipment and the healthcare environment.

This article will discuss the components of a comprehensive program aimed at reducing MRSA infections in hospitalized patients. Obtaining leadership buy-in and gaining their support is essential for the success of programs aimed at reducing MRSA infections. An administration committed to reducing MRSA provides the needed resources to implement a comprehensive program and the motivation for changing to a culture of patient safety.⁵

Problem

Healthcare-associated infections (HAIs) including MDROs such as MRSA remain a major cause of morbidity, mortality, increased hospital length of stay, and increased healthcare costs.¹ Although there is variation in the reporting of MRSA incidence and prevalence, a recent study by the Centers for Disease Control and Prevention (CDC) conducted at 9 U.S. sites from July 2004 through December 2005 indicated there were 8,987 observed cases of invasive MRSA.¹ HAIs numbered 7,639 (85%) and community-associated infections numbered 1,234 (13.7%). There were 114 (1.3%) infections that could not be classified.¹ From the number of observed cases, CDC estimated the prevalence of invasive MRSA infections nationwide in 2005 at 94,000 cases;¹ these infections were associated with death in nearly 19,000 cases.¹

Based on 2004 data, the Pennsylvania Health Care Cost Containment Council reported 13,722 hospitalized patients had a MRSA-related infection. A comparison of patients without a MRSA infection revealed that patients with a MRSA infection were four times more likely to die, and on average, patients with MRSA had an increased length of hospital stay (i.e., up to eight days longer). The average charge for a patient's hospital stay with a MRSA infection was \$87,990, compared to an average charge of \$28,711 for a patient without a MRSA infection.⁶ While not all of these differences are necessarily attributable to the infections alone, they do suggest the magnitude of the problem.

See page 147 for self-assessment questions related to this article.

Prompt Identification and Effective Communication of Status May Reduce MRSA Infections (Continued)

Several factors have contributed to the increase and spread of MRSA, including the unnecessary use of antibiotics over the last two decades for conditions not requiring or responding to antibiotics and the transmission of infections by means of the contaminated hands of healthcare workers from patient to patient due to poor compliance with hand hygiene.^{1,7} MRSA can also be spread from one person to another through contaminated objects or person to person contact in the community.¹

A patient who was in isolation for history of MRSA was in a private room but not placed on isolation precautions for six days. Isolation [precautions were] placed when the error was noted.

Patient was on contact isolation for [vancomycin-resistant enterococci] and MRSA. Staff were not following protocol of wearing gown/gloves.

PA-PSRS Data

PA-PSRS reports that discuss screening for MRSA indicate problems in the following areas: delay in order entry, mislabeling of specimens, and specimens not being collected according to protocol. The following reports demonstrate these problems with MRSA screening.

Patient transferred to unit. MRSA screen of the nares was ordered. Upon reviewing chart (five days later), screen was never sent. Patient also had a history of MRSA of the nares and had roomed with other patients.

A nasal MRSA surveillance was ordered, but the specimen was mislabeled. The unit was notified.

A nasal specimen for MRSA screening was collected incorrectly in the wrong vial instead of the required vial for culture. Floor was notified to recollect.

Analysis of PA-PSRS reports indicates problems with identification and communication of MRSA status, resulting in either delayed implementation of isolation precautions or failed recognition of MRSA status by others due to a lack of chart documentation and/or lack of visible isolation signs. Examples of these problems follow in the reports below.

Patient with history of being treated for MRSA was not documented on chart. [Patient's status was] discovered by anesthesia staff, who notified the nursing floor. The patient went to angiography for a procedure. Report called to floor post procedure, and staff on floor did not notify radiology of MRSA history.

Patient with MRSA, [but there was] no isolation cart or contact isolation sign outside the door.

Effective Components of a Program to Reduce MRSA

Active "Surveillance System"

A surveillance system is an ongoing and comprehensive method of measuring health statuses, outcomes, and related processes of care, and analyzing data and providing information from data sources within a healthcare facility to assist in reducing HAIs.⁸

The success of active surveillance has been demonstrated at the VA Pittsburgh Healthcare System (VAPHS). VAPHS was the leader in researching and implementing initiatives to reduce MRSA infections, providing direction at the national level. The MRSA Prevention Initiative began as a pilot program at VAPHS in 2001. The VAPHS "Getting to Zero" initiative focuses on active surveillance and contact isolation precautions.⁹ Evanston Northwestern Healthcare, Illinois, is another healthcare system that demonstrated success in reducing MRSA with a universal MRSA surveillance program. Upon patient admission to any of its three hospitals, staff conduct a nasal swab of all patients to culture for MRSA. In the first year of the program, Evanston reduced MRSA infection rates by 60%.¹⁰

Beginning in 2008, Pennsylvania hospitals will be required to screen and culture all nursing home patients on admission for MRSA and implement procedures to identify other high-risk patients who require screening.⁸ (For more information, refer to the announcement on page 111 about HAI reporting and the sidebar on page 126 about Pennsylvania legislation.)

Facilities must develop procedures to identify other high-risk patients admitted to the hospital. A comprehensive review of patients infected with MRSA can identify populations at risk within a healthcare facility.⁵ For example, 26% of reports submitted to PA-PSRS identified the intensive care unit (ICU) as the patient care area for patients with a MRSA infection. The National Nosocomial Infections Surveillance System has reported increased rates of MRSA among ICU patients from 38% in 1995 to

Prompt Identification and Effective Communication of Status May Reduce MRSA Infections (Continued)

Pennsylvania Legislation Aimed at Reduction and Prevention of HAIs

Pennsylvania is one of the first states to pass legislation concerning healthcare-associated infections (HAIs), including the following in reverse chronological order.

Act 52 of 2007 Senate Bill No. 968

Act 52 amends the Medical Care Availability and Reduction of Error (Mcare) Act of March 2002 and establishes requirements for internal infection control plans in ambulatory surgical facilities, hospitals, and nursing homes. Act 52 requires facilities to have effective measures for the detection, control, and prevention of HAIs; culture surveillance processes and policies; and a system to identify and designate patients known to be colonized or infected with MRSA or other MDROs.¹

Act 52 establishes requirements for hospitals and nursing homes to report HAI information. Hospitals are required to report HAI data to the Centers for Disease Control and Prevention through its National Healthcare Safety Network. Nursing homes are required to electronically report patient-specific HAI data to the Department of Health and the Patient Safety Authority.¹ For more information, refer to the December 22, 2007, *Pennsylvania Bulletin* (<http://www.pabulletin.com>).

Act 52 states the cost of routine cultures and screenings performed on patients in compliance with a healthcare facility's infection control plan shall be considered a reimbursable cost to be paid by health payers and medical assistance upon federal approval.¹

Act 14 of 2003

In July 2005, Pennsylvania became the first state to publicly report HAI data, which was collected by the Pennsylvania Health Care Cost Containment Council (PHC4). The reports have focused on four types of healthcare associated infections including: central line-associated bloodstream infections, ventilator-associated pneumonia, surgical site infections, and indwelling catheter-associated urinary tract infections.² PHC4, according to Act 14 of 2003, is charged with collecting, analyzing, and reporting information related to improving quality and restraining the cost of healthcare in Pennsylvania.³

Notes

1. Medical Care Availability and Reduction of Error (MCARE) Act. 40 P.S. § 1303.401, *et. seq.* (2007).
2. Pennsylvania Health Care Containment Council. MRSA linked to nearly 14,000 PA hospitalizations in 2004 [press release online]. 2006 Aug 25 [cited 2007 Oct 29]. Available from Internet: <http://www.phc4.org/reports/researchbriefs/082506/nr082506.htm>.
3. Health Care Cost Containment Act 35. P.S. § 449.5 (2007).

60% in 2004.¹¹ Other studies have focused on reducing MRSA infections for ICU patients who have a higher rate of infection than other hospitalized patients.¹² Screening and culturing ICU patients may help reduce the spread of MRSA. Other high-risk patients to consider for screening include those with following history or characteristics: current or recent hospitalization (i.e., within the last 12 months), long-term care facility residence, recent invasive procedure, HIV infection, intravenous drug use, hemodialysis, age over 65 years, recent or long-term antibiotic use, and previous MRSA infection or colonization.^{1,13}

Computerized surveillance systems that identify patients previously screened for MRSA are valuable assets. Identification in this fashion may facilitate communication throughout the facility of patient's MRSA status. For example, facilities with computerized systems may set up databases that prepopulate MRSA status of previously admitted patients and new admissions. Automation may help alert practitioners to this critical clinical information. Additionally, an outreach process for notifying a receiving healthcare facility of a colonized patient prior to transfer is an important component of an active surveillance system.

