PENNSYLVANIA PATIENT SAFETY ADVISORY

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IN THIS ISSUE

Reviews & Analyses

3 Patient Screening and Assessment in Ambulatory Surgical Facilities
As the popularity of these facilities continues to grow and increasingly complex procedures are performed, thorough screening, assessment, and preparation of patients prior to surgery is essential to ensure optimal patient outcomes.

10 Medication Errors: Significance of Accurate Patient Weights
Unknown or inaccurate patient weights can result in doses of prescribed medications that differ significantly from appropriate doses.

16 Safe Intrahospital Transport of the *non*-ICU Patient Using Standardized Handoff Communication
The intrahospital transport of the *non*-intensive care unit patient is often performed by unlicensed hospital personnel who frequently encounter changes in patient conditions that require immediate intervention by licensed healthcare providers.

20 Safety in the MR Environment: MR Screening Practices
The magnetic resonance screening process reduces or, if properly conducted, eliminates the likelihood of an adverse event while the patient is inside the bore of the magnetic resonance imaging system.

Other Features

1 Patient Safety Liaison Engages Healthcare Facilities in the Northeast
Megan Shetterly, RN, MS

2 Letter to the Editor: Hazardous Drug Classification

2 Patient Safety Authority Loses a Founding Leader

Focus on Infection Control

27 Successful Reduction of Healthcare-Associated MRSA Infection Rates

From the Database

36 Data Snapshot: Iatrogenic Burn Injuries

Update

33 Quarterly Update on the Preventing Wrong-Site Surgery Project

About the Pennsylvania Patient Safety Advisory

OBJECTIVE

The *Pennsylvania Patient Safety Advisory* provides timely original scientific evidence and reviews of scientific evidence that can be used by healthcare systems and providers to improve healthcare delivery systems and educate providers about safe healthcare practices. The emphasis is on problems reported to the Pennsylvania Patient Safety Authority, especially those associated with a high combination of frequency, severity, and possibility of solution; novel problems and solutions; and those in which urgent communication of information could have a significant impact on patient outcomes.

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Patient Safety Liaison Engages Healthcare Facilities in the Northeast

Megan Shetterly, RN, MS

Megan Shetterly, RN, MS
Patient Safety Liaison, Northeast Region
Pennsylvania Patient Safety Authority

The Pennsylvania Patient Safety Authority developed its Patient Safety Liaison (PSL) Program in response to feedback from patient safety officers (PSOs) who requested a greater Authority presence in Pennsylvania's healthcare facilities. The role of the PSL is to provide guidance, coordinate educational programs, encourage collaboration, and solicit feedback from healthcare facilities that report Incidents and Serious Events under Act 13 of 2002.

As the PSL for the Northeast Region of Pennsylvania, I have met many healthcare professionals whose dedication to patient safety is clearly evident. With so many competing priorities, patient safety is sometimes difficult to accomplish. However, with persistence and creativity, it is effective. Let me share some examples.

Pocono Medical Center's leadership has endorsed a program it also calls the Patient Safety Liaison Program. One staff member from each clinical department has been given the distinction of being a PSL. This practice extends the reach of the PSO so that the organization has a team of individuals who will identify and report identified patient safety needs. Together, this cohesive group will work to improve patient safety within their organization. Authority representatives provided assistance at the program kickoff meetings in January 2009 and look forward to sharing updates on the medical center's progress.

Another unique patient safety initiative implemented by some ambulatory surgery facilities (ASFs) involves color banding pediatric patients consistent with the Broselow scale. However, one ASF in the Northeast Region takes the initiative one step further and also bands the pediatric patient's parent with a duplicate color band that contains the patient's unique identifiers.

The move to standardize color-coded wristbands, which began in Pennsylvania, is a notable change to improve patient safety, and has spawned a regional, national, and international response. With each facility visit, I communicated how a united system of standardized color bands can affect patient safety. Since this program was actually born out of initiatives in the Northeast Region, most Northeast facilities have adopted this practice. But, I did find one organization that was having some difficulty. Following a recent organizational merger, color-coded wristbands were changed to be uniform throughout the internal system/network. There was some resistance to change to the Pennsylvania initiative's (The Color of Safety Task Force) color codes, but leadership within the organization and its community patient safety members prevailed. Once the PSO took relevant Authority information to her patient safety committee, there was strong support to initiate change. This was a win for the organization, the community, and ultimately for every patient who is cared for in an organization that has adopted this practice.

Every healthcare facility will evolve at its own pace in regard to the culture of patient safety. Some have made great strides in adopting best practices. My job is to help everyone achieve a culture in which all providers participate in creating a safe environment for patients and an environment in which patients feel comfortable participating in their own healthcare. Each facility I've visited has made some relevant change in its systems or processes in order to improve patient safety.

Collaborating with peers about these changes is important. As a PSL, I have personally discussed with PSOs and staff the multiple risk reduction strategies and best practices available to them through the Authority (e.g., *Advisory* articles, patient safety tools and resources, Consumer Tips, brochures). In response to requests for information and resources—such as medication reconciliation forms, healthcare-associated infection disclosure letters, vendor information on color-coded bands, and intravenous lines for contrast injectors—many PSOs forward facility-specific information to my attention and grant permission to share this with others in need.