The following points summarize screening strategies facilities may implement to reduce the spread of MRSA (an asterisk indicates a strategy required for implementation by Act 52⁸):

- Developing standing orders for MRSA screening to increase compliance
- Screening for MRSA all nursing home patients and other high-risk populations identified at the facility*
- Screening high-risk patients on admission, transfer, and discharge from the facility¹⁴
- Obtaining cultures within two hours of admission¹⁴
- Providing mandatory educational programs for facility personnel*
- Educating staff on proper specimen technique and requiring annual competency¹⁴
- Providing patient care areas with adequate supplies to perform nasal and/or wound cultures¹⁴

Prompt Identification and Effective Communication of Status May Reduce MRSA Infections (Continued)

- Developing a method to identify patients on admission who previously screened MRSA-positive⁵
- Developing a process to notify receiving healthcare facilities about patients who are known to be colonized or infected with MRSA^{5*}
- Educating and training healthcare workers to ensure policies and procedures for contact isolation are understood and practiced^{7,16}
- Educating patients, family members, and visitors (e.g., using informational handouts) about proper hand hygiene, use of gown and gloves, and care of equipment^{7,16}
- Conducting ongoing audits to determine effectiveness of methods implemented^{7,16}

Isolation Precautions

Since 1983, CDC has recommended that facilities place patients with known or suspected infections or colonization with MDROs such as MRSA in contact isolation.⁷ Contact isolation includes adherence to hand hygiene and the use of gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment. Contact isolation is intended to prevent the transmission of infectious agents, which are spread by direct or indirect contact with the patient or the patient's environment.¹⁵ A single patient room is preferred for isolation. When single room isolation is not possible, cohorting care may be implemented to prevent transmission of MRSA. Cohorting refers to the practice of grouping patients infected or colonized with the same infectious agent together to confine their care to one area and prevent spread of the organism to susceptible patients (cohorting patients). During infectious outbreaks, healthcare workers may be assigned to a cohort of patients to further limit opportunities for transmission (cohorting staff).¹⁶ Although there have been limited studies demonstrating the effectiveness of cohorting patient care, when properly executed, cohorting may limit the opportunities for transmission of MRSA from patient to patient by means of healthcare workers' contaminated hands or clothing.⁷

Facilities may consider the following strategies aimed at the processes for implementation of isolation precautions:

- Providing adequate supplies for isolation that are readily available in all patient care areas
- Including consistent documentation in the medical record of isolation precautions for MRSA patients
- Assigning designated staff to post appropriate signage for contact isolation outside the patient rooms
- Discussing isolation status for MRSA during hand-off communication within the facility⁵
- Ensuring easy access to alcohol-based hand rubs¹⁷
- Promoting skin care by providing hand lotions¹⁷
- Providing ongoing education to healthcare workers about hand hygiene techniques and clinical situations that warrant hand washing¹⁷

Hand Hygiene

Hand hygiene may be the single most important measure for controlling the transmission of MDROs. Since 1987, CDC has recommended that staff participate in hand washing after patient contact.⁷ In October 2002, CDC suggested that alcohol-based hand rubs be the primary choice for hand decontamination and named antimicrobial soaps as an acceptable alternative for when hands are visibly contaminated. Hand rubs can be used in a variety of clinical situations, including before and after patient contact and after touching objects in the patient environment that could be associated with colonized pathogens.¹⁷ Despite the evidence supporting hand washing as a key element in reducing transmission of HAIs, healthcare workers' adherence to recommended hand hygiene practices is unacceptably low, with average compliance estimated as less than 50% in acute care facilities.⁵ Handwashing frequency varies by type of healthcare worker and by clinical service.¹⁸ Several barriers have been identified that prevent healthcare workers from performing hand hygiene. These include inadequate staffing, inaccessible sinks or lack of hand gel products, and reluctance due to skin irritation from frequent hand washing.^{5,19,20}

Implementing a comprehensive hand hygiene program may improve hand washing compliance among healthcare workers. Elements of a successful, sustainable hand hygiene program include the following:

Prompt Identification and Effective Communication of Status May Reduce MRSA Infections (Continued)

- Conducting routine observation of hand hygiene practices and providing consistent feedback¹⁷
- Using reminders in the workplace (e.g., posters) to motivate compliance with hand hygiene¹⁷
- Educating patients about hand washing and transmission of infectious diseases in its absence, and encouraging patients to ask healthcare workers if they have washed their hands¹⁷
- Using motivational activities (e.g., contests among patient care areas for the highest compliance rates) to achieve long-lasting compliance¹⁷

Environmental Issues

Equipment. Multiple studies have demonstrated that equipment carried by healthcare workers (e.g., stethoscopes, tourniquets, sphygmomanometer cuffs, otoscopes, pagers, scissors) and other items transported from patient to patient can become contaminated. These items may serve as a vector for MRSA and other MDROs, either through direct contact with patients or through contact with healthcare workers' contaminated hands.⁷

Strategies to target equipment that has potential to serve as a vector for transmission of MRSA may include the following:

- When a patient is in isolation, dedicating equipment solely to his or her care, when-ever possible⁷
- Setting a schedule to regulate cleaning of patient's room and equipment in use for his or her care⁷
- Implementing processes to ensure equipment is adequately cleaned and disinfected for use between patients⁷

Patient care area. Another area of concern is the patient's bed and surrounding surfaces. MRSA has been isolated from a variety of patient care items and environmental surfaces. Muto et al. cited a study that found that MRSA could survive on the external surface of sterile goods packages for more than 38 weeks.⁷ The cleaning and disinfecting of all patient care items is important, especially those closest to the patient that are likely to be touched

(e.g., bedrails, bedside tables, commodes, door-knobs, telephones, nurse call buttons).

Strategies aimed at disinfecting patient rooms may include the following:

- Conducting in-service education for house-keeping personnel that addresses:
 - Transmission modes of MRSA and other MDROs
 - Assigned daily cleaning time
 - Additional cleaning throughout the shift
 - Use of a checklist to track cleaning^{7,16}
- Frequently cleaning and disinfecting commonly touched surfaces^{7,16}
- Thoroughly applying disinfectant by "active damp scrubbing" or "wet bucket" (These methods involve saturating the surface with disinfectant, leaving surfaces wet for 10 minutes and then wiping dry with clean towels, as opposed to the traditional method of quickly wiping surfaces with a cloth lightly sprayed with disinfectant.)⁷
- Assigning cleaning personnel to specific patient care areas^{7,16}
- Strictly adhering to facility procedures for cleaning and disinfecting^{7,16}
- Using disinfectants effective against MRSA, such as quaternary ammonium compounds, phenolics, and iodophors for housekeeping⁷

Summary

The incidence of MRSA infection continues to increase among hospitalized, at-risk patients. Analysis of PA-PSRS reports identified that screening procedures are not consistently performed, and that even when facilities identify MRSA-positive patients, failure to communicate patients' MRSA statuses is common. Limiting the risk of MRSA transmission involves the development of a comprehensive program that includes the following essential elements: conducting active surveillance, adherence to contact isolation precautions, improvement in healthcare workers adherence to hand hygiene protocols, improvement in the decontamination of medical equipment and the healthcare environment, and ongoing evaluation of processes implemented to reduce MRSA transmission.⁹

Prompt Identification and Effective Communication of Status May Reduce MRSA Infections (Continued)

As hospitals and other healthcare facilities begin to implement the essential components of a comprehensive program to prevent the transmission of MRSA, it is theorized that the same results seen at VAPHS and Evanston Northwestern will be replicated nationwide.

Notes

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Reducing Complications from Interscalene Blocks

An interscalene block (ISB) is a regional anesthetic technique that provides anesthesia and analgesia to the shoulder and lateral regions of the arm and forearm. The block involves injection of local anesthetic to block the brachial plexus. It is the second most common upper extremity peripheral nerve block performed in outpatient settings, after axillary blocks.¹ ISBs are also growing in popularity—a 25% increase in the number of ISBs administered has been reported over 5 years.¹ A study of anesthesiologists in the United States revealed that more than 60% administer ISBs in their practice, and these respondents expected the use of this block to increase over time.² (Refer to the sidebars for additional information on ISB techniques and variations.)

Benefits

The block is easy to learn and to perform.^{1,2} Landmarks for ISB are readily identifiable.^{1,2} The patient requires no special positioning of the arm or shoulder for the block to be performed.^{1,2} Moreover, because patients are comfortably positioned, pressure-induced neuropraxias can be avoided.³ Also, when it involves the appropriate setup and experienced physicians, ISB should not prolong the perioperative course.^{1,2} Compared to general anesthesia, ISB provides excellent intraoperative anesthesia and postoperative analgesia with fewer side effects (e.g., nausea and vomiting, urinary retention, excessive sedation, overnight hospitalization, postoperative pain) and greater satisfaction of both the patient and healthcare team.^{1,4} ISB does not involve the endotracheal intubation required for general anesthesia, thus avoiding its associated respiratory complications.³ For patients at risk for respiratory complications secondary to intubation and general anesthesia, ISB may be considered an excellent technique.

Moreover, several studies demonstrated less intraoperative blood loss^{1,2} with the use of ISB than with use of general anesthesia. ISB may also reduce or prevent physiological responses associated with inadequately treated pain, such as increased sympathetic nervous system activity and increased production of antidiuretic hormone, cortisol, glucagon, aldosterone, and catecholamines²—changes that reduce intestinal motility and promote hyperglycemia, tachycardia, hypertension, myocardial work, and the potential for myocardial ischemia.² ISB improves shoulder mobility in the immediate postoperative period, facilitating physical therapy.^{1,5}

See page 147 for self-assessment questions related to this article.

PA-PSRS Reports

While ISB has many advantages, it can be associated with problems, as indicated by the 23 reports submitted to PA-PSRS since its inception in June 2004. As the Table indicates (see next page), almost three-fourths of the PA-PSRS reports involving ISBs had at least one of the following complications: dyspnea, chest pain, chest tightness, seizure, irregular heartbeat, and ineffective pain control.

More than half (54%) of the ISB-related reports were Serious Events (i.e., indicating patient harm), compared to 4% of PA-PSRS reports overall.

Here are some ISB-related occurrences reported to PA-PSRS:

A 58-year-old patient underwent an interscalene block for shoulder surgery and sustained respiratory failure and died. A possible cause of death may have been a paralyzed hemidiaphragm caused by the block.

A patient was given an interscalene block, and within a few seconds, had a clonic-tonic seizure. The patient was intubated and admitted.

A patient who received an interscalene block for shoulder surgery reported she could not swallow. After three hours, she was transferred to the [emergency room] for inability to swallow.

Indications

When ISB is used as the sole anesthetic in patients with comorbidities, general anesthesia and endotracheal intubation can be avoided.^{3,5} ISB can be combined with general anesthesia, reducing postoperative pain and supplemental analgesics and extending the patient's ability to sleep comfortably.¹ Postoperative analgesia can also be extended by instilling a longer acting local anesthetic through an indwelling catheter^{1,3} into the area of the brachial plexus for continuous infusion.

ISB can be used for intraoperative anesthesia and/or postoperative analgesia for upper arm and shoulder surgical procedures, including the following:^{1,5}

- Performing clavicle procedures
- Performing arthroscopic shoulder procedures
- Managing a frozen shoulder

Reducing Complications from Interscalene Blocks (Continued)

- Repairing a fractured humerus
- Inserting vascular shunts
- Treating reflex sympathetic dystrophy/causalgia
- Preventing autonomic hyperreflexia in susceptible patients undergoing shoulder surgery

With surgery of the medial arm or axilla, ISB may require additional supplementation with a separate intercostobrachial nerve block.¹

Contraindications

Patient Condition

Several medical conditions are contraindications for ISB. ISB complications are more likely in patients who have limited pulmonary reserve, such as in the following conditions:

- Severe obstructive or restrictive respiratory disease unless mechanically ventilated^{2,3}
- Respiratory insufficiency^{1,5}
- Myasthenia gravis²
- Status post-pneumonectomy on the contralateral side³
- Contralateral hemidiaphragmatic dysfunction²
- Pre-existing contralateral vocal cord paralysis²

Patients whose anatomical landmarks are not easily identifiable may not be appropriate candidates for ISB, including patients who have the following conditions:

- Morbid obesity^{1,4,6}
- Short/thick necks⁴
- Inadequate muscle tone in the interscalene area⁴

However, ISB may be performed on patients with challenging anatomical landmarks with the use of a nerve stimulator and/or ultrasound.^{1,7}

ISB Side Effect/Complication	Percent of ISB-Related PA-PSRS Reports
Dyspnea	26%
Seizure	17%
Chest pain/tightness	13%
Irregular heartbeat	9%
Ineffective pain control	9%
Drooping eyelid	4%
Dysphagia	4%
Decreased SpO ₂	4%
Unresponsive	4%
Rash	4%
Pneumothorax	4%

Table. ISB Complications Reported to PA-PSRS in 23 Reports

Other patient conditions that must be considered and may be contraindications for ISB include the following:

- Local infection at the injection site^{1,5}
- Sepsis⁵
- Coagulopathy^{1,4,5}
- Peripheral neuropathy¹
- Previous injury to the brachial plexus¹
- Inability to communicate and cooperate effectively (e.g., comatose, under general anesthesia, mentally ill, dementia)^{1,5} (However, ISB can be performed on a sedated patient if the practitioner used ultrasound and a nerve stimulator.^{1,7})
- Inability to remain still and in the prescribed position⁵
- Allergy to the local anesthetic to be administered^{1,5}

Other Significant Issues

Bilateral ISB is absolutely contraindicated.^{1,3} ISB is not appropriate in the absence of patient consent or if the following exist: a lack of resuscitative equipment or lack of adequate training for or lack of demonstrated proficiency by personnel performing ISB.^{1,5,8}

Reducing Complications from Interscalene Blocks (Continued)

Common Side Effects

A successful ISB produces an ipsilateral phrenic nerve block.^{1-5,9} The phrenic nerve is the sole motor supply to the diaphragm, and ipsilateral hemidiaphragmatic paresis occurs in up to 100% of patients receiving ISBs.^{1,2,5,9} Usually, phrenic nerve palsy is well tolerated, and is often unnoticed by healthy patients.³ However, forced vital capacity decreases by approximately 25%, which can produce ventilator compromise in patients with limited pulmonary reserve, requiring assisted ventilation.^{1,3,4,6}

Horner's syndrome⁵ may occur when the local anesthetic spreads to the stellate ganglion with its cervical sympathetic nerves.¹⁻⁴ Symptoms include ptosis of the eyelid, miosis, and anhidrosis of the face.¹⁰ However, the existence of Horner's syndrome, may not indicate that the brachial plexus is adequately blocked.³

Dysphagia^{1,3} occurs frequently and may persist until the block begins to resolve.

Complications

Overall Incidence

The overall incidence of other short-term and long-term complications is reported to be 0.3% to 0.4%.^{1,6,11} However, one review¹ indicates that for specific complications and side effects, the incidence may vary dramatically from study to study: from 0.2% for convulsions and pneumothorax to nearly 75% for Horner's syndrome.

Unsuccessful Blockade

One of the most common complications is failure to achieve an adequate block, usually resulting from the anesthetic missing a nerve in the lower nerve root distribution.⁵ This has been reported to occur in 3% to 30% of all brachial plexus blockades attempted.⁴

Unintended Blockade

If the recurrent laryngeal nerve is inadvertently blocked, vocal cord palsy occurs^{1,2,4,5,9} with symptoms of hoarseness⁵ and possibly acute respiratory insufficiency.^{4,9} This complication is ordinarily of

ISB Technique and Onset

In 1970, Winnie first described the ISB technique that is most commonly used today.¹ This lateral approach is considered the current standard of practice, has a success rate of at least 94%,² and involves the following.

Positioning

- Place the patient in supine position.^{2,3}
- Position the patient's head—extended and rotated 45°—to the contralateral side.^{2,4} This position exposes anatomical landmarks.
- Rest the patient's ipsilateral arm pronated along the side of the patient's body, in a direction toward the patient's ipsilateral knee.²
- To accentuate the interscalene groove, ask the patient to
 - sniff forcefully;⁴ or
 - elevate his/her head slightly,^{2,4} which brings the clavicular head of the sternocleidomastoid muscle into view.

Palpation

- Roll fingers posteriolaterally off the clavicular head of the sternocleidomastoid muscle and drop onto the anterior scalene muscle.^{2,3}

- Palpate laterally to the interscalene groove that lies between the anterior and middle scalene muscles.^{2,4}

Needle Insertion

- Insert the needle point at the level of C6, identified by the cricoids cartilage.² (This often is next to where the external jugular vein crosses over the sternocleidomastoid muscle.²)
- Insert the needle perpendicular to the skin in all planes.^{2,4}
- Use a 1 to 1.5 inch, 22- or 23-gauge needle because the brachial plexus is relatively superficial.^{2,4}

Advance the Needle

- Advance the needle in a caudal, medial, and slightly dorsal direction.² A 45° to 60° caudal direction will more likely to prevent the needle from passing between two cervical transverse processes and puncturing the vertebral artery or the epidural or subarachnoid spaces.⁴

(Continued on page 133)

Reducing Complications from Interscalene Blocks (Continued)

little consequence unless bilateral laryngeal nerve palsy results, which may produce severe laryngeal obstruction.²

Tapia's syndrome, or cranial nerve X and XII palsy, may also occur following ISB.² Symptoms include one-sided cord paralysis, aphonia, and the patient's tongue deviating toward the side of the block.²

Another unintended consequence of ISB may be the rare but potentially fatal complication of neuraxial blockade, or total spinal anesthesia, in which the local anesthetic intended for the brachial plexus sheath reaches the central nervous system (CNS).^{1-5,9,12,13} This may occur as a result of

- accidental injection of the local anesthetic into the epidural,^{1-5,12,13} subdural,¹ or subarachnoid space,^{1,2} which more readily occurs when the ISB needle is not sufficiently caudad;¹
- subdural injection, which may occur when, anatomically, the dural cuff that surrounds

the trunks of the brachial plexus extends beyond the intervertebral foramen;¹ or

- use of perineural local anesthetics, which may travel in retrograde from the peripheral nerves to the CNS.¹

Total spinal anesthesia may result in loss of consciousness or cardiac and/or respiratory arrest, requiring intubation and ventilator support.¹ If recognized immediately and adequate support is provided, this complication is not necessarily fatal.