It's a pleasure to be working with such a passionate team of PSOs whose commitment to patient safety is so evident. As the Northeast Region PSL, I look forward to continuing our collaborative efforts in strengthening all Pennsylvania facilities' patient safety programs. This is just the beginning of a program that will set the stage for bigger and better achievements in the world of patient safety.

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Letter to the Editor

Hazardous Drug Classification

Regarding the article "Hazardous Spills: The Safe Handling of Hazardous Drugs" in the September 2008 issue of the *Pennsylvania Patient Safety Advisory*, it probably should be added in an addendum that U.S. Environmental Protection Agency classifies some drugs by characteristic(s). Hence, these drugs are by definition hazardous (e.g., paraldehyde, chloral hydrate). This classification bears on the proper disposal. For additional information, please see http://www.mainebenzo.org.

Stevan Gressitt, MD, Medical Director
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Editor's Note

Thank you for your letter to the editor regarding the September 2008 Pennsylvania Patient Safety Advisory *article "Hazardous Spills: The Safe Handling of Hazardous Drugs" and for providing the additional information link to the Safe Medicine Disposal for Maine Program.*

The application of U.S. Environmental Protection Agency characteristics (i.e., ignitability, corrosively, reactivity, toxicity) occurs when the drug becomes a waste.[1] *The focus of the September 2008 article was the safe handling of these drugs during the entire life cycle, including manufacturing, transporting, dispensing, and administering, before ending at waste disposal. The article's risk reduction strategies include cradle-to-grave considerations for hazardous drugs because many chemotherapy agents are now used for noncancerous conditions, a practice that increases exposure to healthcare providers, patients, and families. The National Institute for Occupational Safety and Health, American Society of Health-System Pharmacists, Oncology Nursing Society, and Occupational Safety and Health Administration standards apply from receipt of the drug to administration and/or disposal.*

Note

1. United States Environmental Protection Agency. What makes a waste hazardous? [online]. 2000 Oct [cited 2009 Feb 13]. Available from Internet: http://www.epa.gov/osw/wycd/manag-hw/e00-001e.pdf.

Patient Safety Authority Loses a Founding Leader

Alan B.K. Rabinowitz, the Pennsylvania Patient Safety Authority's first administrator, lost his battle with cancer Friday, February 6, 2009.

Alan was appointed the first administrator of the Pennsylvania Patient Safety Authority in November 2002. Under his tenure, the Authority garnered national recognition and won the prestigious 2006 John Eisenberg Award for advancing patient safety and quality, given jointly by the National Quality Forum and the Joint Commission.

As the first employee of the Authority, Alan also paved the way in the development and implementation of the Pennsylvania Patient Safety Reporting System (PA-PSRS) and initiated publication of the Pennsylvania Patient Safety Advisory. Articles in the Advisory have garnered national attention and brought issues such as wrong-site surgery and standardizing color-coded wristbands to the forefront of the healthcare industry.

"Alan was passionate about making sure the Patient Safety Authority did all it could to protect patients in Pennsylvania," said Dr. Robert Muscalus, former chair of the Pennsylvania Patient Safety Authority Board of Directors.

Before his appointment as administrator, Alan spent more than seven years as chief of staff in the Pennsylvania Department of Health. He previously worked in the private sector and, from 1979 through 1987, was on the personal staff of Governor Dick Thornburgh.

Alan's dedication to public service and in particular to the Patient Safety Authority is unmatched. His passion for helping others carried over into his personal life through his kind contributions to the Hospice of Central Pennsylvania, where he prepared and delivered elaborate full-course meals to the residents and their families for holidays and special occasions each year.

Alan B.K. Rabinowitz, first administrator of the Pennsylvania Patient Safety Authority

"Alan was a very special man who gave so freely of his talents," said Susan Resavy, director of family services at the Hospice of Central Pennsylvania. "He called us several years ago offering to prepare and deliver meals. He would travel anywhere we asked him to. He touched so many people's lives at a difficult time for them."

As the Authority continues to educate the healthcare facilities through the Pennsylvania Patient Safety Advisory and other educational resources, Alan's efforts are remembered often by me and other Authority staff for building the strong foundation that the organization rests upon. He will be greatly missed.

Memorial contributions may be made in Alan's honor to Hospice of Central Pennsylvania, PO Box 266, Enola, PA 17025.

Michael Doering, MBA
Executive Director
Pennsylvania Patient Safety Authority

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Patient Screening and Assessment in Ambulatory Surgical Facilities

ABSTRACT

Ambulatory surgical facilities (ASFs) provide surgical care to patients who do not require hospital admission for their postoperative care. The popularity and growth of ASFs on a national scale has been attributed to an increased throughput of patients, reduction in staff and surgical costs, and more personalized care. Along with the progression in volume, increasingly complex procedures are being performed at ASFs. In addition, patients with more complex medical conditions are having surgery in the ASF setting. Thorough initial assessment of patients is required to identify any concerns or disease processes, such as obstructive sleep apnea or cardiovascular disease, which could potentially cause intraoperative or postoperative problems. From June 2004 to December 2008, the Pennsylvania Patient Safety Authority received 467 reports related to the preoperative screening or assessment process in ASFs. Two hundred three of these reports indicate the patient experienced harm. Risk factors are discussed, as well as processes to ensure a thorough preoperative screening and assessment of patients to identify risk factors. (Pa Patient Saf Advis 2009 Mar;6[1]:3-9.)