Inadvertent blockade of the upper cervical nerve roots can lead to anesthesia in the head and neck.⁵ Contralateral anesthesia has also been reported.¹

Unintended blockade also results when the block is instilled in the incorrect side. The following PA-PSRS report highlights this problem:

The patient was scheduled for a left shoulder surgery. The anesthesiologist asked the

ISB Technique and Onset (Continued)

- While the palpating fingers remain in the interscalene groove at C6, advance the needle slowly until one of the following occurs:
 - A single paresthesia occurs in the ipsilateral upper extremity.²
 - If a peripheral nerve stimulator is used, a twitch at or below the shoulder occurs with electrical nerve stimulation of less than 0.5 mA. A deltoid twitch at less than 0.3 mA is as successful an indication of needle placement as is a biceps twitch.^{2,5}

Injection

- The clinician injects the local anesthetic in 3 to 5 mL increments,⁵ and aspiration is repeated for every 10 mL injected.³
- Upon injection of local anesthesia, the interscalene groove distends (interscalene triangular swelling),⁴ bounded by the following:
 - Medial border of the middle scalene muscle
 - Lateral border of the anterior scalene muscle
 - Clavicle between the insertion points of these two muscles

Onset of ISB

If a peripheral nerve stimulator is used, twitching disappears immediately upon beginning the anesthetic injection. The

local anesthetic moves the nerves away from the end of the stimulator needle.³ Motor blockage occurs within five minutes of injecting the local anesthetic.² By five minutes, most patients exhibit cervical sympathetic ganglia blockade, including the following:²

- Unequal pupil size
- Increased regional skin temperature and skin blood flow
- Weakened vasoconstrictor response to inspiratory gasp

If bupivacaine is used, the first indication of the onset of ISB is the "money sign"—when the patient rubs thumb against the index and middle fingers.¹ Within a few minutes, the patient cannot raise a straightened arm. Within 15 minutes, the block is sufficiently complete to begin surgery.^{4,5}

Notes

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Reducing Complications from Interscalene Blocks (Continued)

patient if he was having surgery on his right shoulder. The patient replied “yes,” and the anesthesiologist performed an ISB on the right shoulder. After the procedure, the nurse informed the anesthesiologist that the surgical consent was for the left shoulder.

Intravascular Injection

Several major blood vessels are located near the brachial plexus, creating a risk of vessel wall trauma and intravascular injection during ISB.^{1,4,5} Such vessels include the vertebral, subclavian, and carotid arteries.^{3,4,9}

Systemic Toxicity of Local Anesthetic^{1-5,9}

As with all uses of local anesthetics, toxicity rarely occurs unless the maximum safe dose of local anesthetic are exceeded or there is an inadvertent

intravascular injection.² Both of these mechanisms allow the local anesthetic to reach the brain, resulting in CNS toxicity that may produce seizures.^{1-4,6,12} CNS toxicity occurs during 0.2% of ISBs.² Vertebral artery cannulization with a continuous interscalene catheter has resulted in CNS toxicity with the use of bupivacaine.² Initial symptoms of CNS toxicity may include dizziness, tinnitus, perioral numbness, lightheadedness, shivering, tremor, and muscle twitching. Ultimately, tonic-clonic seizures occur.²

Cardiovascular toxicity may also occur during ISB placement, including severe dysrhythmia and cardiac arrest.^{2,3,9,12} The systemic effect of the local anesthesia exerts a dose-dependent decrease in myocardial contractility and decreases the rate of conduction in Purkinje fibers and the myocardium. Bupivacaine is more cardiotoxic than ropivacaine,

ISB Variations

Local Anesthetic

The following agents are used for ISB:^{1,2}

- 2% to 3% 2-chloroprocaine
 - Short duration (i.e., less than one hour)
 - Rapid onset
- 1% to 1.5% lidocaine or 2% mepivacaine
 - Medium duration (i.e., three hours)
 - Rapid onset
- 0.5% to 0.75% bupivacaine or ropivacaine
 - Prolonged duration (i.e., more than 7 hours) or continuous ISB blockade
 - Longer onset

Multiple Injections

Winnie's³ standard technique relies on using a single injection of local anesthetic within the fascial compartment. More recently, multiple injections using as little as a total of 20 mL have been administered safely and effectively, compared to the 40 mL of a single injection.^{1,2} The injections are targeted at specific predetermined locations within the brachial plexus sheath.¹ However, the multiple injection technique may increase the risk of nerve trauma² from unrecognized injection of local anesthesia into a partially anesthetized peripheral nerve.¹ Moreover, patients may be less receptive to multiple injections.²

Adjunctive Medications

Adjunctive medications to local anesthetics may affect the quality of anesthesia or its time of onset or duration.

Epinephrine

When added to local anesthetic solutions, epinephrine decreases systemic absorption, reducing the potential for local anesthetic toxicity to the central nervous and cardiovascular systems.^{1,2} Decreased systemic absorption promotes a longer brachial plexus block duration and improved quality of anesthesia.^{1,2} It may also help detect intravascular injection² because of the drug's systemic effects if it reaches the vascular system. Because ropivacaine is already a potent vasoconstrictor, adding epinephrine has little effect on the duration of this block.² Forty to 60 mL of 1.5% mepivacaine (~10 mg/kg) with epinephrine 1:200,000 can provide anesthesia for 3 to 4 hours.⁴

Alpha-2-Adrenergic Agonists

Interscalene administration of clonidine also prolongs the blockade of short and intermediate local anesthetics and ropivacaine.² However, it does not reduce systemic absorption of local anesthetics to the same degree as epinephrine; therefore, it produces greater peak plasma concentrations of local anesthesia. As a result, clonidine's margin of safety for systemic toxicity tends to be narrower. Clonidine may be used when epinephrine is contraindicated.²

Sodium Bicarbonate

By increasing the pH of the local anesthetic, sodium bicarbonate increases the amount of the uncharged, nonionized form of the drug.^{1,2} Nonionized local anesthesia crosses nerve membranes more readily, resulting in rapid onset of the block. While this rapid onset does not occur with all local anesthetics, 1 mEq of sodium bicarbonate per 10 mL of mepivacaine significantly decreases the onset time without prolonging the duration of motor or sensory brachial plexus blockade.⁵

(Continued on page 135)

Reducing Complications from Interscalene Blocks (Continued)

mepivacaine, or lidocaine because of slow recovery of sodium channels in the heart.^{2,3}

Pulmonary

Placing the block too inferiorly within the interscalene groove may result in a pneumothorax.^{1-5,12,14} This rare complication occurs during 0.2% of ISBs.² Bronchospasm may also occur, which is probably caused by a sympathetic blockade down to the level of T1 to T4, combined with a relative excess of parasympathetic tone.²

Nerve Injury

Nerve injury may be apparent immediately or may not be recognized until two to three weeks after ISB is performed.^{5,12} The appearance of clinical symptoms may be delayed depending on the development of inflammation, micro hematoma, or perineural

edema.¹² The incidence of these injuries may be underestimated because the symptoms are usually minor and the anesthesiologist does not ordinarily see the patient beyond the first few postoperative days.¹²

Neuropathies involve acute, nonacute, and permanent dysfunction.²⁻⁴ Acute nerve complications include pain and paresthesia,² as well as brachial plexus injuries such as plexitis, palsy, and neuritis.^{2,9,12} Brachial plexus injury is extremely rare.²

Long-term, nonacute complications that spontaneously resolve from one to more than nine months after ISB may include the following:

- Brachial plexus neuropathy^{1,2,12}
- Severe plexus lesion/damage¹²

ISB Variations (Continued)

Continuous Interscalene Brachial Plexus Blockade¹

A catheter inserted into the interscalene brachial plexus sheath can provide continuous perineural infusion of a long-acting local anesthetic. This procedure can improve short-term analgesia and rehabilitation.

Ambulatory Interscalene Brachial Plexus Blockade¹

Disposable elastometric balloon pumps and programmable mechanical pumps have been used successfully to provide analgesia for patients at home after rotator cuff repairs, but no large scale trials of this modality have occurred to date.

Brachial Plexus Sonography^{1,6}

High-resolution ultrasound can be used for ISB in the following ways:

- Identify and teach about brachial plexus anatomy
- Safely guide the interscalene needle during insertion and probing
- Correctly place a catheter under direct dynamic visualization

This methodology is well suited for patients with anatomical landmarks that are difficult to identify (e.g., morbid obesity).

Posterior Approach¹

A posterior approach to ISB may provide anesthesia to the forearm and hand, which the traditional approach does not. The following steps comprise the posterior approach:

- A 21-gauge 9 cm needle attached to a 5 mL syringe is inserted 3 cm lateral to the interspinous

line at a level midway between the C6 and C7 spinous processes.

- The needle is inserted perpendicular to the skin, through the trapezius, splenius cervicis, and levator scapulae muscles; over the C7 transverse process; and through the posterior and middle scalene muscles.
- The needle tip is within the brachial plexus sheath when a definitive loss of resistance is felt, indicating penetration of the fascial layer on the anterior surface of the middle scalene muscle.
- The clinician then injects a total of 40 mL of local anesthetic incrementally.
- A peripheral nerve stimulator can be used to locate the interscalene brachial plexus from the posterior approach.

Notes

1. Brull R, McCartney C, Sawyer R, et al. The indications and applications of interscalene brachial plexus block for surgery about the shoulder. *Acute Pain* 2004;6(2):57-77.
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Reducing Complications from Interscalene Blocks (Continued)

Rarely, permanent injury has been reported, such as permanent phrenic paralysis^{1,10} and even permanent loss of cortical cord function.¹⁵

Moreover, the following conditions may be associated with but not caused by ISB:

- Sulcus ulnaris syndrome (i.e., entrapment neuropathy of the ulnar nerve at the medial epicondyle of the elbow)^{1,12}
- Complex regional pain syndrome^{1,12}
- Carpal tunnel syndrome^{1,12}

While ISB does not cause these conditions, ulnar neuropathies may be related to positioning of the arm or in susceptible patients with edema around the nerve.¹²

Vasovagal Response

The “beach chair” (i.e., seated) position is often used for shoulder surgery. Sudden profound hypotension and bradycardia may occur in 13% to 24% of patients who have ISBs and are positioned in this manner for the operative procedure.¹⁻³ The Bezold-Jarisch reflex occurs when venous pooling and increased sympathetic tone produce a low-volume, hypercontractile ventricle. This reflex activates the parasympathetic nervous system and sympathetic withdrawal.² While the arterial vasodilation and bradycardia are usually transient and reversible,^{1,3} cardiac arrest may occur.²

Other Complications

Other reported complications of ISB include hematoma,^{5,12} aspiration of blood,¹² tracheal abrasion/puncture,⁵ infection,⁵ pneumothorax,³ and auditory disturbance.¹

Risk Reduction Strategies

Several strategies can reduce complications, enhancing patient safety.

Prior to ISB

- The clinician performing the block needs to undergo training and demonstrate competencies in the various ISB techniques available.²
- Patients selected for ISB are undergoing major shoulder surgery (reconstruction) or minor arthroscopic shoulder procedures.² ISB success varies anatomically, and the clinician’s familiarity with this success distribution will guide whether this block

is appropriate for the operative procedure planned.²

- ISBs are contraindicated for patients with certain conditions, such as patients who are unable to tolerate a 25% reduction in pulmonary function.²
- It is prudent to have monitoring and resuscitation equipment available,⁵ including electrocardiography, pulse oximetry, and oxygen administered by nasal cannula.³
- Marking the surface anatomy prior to the block will help ensure that ISB is performed accurately and effectively.⁵
- ISBs are performed after the patient has fasted and has fully consented.⁵
- Educating patients about ISB reduces anxiety, promotes cooperation, and ensures patients will notify the physician if complications arise.¹⁶ Such information can be reinforced by providing a brochure to the patient at the surgeon’s office.⁶ Information can include the following:⁶
 - Explanation of the procedure
 - Purpose of a brachial plexus nerve block
 - Indications and contraindications for ISB
 - Use of a numerical or visual scale to rate pain
 - Potential side effects and complications
 - Picture of brachial plexus anatomy
 - Importance of notifying the physician when first paresthesia occurs during ISB placement

During ISB

- Performing the ISB with strict adherence to asepsis will reduce the risk of infection.⁵
- Needle placement:
 - Traditionally, needle placement for ISB has been perpendicular to the skin in every plane.² However, there may be a greater possibility of the needle passing through the intervertebral foramen if the needle is advanced too deeply in this position. Therefore, the risk of spinal cord damage during ISB is greater.¹⁷
 - A recent study of 50 patients using magnetic resonance imaging of the cervical region revealed that a needle angle of 60° relative to the sagittal plane at

Reducing Complications from Interscalene Blocks (Continued)

- the level of C6, aimed in a slight posterior, steeply caudal trajectory, would more likely avoid inadvertent sub-arachnoid, epidural, or vertebral artery injection.^{1,2,17,18}
- Seizures are less likely when using an axillary approach to brachial plexus blockade, rather than a supraclavicular or interscalene approach.¹ However, this must be balanced with the increased risk of local anesthetic toxicity if the axillary trajectory involves a transarterial approach.¹
 - **Drugs:**
 - Avoiding highly concentrated local anesthetics (e.g., greater than 1.5% lidocaine) may reduce the risk of nerve injury.¹
 - When large doses of long-acting local anesthetic are required, ropivacaine has a more favorable toxicity profile than bupivacaine.^{1,5}
 - If the patient receiving ISB will be placed in a beach chair position for shoulder surgery, prophylactic β -adrenergic blockade may decrease the occurrence of vasovagal events.¹ If this complication occurs, giving a β_1 -agonist (Ephedrine) increases heart rate, systolic and diastolic blood pressure, and cardiac output.¹
 - Giving the lowest effective dose (e.g., via multiple injection technique) may reduce iatrogenic complications.^{1,2}
 - **Needle probing/injection**
 - Withdraw the needle and consider cancelling ISB if a patient complains of severe pain or paresthesia.²
 - Discontinuing needle probing at the first paresthesia or muscle twitch may reduce the risk of iatrogenic injury.²
 - Diligent aspiration, alternated with small incremental injection, may reduce the risk of intravascular injection of local anesthetic during ISB.¹

Documentation

Comprehensive documentation¹⁰ of the following will capture important information related to ISB:

- Preoperative discussion of the ISB procedure, benefits, risks, possibility of nerve damage, and education materials provided

Paresthesia versus Peripheral Nerve Stimulator

An effective ISB results when the local anesthetic is injected in close proximity to the brachial plexus. There are two end points that indicate accurate needle tip placement:

1. **Paresthesia**
Paresthesia is an electric shock sensation over a nerve distribution that occurs as the needle tip encroaches the epineurium. While Winnie indicated that a successful ISB is associated with obtaining paresthesia below the level of the shoulder,¹ a recent study² revealed a 100% ISB success rate with paresthesia sites of the upper arm, elbow, forearm, hand, as well as the shoulder. Advantages of paresthesia are that no extra equipment is required and the technique's portability.³ The disadvantage is the potential for nerve injury as the needle tip encroaches or breaches the epineurium.³ Paresthesia also requires the patient to communicate a response to the electric sensation once it is felt.
2. **Peripheral nerve stimulator**
A nerve stimulator induces muscle twitches through a nerve stimulator needle. A deltoid twitch or a biceps twitch determines accurate needle placement and therefore ISB success. The advantage of this technique is its objectiveness (by means of skeletal muscle movement)⁴ in determining accurate or inaccurate placement. For example, if nerve stimulation evokes hiccups, the needle tip may be too far anterior. A trapezius twitch would require needle placement more anteriorly.³ The incidence of certain complications may be reduced. Use of a short, beveled nerve stimulator needle increases the success rate of the block, but it may not decrease the risk of nerve damage.⁵

Notes

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- Approach/trajectory of needle
- Type and length of needle used

Reducing Complications from Interscalene Blocks (Continued)

- Type, dose, and concentration of local anesthetic and adjunctive medications administered
- Method used to confirm needle placement (For additional information on the following methods, refer to the sidebar “Paresthesia versus Peripheral Nerve Stimulator” on the previous page.)
- If peripheral nerve stimulator is used to confirm needle placement:
 - The type and settings
 - The strength and location of muscle contractions
 - Number of attempts
 - Presence or absence of paresthesia and actions taken in response
- If paresthesia is used to confirm needle placement:
 - Number of attempts
 - Presence and location of paresthesia
- Patient response
- Actions taken in response to acute complications

Follow-Up

When patients experience dysphagia, check periodically for the gag reflex. Do not permit the patient to drink liquids and do not discharge the patient until the dysphagia resolves. Because ISB may have long-term sequelae, many clinicians have proactively established a mechanism for long-term follow-up, should the need arise.¹⁰

Implementing these strategies will help to ensure that patients undergoing ISB will enjoy its benefits while reducing the risk of iatrogenic complications associated with this technique.

Notes

1. Brull R, McCartney C, Sawyer R, et al. The indications and applications of interscalene brachial plexus block for surgery about the shoulder. *Acute Pain* 2004;6(2):57-77.
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Smart Infusion Pump Technology: Don't Bypass the Safety Catches

Computerized prescriber order-entry and bar-code applications for drug dispensing and administration are capable of reducing medication errors. Yet, even if these technologies are fully implemented, serious medication errors remain possible, especially errors associated with the administration and titration of intravenous (IV) high-alert medications such as dopamine, heparin, and insulin. Even if the right drug and dosing information are at hand, a misprogrammed infusion pump can leave a patient only a button press away from harm. One study showed that the most common reason for the administration of wrong doses of intravenous medication was an error in programming IV infusion pumps (41%), and this step in the medication-use process was associated with the highest impact.¹

A new technology, commonly referred to as “smart” infusion pumps, is beginning to play a role in reducing the risk of administering IV medications. There are several functions of a smart pump, including the ability to store dosing guidelines in a drug library and to apply those guidelines during pump programming to warn clinicians about potential unsafe drug therapy.² These drug libraries allow organizations to enter various drug infusion protocols with hospital-defined upper and lower dosing limits stored in the pump's memory. If a dose is programmed outside of established “soft-stop” limits, the pump sounds an alert, informing the clinician that the dose is outside the recommended range and requiring confirmation by the clinician that he or she intended to go outside this soft limit (see Figure). Organizations can also establish “hard-stop” limits that will not allow users to exceed the preset limits in the pump. Some pumps can integrate patient monitoring and other patient parameters such as age or clinical condition, and most modern pumps can generate logs of recorded data for doses that trigger dose limit warnings. A survey of hospital pharmacists by the American Society of Health-System Pharmacists in 2006 showed that 32% of hospitals reported using smart pumps.³

One example of an event submitted to PA-PSRS where the use of a smart pump could have prevented harm states:

A patient with a previous history of hemothorax was on a heparin infusion upon admission. The ambulance personnel relayed the drip was to infuse at 60 mL/hr. The nurse at the admitting facility set the pump to infuse 60 mL/hr. When the night shift nurse assessed the patient, she found that



Figure. Example of “Soft-Stop” Limit. Image provided courtesy of ECRI Institute.

the heparin was infusing at 6,000 units/hr (60 mL/hr). The heparin infusion was stopped. The patient's PT result was 99.45, PTT was 240, INR was 43.4, and blood pressure was 78/40. At 11 p.m., the patient was found [with agonal respiration]. The patient was intubated and placed on ventilator. Protamine and vitamin K 10 mg IV push were given, and the patient was transferred to another facility.

An example that demonstrates the ability of smart pumps to prevent harm from misprogramming infusion pumps occurred in an emergency department (ED) where a physician wrote an order for **INTEGRILIN** (eptifibatid) but inadvertently prescribed a dose appropriate for **REOPRO** (abciximab).⁴ The Integrilin infusion was initiated and continued for approximately 36 hours after the patient was transferred to a medical/surgical unit. During this time on the unit, the patient's mental status deteriorated. This infusion event occurred while the hospital was switching to a new smart infusion pump. As the nurse transferred the infusion parameters from the old infusion system to the new system, safety software incorporated in the device alerted the nurse that there was a “dose out of range.”

The pump would not allow the nurse to continue until a pharmacist was called and the mistake was corrected.

Smart Infusion Pump Technology: Don't Bypass the Safety Catches (Continued)

In another case, a hospital's heparin protocol called for a loading dose of 4,000 units followed by a constant infusion of 900 units per hour. The loading dose was administered correctly, but the nurse inadvertently programmed the continuous dose as 4,000 units per hour. Since the pump limit for heparin as a continuous infusion was set at 2,000 units per hour, the infusion device would not start until the dose was corrected.

Unfortunately, errors may still occur when using this technology. Numerous reports sent to PA-PSRS include examples of errors associated with the use of smart infusion pumps. Some examples include similar types of errors that may occur with the use of general infusion pumps. For example, one contributing factor to the misprogramming of smart infusion pumps arises when organizations do not use standardized concentrations of high-alert medications.

Hospital policy dictates that the standard Levophed solution is 4 mg/500 mL. The pharmacy sent 4 mg/250 mL. The nurse programmed the smart pump incorrectly by entering the standard solution (4 mg/500 mL). The medication was titrated to achieve a systolic blood pressure of 90. Patient did not suffer any adverse effects as result of error.

Patient had heparin infusing per standard protocol. On assessment, smart pump was found to be programmed incorrectly. The patient was to receive 1,000 units or 20 mL/hr. Pump was programmed for the 25,000 units in 250 mL concentration. Bag hanging was the 25,000 units in 500 mL concentration. Therefore, patient was receiving half the ordered dose. The patient's next [activated partial thromboplastin time (aPTT)] was subtherapeutic.

There are many examples of "wrong rate" medication errors in reports submitted to PA-PSRS, involving general infusion pumps as well as smart infusion pumps when practitioners inadvertently switch IV lines between separate infusion pumps or dual-chambered infusion pumps.

This unit received the patient from the critical care setting with an insulin infusion 0.4 mL/hr and IV fluid at 100 mL/hr. When the patient was disconnected from the pump to reprogram the smart pump to the medical surgical profile, the infusion lines were inadvertently switched. When the pumps were restarted, the patient received the

insulin at the IV fluid rate and the patient received approximately 40 units of insulin. The patient's blood sugar was immediately checked and was down from 200 to 100.

Wrong-dose errors have been reported to PA-PSRS when inaccurate patient weights were used to calculate and program weight-based doses on smart pumps, because of mixups between weight in pounds and weight in kilograms.

Nurse set the dopamine infusion via smart pump at 170 kg as weight instead of 170 lbs. Corrected by the nurse and the doctor made aware. [Vital signs were] monitored.

Because new types of information—more than just rate and volume to be infused—are entered into smart pumps, there is now an opportunity for new types of errors associated with these pumps. For example, practitioners may inadvertently choose the wrong drug or the wrong unit of measure in the smart pump's library.

Wrong Drug

The nurse incorrectly programmed the smart pump for a Lasix infusion instead of Brevibloc as was ordered. The rate was infusing at 5 mL/hr instead of the ordered 17.5 mL/hr dose.

Upon assessment, [staff] found Levophed running on a smart pump programmed for neosynephrine infusion at 200 mcg/min. The Levophed solution was not scanned prior to administration and the wrong medication was administered. The patient had orders for both vasopressors.

Wrong Unit of Measure

Labetalol ordered to run intravenously at 5 mg/hr. The smart pump's library was set for mg/min and the medication was given at 5mg/min. [emphasis added]

Propofol was ordered at 80 mcg/kg/hr but was programmed at 80 mcg/kg/min. The rate was changed and the patient was overly sedated but there was no change in the vital signs. The medication was discontinued and the physician was made aware. [emphasis added]

One Serious Event reported to PA-PSRS occurred when the smart pump was programmed at a 10-fold overdose because there was no preprogrammed dose limit in the library.

Smart Infusion Pump Technology: Don't Bypass the Safety Catches (Continued)

Nurse hung the patient's [total parenteral nutrition (TPN)] to run at 625 mL/hr instead of the ordered 62.5 mL/hr x 24 hours. The infusion pump was incorrectly programmed at 625 mL/hr. Depending on pump library chosen, there is no hard stop for the TPN, which allowed the incorrect entry. Error discovered after 1 hour and 30 minutes when the patient became short of breath. The patient was treated appropriately for elevated potassium and glucose, but three hours later the patient coded and expired.

Overridden Libraries

Equally important as the built-in safety capabilities of the smart pump is the role of the clinician to consistently use the technology to its fullest potential. As with other technologies, clinicians have sometimes bypassed its use, only to realize its true value after a serious error has occurred that could have been prevented with the technology.⁵

Rothschild et al. indicated that IV medication errors and adverse drug events were frequent and could be detected using smart pumps. However, violations during the intervention periods included 571 (25%) bypasses of the drug library. The authors concluded that there was no measurable impact found on the serious medication-error rate, likely in part due to poor compliance. The study concluded that although smart pumps have great promise, technological and nursing behavioral factors must be addressed.⁶ It is noted that this study was conducted with an early-generation smart pump that required users to opt into the drug library. Most newer pumps encourage use of the drug library by presenting it to the user at startup and allowing the user to opt out if necessary.

The following account describes one instance of bypassing a drug library. A 19-year-old obese woman, who had recently undergone cesarean section delivery of a baby, presented in the ED with dyspnea. Believing the patient had developed a pulmonary embolism, the physician prescribed an IV heparin bolus dose of 5,000 units followed by a heparin infusion at 1,000 units per hour. After administering the bolus dose, a nurse started the heparin infusion but misprogrammed the pump to run at 1,000 mL per hour, not 1,000 units per hour (20 mL per hour). By the time the error was discovered, the patient had received more than 17,000 units (5,000 unit loading dose and about 12,000 units from the infusion) in less than an hour. A smart pump with dosing limits for heparin had been used, so the programming error should have been

recognized before the infusion was started. However, the nurse had elected to bypass the dose-checking technology and had used the pump in its standard mode. Fortunately, the patient did not experience adverse bleeding, as her aPTT values were as prolonged as 240 seconds when initially measured and 148 seconds two hours later. Further investigation of this event uncovered that, like the nurse involved in this error, most nurses in this hospital were bypassing the dose-checking technology available with the smart pumps.⁵

There are many reports in PA-PSRS of clinicians who override the library to infuse medications, thus bypassing the built-in capabilities of the pumps.

The smart pump was not programmed using guide rails and programmed as basic infusion. The rate was programmed 50 mL/hr for a 14-year-old patient receiving amiodarone. The order was for 50 mg/hr, which should have run at 27.7 mL/hr. The patient became short of breath. The nurse was notified, and incentive spirometry and nebulizer treatments were given. Patient stated he had relief with the treatments but not complete relief. The patient was unable to sleep overnight and had to sit straight up while in bed to breathe well. It was discovered the next day that amiodarone was infusing at too high a rate, and the rate was adjusted. The infusion dose corrected and the patient was able to breathe better after the dose corrected. [emphasis added]

Nurse hung a [peripheral parenteral nutrition] via pump but bypassed the drug library and programmed the rate at 417 mL/hr instead of the ordered rate 41.7 mL/hr.

Nurse programmed smart pump to infuse heparin at 650 mL/hour instead of ordered dose of 650 units/hour. Drug library not used to program the heparin in the smart pump. The physician was notified and the heparin was discontinued. The patient's lab values checked and protamine sulfate administered. [emphasis added]

The nurse found the patient's Lasix drip infusing at 100 mg/hour instead of ordered rate of 10 mg/hour. The correct drip rate was recorded on the pharmacy label, but the drug library in smart pump was not utilized to program the infusion and automatically compute dosage. The incorrect rate

Smart Infusion Pump Technology: Don't Bypass the Safety Catches (Continued)

was infusing for 1.5 hours; no untoward reaction. [emphasis added]

Studies about smart pump implementation have provided some answers about why clinicians have chosen to bypass the dose-checking technology, including

- falsely low perceptions of risk;
- failure to make adjustments in the drug library when alerts are not credible;
- extra work to use the technology, time pressures, distractions, interruptions;
- clinical emergencies; and
- a culture that inadvertently supports at-risk behaviors, including technology work-arounds.¹⁻³

Smart pumps that turn on in standard mode (i.e., no dose checking) or default to standard mode can also discourage compliance, as it takes extra effort to switch the pump to the dose-checking mode and to access the library. Most pumps sold today (and all pumps that received a high rating in ECRI Institute's October 2007 evaluation of general-purpose pumps⁷) encourage use of the drug library by presenting the library to the user at start-up and allowing the user to opt out when necessary. In reviewing data from facilities that use modern drug library software, ECRI Institute found usage compliance rates above 90%, depending on whether the drug library includes most drugs and fluids used by each care area.⁸ Data-mining tools such as software that parses through pump logs can be used to improve compliance by monitoring use of the drug library and telling nursing management which drugs see the most alerts in each care area.

Safe Practice Strategies

Healthcare providers can compare using smart pump technology to using a seatbelt. Unlike airbags, which are safety features that are not optional and not subject to being bypassed by the user, seatbelts are an *optional* safety feature. They can be bypassed, just like dose-checking technology, despite a policy that may require their use. Thus, it is not enough to purchase smart pumps, program the library once, distribute the pumps, educate users, and hope that the dose-checking feature will always be used. Facilities can prepare to maintain their systems by collecting and reviewing log analysis data

on a regular basis and modifying drug libraries when necessary. Such activities can support a larger initiative to create a culture of safety that drives clinicians to avoid bypassing such a safety feature, or to report conditions that encourage work-arounds so they can be remedied. A culture of safety also promotes the critical thinking necessary to evaluate pump alerts from a clinical and safety perspective, significantly limiting overrides to situations that have been fully appraised. Thus, a culture of safety is fundamental to both compliance with using the smart pump technology as well as heeding the alerts that may arise. In addition, organizations may consider some of the following steps if they are considering purchasing and implementing smart infusion pumps in the near future.⁹

- Just like other forms of technology, a readiness assessment is essential with particular attention to the organizational culture when planning for the use of this technology.
- Establish a multidisciplinary team to determine best practices including IV-related policies and procedures and standardized concentrations, dosing units (e.g., mcg/min versus mcg/kg/min), and drug nomenclature, which should be consistent with what appears on the medication administration record, the pharmacy computer system, and other technology used in the institution.
- Determine dosage limits for infusions and bolus doses on the basis of current policy and practice, the literature, and consensus among the group. Also decide which dose limits require a hard stop versus a soft stop.
- Develop care-area-based dosage limits (e.g., for adult intensive care unit [ICU], adult general care, pediatric ICU, pediatric general care, labor and delivery, anesthesia) and procedures for nurses to follow when a drug is not in the software library or a nonstandard concentration must be used.
- Another important enabler of smart pump technology is the use of wireless connectivity. With the addition of a wireless card on each pump (similar to those used for laptop computers), wireless coverage in care areas, and a server to house and process information, a facility can regularly download event/alarm logs from the pumps and upload new drug libraries to them, all without

Smart Infusion Pump Technology: Don't Bypass the Safety Catches (Continued)

the need to locate and touch each device. ECRI Institute considers the use of wireless technologies to be a critical part of maintaining a practical, flexible dose error reduction system and permitting further software upgrades and updates to devices over time.⁷

Additional measures for facilities to consider that can nurture compliance with smart pump technology and attention to the alerts include the following:

- Analyze pump logs, evaluate overrides (which can point to mismatches between limits and typical care practice) and reprogrammings (which indicate a “good catch”), and make necessary adjustments to the drug library.
- Monitor and measure compliance with the technology to identify and remove any barriers to the safe and appropriate use of these pumps.
- Publicize salient examples of “good catches” to frontline caregivers to underscore the utility of drug libraries.
- Conduct focus groups and satisfaction surveys to solicit nursing feedback.

Do not have healthcare clinicians view the dose-checking feature of smart pumps as an option that

can be turned on or off. The alerts that arise from the system should not be allowed to be bypassed without serious consideration. For every error like those described above, there are many more that have been prevented because smart pump technology has been employed. There is little doubt that smart pumps can save lives if properly implemented *and* used.

Notes

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CT Scans May Affect Implantable Electronic Devices

PA-PSRS received a report of a patient experiencing unanticipated electrical stimulation from an implanted electronic neurostimulator during a computed tomography (CT) scan with a 64-slice CT scanner. When the neurostimulator activated, the patient moved, resulting in an unclear CT image. Another CT scan was performed, and again the neurostimulator fired. However, the patient was able to remain still during the second scan to obtain a clear image. The PA-PSRS report on the patient experiencing unanticipated electrical stimulation is described below:

The patient had an implanted neurostimulator unit that proceeded to give him a shock when he was scanned (CT) in that area. They repeated the scan in that area [because] the patient jumped when it gave him a shock the first time and they did not get a clear image. This time, staff explained to him not to jump so they could get a clear picture. The patient was able to comply even though the scanner [caused him to be shocked] again. Staff member was in the room with the patient when this whole event happened; [the staff member] called the [device manufacturer], and they stated that this has happened before with the 64-slice scanning units, and that the device should have been turned off.

Background

Implantable electronic devices (IEDs) are susceptible to a wide range of external interference. There have been reports of individuals with implanted electronic devices being shocked while passing through retail anti-theft systems and airport security systems.¹ Less reported is the fact that x-rays produced from CT devices can also interfere with IEDs.

IEDs consist of a sealed package of electronics and of electrodes that are directly connected to the heart, muscle, or nerves.¹ Implanted devices generate a series of voltage pulses that are delivered to the patient via the electrodes. Some devices, such as certain pacemakers and implantable cardioverter-defibrillators, sense or measure small voltage changes within the heart (i.e., electrical cardiac signals).² It is possible that some of those devices can sense the change in voltage induced by ionizing radiation. That change in voltage level may be significant enough to interfere with the normal operation of implanted devices.

A malfunction of the IED during a CT scan leading to a shock to the patient (e.g., from an implantable

neurostimulator) could result in the patient experiencing pain or cause the patient to move, thereby compromising the quality of the image. The amount of interference depends on a number of factors, including the amount of tissue between the implanted electronic device and the CT scanner (tissue can attenuate the x-ray beam) and/or the x-ray dose rate.

Evidence of CT Scan Interference

In a study conducted by McCollough et al., the authors observed that 37 of 41 implantable cardiac rhythm management devices (ICRMDs) (i.e., pacemakers, cardioverter defibrillators) were affected by CT irradiation. Seventeen ICRMDs were affected at typical clinical doses and 20 at maximum dose levels. The study was conducted using a 16-slice and a 64-slice CT scanner. Oversensing was the most common anomaly observed for all of the ICRMDs tested. Oversensing is a sensed event other than the intrinsic cardiac activity events of an ICRMD. The effects on the ICRMDs were only observed when the x-ray beam was directly over the devices.²

The study authors observed oversensing effects that would not have a detrimental outcome and effects that could be potentially problematic.² Specific oversensing effects included inhibition and tracking. Inhibited pacemaker output occurs when depolarization (i.e., heart muscle contraction from the electrical stimulation) is sensed during normal pacing operations, and the sensed event resets the timing cycle of a particular heart chamber. Tracking occurs with devices programmed to the P-synchronous pacing mode, in which a sensed atrial event triggers a ventricular pacing pulse.

The less harmful effects of oversensing include devices programmed to P-synchronous pacing mode and those with atrial antitachycardia features. When in P-synchronous pacing, the arterial sense amplifier of the device may trigger nonphysiologic tracking resulting in inappropriately increased ventricular rates. The end result is considered harmless because the pacing rate is limited by an upper rate limiting feature. In devices with atrial antitachycardia features, oversensing can introduce extra senses that may stimulate an atrial arrhythmia. The resulting atrial arrhythmia may cause a false detection and deliver an unnecessary atrial antitachycardia pacing therapy.² However, unnecessary atrial antitachycardia pacing was not observed during the McCollough et al. study.

A potentially more serious oversensing event of a device's ventricular sense amplifier, pacing inhibition, may occur. In this case, pacing inhibition may

CT Scans May Affect Implantable Electronic Devices (Continued)

be clinically significant for pacemaker-dependent patients if the inhibition persists, for example, more than three seconds. This lengthy inhibition may occur during dynamic scanning because during dynamic scanning, a portion of the patient remains stationary within the plane of the x-ray beam.²

Potential Cause and Effects

The cause of CT scanner interference on implantable electronic devices may, in part, be due to newer scanners designed for faster scans. One way to increase faster scan times is to increase the x-ray dose rate. The higher dose rate could increase the likelihood of interference.

The effects of CT scans on implantable electronic devices are typically transient because the interference would occur only during the time of x-ray exposure. In most cases, the implantable device would resume normal operation, but in some cases, the device might need to be reprogrammed by a physician. Irreversible damage may occur if the x-ray dose is very high; high dosage is usually only used during radiotherapy, not diagnostic procedures.¹

The effect of a CT scan on patients with IEDs would depend on the type of implantable device. For example, the pacing pattern of an implanted cardiac device (i.e., life-supporting) may change or become interrupted, which may prove harmful to the patient. However, a CT scan's effect on a non-life-support device (e.g., an implantable neurostimulator) may only result in temporary discomfort for the patient as described in the PA-PSRS report above.

Conclusions

From the PA-PSRS report and the evidence described above, implantable electronic devices can be susceptible to interference from CT scanners.

The effects of the interference can be potentially harmful. The degree of harm depends on the patient and the type of implanted device as described in the sections above. In addition to asking the patient to verify an implanted device, facilities have the option of performing a scout view to identify any IED before the actual scan. The CT scout view—a preliminary image prior to performing the major scan—uses a much lower x-ray dose rate and would most likely not interfere with the implanted device.¹

In the PA-PSRS report above, the neurostimulator manufacturer reportedly suggested that the implanted neurostimulator device should have been turned off prior to the CT scan. In most cases, non-life-supporting implanted devices such as a stimulator can be turned off during the scan without serious harm to the patient. However, life-supporting implanted devices such as a pacemaker or cardiac defibrillator cannot be turned off. Healthcare facilities typically have protocols in place for procedures that could affect the normal operation of an implanted device. Often, the physician that implanted the device is consulted to determine how best to perform the procedure without undue risk to the patient. Also, implantable device manufacturers are often consulted to determine the best course of action. Physicians who prescribe the CT scan and technicians who perform the CT scan must be aware of the presence of IEDs in order to take appropriate action to prevent harm to the patient during the scan.

Notes

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Hats Off to the Unsung Heroes

One of the unique features of the PA-PSRS program is that it receives reports not only of Serious Events (adverse events), but also Incidents (near misses). No other state requires the reporting of Incidents, which account for about 96% of all reports submitted to PA-PSRS. Since its inception in June 2004, PA-PSRS has received more than 600,000 near-miss reports.

This database is rich with examples of how healthcare workers have promoted recovery from medical errors and prevented patient harm. However, what is interesting is that many times patient harm was prevented by someone other than the healthcare worker who was most directly involved with the error; that is, someone who might not ordinarily be seen in the role of preventing the patient harm that a specific error might produce.

The exciting thing about these reports is that these healthcare workers went beyond their job description—"It's not my job" did not seem to be in their vocabulary. They took it upon themselves to go the extra mile for the sake of patient safety.

For example, hundreds of PA-PSRS reports involve discontinuity of ordered oxygen therapy during patient transport from one department to another. Ordinarily, prior to transport, the nurse is responsible for ensuring that the patient is properly set up with a source of portable oxygen. However, in many instances, a transporter informed a nurse of an incorrect oxygen set up, after which this error was corrected by nursing. Transporters have found problems in every phase of oxygen delivery, including cannulas not applied, oxygen tubing not connected to portable oxygen tanks, regulators not turned on, tank valves unopened, and empty or extremely low supply in oxygen tanks. Transporters who spoke up—telling the nurse of their concerns—have prevented many patients from developing respiratory compromise.

Here is just one example.

A transporter arrived to pick a patient up for an x-ray. The patient was in a chair with a nasal cannula applied with oxygen tubing attached to a portable oxygen tank. The transporter asked the nurse to complete a form indicating that the application of the

patient's oxygen was correct. After the nurse signed the form, the transporter noticed that the oxygen valve had not been turned on.

Another example involves phlebotomists. Again, in hundreds of reports, phlebotomists have discovered patients without identification wristbands. The phlebotomists have notified nursing who, in turn, confirmed patient identification and applied proper wristbands. While the phlebotomist was delayed in drawing blood specimens on these patients until after the wristband was applied, these healthcare workers performed a valuable service, ensuring that wrong patient errors were less likely to occur as a result of their intervention.

Unfortunately, on rare occasions, these efforts to prevent patient harm have not been positively received, as evident in the following PA-PSRS report.

During morning lab draws, the lab tech discovered a patient had no identification band. The tech notified the clerk, who got a band and asked the tech to band the patient. Because the tech did not know the patient, he asked a nurse to come to the patient's room. The nurse banded the patient without identifying the patient, stating she was not the patient's nurse and didn't know the patient. Because the patient was not oriented, verbal identification from the patient was impossible. The lab tech returned to draw the specimen when someone was available to accurately identify the patient.

What is important to remember is that all staff in a healthcare facility can really make a difference. Respecting and acting appropriately when other personnel present concerns not only promotes teamwork but also enhances patient safety. Other personnel who may not have primary responsibility for such things as oxygen maintenance or patient identification are part of the healthcare team. They can be the eyes and ears to identify important patient safety issues and report problems to the appropriate healthcare team member who can resolve it.

So, hooray for these unsung heroes and continue your good work!

Self-Assessment Questions

The following questions about selected *Patient Safety Advisory* articles may be useful for internal education and assessment. You may use the following examples or come up with your own.

Insight into Preventing Wrong-Site Surgery

- Actions associated with wrong-site surgery in Pennsylvania include all EXCEPT which one of the following?
 - Scheduling the operation incorrectly
 - Having the surgeon refer to office records to verify the site
 - Having the patient mark the site
 - Having the surgeon mark the site
 - Having the surgeon indicate agreement with the information the nurse provides during the time out
- The accuracy of which of the following document(s) should be checked and should agree prior to doing a time out?
 - The consent
 - The consent and the schedule
 - The consent, the schedule, and the history & physical examination
- Actions associated with preventing wrong-site surgery in Pennsylvania include all EXCEPT which one of the following?
 - Using a checklist for verification of the documents
 - Doing a time out before administering a regional anesthetic
 - Marking the correct extremity anteriorly for surgery in the prone position so that it can be seen best before anesthesia is induced
 - Allowing staff to interrupt the time out with the surgeon to voice their own concerns
 - Having the correct spinal level confirmed by a radiologist

Prompt Identification and Effective Communication of Status May Reduce MRSA Infections

- Which one of the following is the most common mode of methicillin-resistant *Staphylococcus aureus* (MRSA) transmission?
 - Equipment in the patient's room
 - Airborne particles
 - Blood and body fluids
 - Contaminated hands of healthcare workers
- An active surveillance program includes which one of the following?
 - Obtaining cultures for MRSA two days after admission
 - Culturing all patients
 - Using a hand hygiene program
 - Increasing housekeeping staff
- All of the following risk reduction strategies may reduce MRSA infections EXCEPT?
 - Developing standing orders to screen high-risk patients for MRSA
 - Placing patients screened for MRSA on contact isolation until results are known
 - Ensuring easy access to hand gels for use after patient contact
 - Educating patients and families about healthcare-associated infections
 - Treating non-affected patients with prophylactic methicillin

- All of the following characteristics may identify patients at high risk for developing MRSA infections EXCEPT?
 - HIV infection
 - Age under 65 years
 - Hospitalization within the last 12 months
 - Long-term care residence

Reducing Complications from Interscalene Blocks

- Which one of the following needle trajectories may reduce the risk of inadvertent subarachnoid, epidural, or vertebral artery injection?
 - A needle angle of 60° relative to the sagittal plane at the level of C6 and aimed in a slight posterior, steeply caudal direction
 - Needle is perpendicular to the skin in every plane
 - A needle angle of 45° relative to the sagittal plane and aimed anteriorly in the interscalene groove
- The concentration of local anesthetic used in ISB has no effect on the risk of nerve injury.
 - True
 - False
- Surgical procedures appropriate for ISB include all EXCEPT which one of the following?
 - Clavicle/shoulder procedures
 - Treatment of sympathetic dystrophy
 - Surgery of the hand/forearm/medial elbow
 - Insertion of vascular shunts
 - Insertion of a pacemaker
- Contraindications and patient conditions to consider before performing ISB include all EXCEPT which one of the following:
 - Patients with low body mass index
 - Myasthenia gravis
 - Contralateral hemidiaphragmatic dysfunction
 - Sepsis
 - Peripheral neuropathy
- Complications and unintended consequences of ISB include all EXCEPT which one of the following?
 - Chronic obstructive pulmonary disease and epicondylitis
 - Carpal tunnel syndrome
 - Seizure
 - Unintended nerve blockade
 - Vocal cord palsy
- Risk reduction strategies for ISB include all EXCEPT which one of the following?
 - Avoiding use of highly concentrated local anesthetics
 - Marking surface anatomy
 - Discontinuing needle probing at the first paresthesia or muscle twitch
 - Availability of monitoring/resuscitative equipment
 - Maintaining glycemic control

The Patient Safety Authority works with the Pennsylvania Medical Society to offer *AMA PRA Category 1 Credits™* for selected portions of the *Patient Safety Advisory* through the online publication *Studies in Patient Safety: Online CME Cases*. Go to <http://www.pamedsoc.org> to find out more about patient safety CME opportunities.



An Independent Agency of the Commonwealth of Pennsylvania

The Patient Safety Authority is an independent state agency created by Act 13 of 2002, the Medical Care Availability and Reduction of Error (“Mcare”) Act. Consistent with Act 13, ECRI Institute, as contractor for the PA-PSRS program, is issuing this publication to advise medical facilities of immediate changes that can be instituted to reduce Serious Events and Incidents. For more information about the PA-PSRS program or the Patient Safety Authority, see the Authority’s Web site at www.psa.state.pa.us.



ECRI Institute, a nonprofit organization, dedicates itself to bringing the discipline of applied scientific research in healthcare to uncover the best approaches to improving patient care. As pioneers in this science for nearly 40 years, ECRI Institute marries experience and independence with the objectivity of evidence-based research. More than 5,000 healthcare organizations worldwide rely on ECRI Institute’s expertise in patient safety improvement, risk and quality management, and healthcare processes, devices, procedures and drug technology.



The Institute for Safe Medication Practices (ISMP) is an independent, nonprofit organization dedicated solely to medication error prevention and safe medication use. ISMP provides recommendations for the safe use of medications to the healthcare community including healthcare professionals, government agencies, accrediting organizations, and consumers. ISMP’s efforts are built on a non-punitive approach and systems-based solutions.