Introduction

Ambulatory surgical facilities (ASFs) are defined by the Pennsylvania Health Care Facilities Act as a facility, not located upon the premises of a hospital, which provides specialty or multispecialty outpatient surgical treatment.[1] ASFs afford patients the opportunity to undergo surgical and procedural services in a nonhospital setting. ASF popularity and volume continues to grow, with the number of visits to freestanding ASFs estimated to have increased nationally by 300% from 1996 to 2006.[2] By 2006, an estimated 57.1 million procedures were performed during 34.7 million ambulatory surgery visits.[2] The proliferation of ASFs has been attributed to a number of factors, including increased throughput of patients, reduction in staff and surgical costs, and more personalized care.[3] Advances in anesthetic and surgical techniques have also contributed to the growth in the number and complexity of procedures in ASFs. Along with the greater complexity of procedures, there has been an increasing shift to performing procedures in ASFs on patients who have more complex medical conditions, including some that have been associated with a heightened risk of adverse postoperative outcomes.[2]

Reports submitted to the Pennsylvania Patient Safety Authority indicate that medical conditions that are not detected during the preoperative screening and assessment process may place patients at increased risk for postoperative complications requiring hospital admission. Identification of these medical conditions through a thorough preoperative screening and assessment process is integral to providing safe patient care in the ASF setting. This article will review medical conditions associated with increased perioperative risk in the ASF setting. Risk reduction strategies are presented to assist healthcare providers during the preadmission screening and preoperative assessment process, allowing early identification of patient risk factors.

Authority Reports

Reports submitted to the Authority from June 2004 to December 2008 were reviewed to identify potential issues involving the preoperative screening or assessment process. Of the 467 reports identified, 203 (43%) were reported as a Serious Event, most often involving a complication requiring transfer to an acute care setting. Two hundred thirty-four of the total reports (50%) involved an elderly patient (older than 65). Twenty-three reports (5%) involved a pediatric patient.

One hundred twenty-four event reports (27%) submitted by ASFs indicated that screening and assessment processes required improvement. In 85 reports (18%), the patient had a condition, such as an arrhythmia or sleep apnea, which may have put the patient at increased risk during the procedure, but no improvement to the ASF's screening and assessment process was recommended by the ASF. A variety of conditions were identified as potentially missed during the screening or assessment process; most frequently reported conditions include a cardiac history, arrhythmia, and poor respiratory status. The following are examples of reports to the Authority in which the ASF indicated that the screening and/or assessment process needed improvement:

> *No patient prescreening was obtained prior to admission. After reviewing patient information, it was noted the patient had a history of Clostridium difficile. Reviewed information with the anesthesiologist, and then contacted the infection control nurse at the medical center and was advised to cancel the procedure pending further data about the C. difficile [history].*

> *A patient with a history of drug abuse and smoking had an upper endoscopy procedure. The procedure was uneventful. At the end of the procedure the patient went into laryngeal spasms that required intubation and subsequent transfer to the hospital.*

> *A pediatric patient presented for surgery with a body mass index (BMI) greater than 30 and has a history of asthma. The case was canceled by the anesthesiologist because, per the facility guidelines, morbidly obese patients are not appropriate candidates to have a procedure at the surgi-center.*

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The patient did not report a prior history of a low platelet count. The patient experienced postoperative bleeding and was transferred to the hospital. The preoperative screening tool was reevaluated to include an assessment of prior or current blood dyscrasias.

A patient admitted for surgery revealed a history of a recent myocardial infarction, congestive heart failure, and chronic obstructive pulmonary disease. The patient's cardiologist was notified and determined the patient was not an appropriate candidate for the surgery center.

The preoperative interview determined that a patient admitted for a cystoscopy was morbidly obese and had a history of sleep apnea and congestive heart failure. The preoperative screening process will be evaluated.

Risk Factors

In a previous *Patient Safety Advisory* article, the following factors identified in the literature that predict an increased risk for hospital admission or death following outpatient surgery were discussed:[4]

- Patient age greater than 85 years
- Peripheral vascular disease
- Operating room (OR) time greater than one hour
- Malignancy
- Positive HIV status
- Heart disease
- A requirement for general anesthesia

Additional factors have been identified in the literature that may place a patient at risk in the ambulatory setting. These factors support the importance of identifying patient conditions to help avoid unfavorable outcomes related to surgery in ASFs, and they include obstructive sleep apnea, cardiovascular disease, hyperactive reactive airway disease, obesity, and end-stage renal disease (ESRD).

Obstructive Sleep Apnea

Obstructive sleep apnea (OSA) is undiagnosed in an estimated 80% of affected patients, and the incidence of presumed or diagnosed OSA is predicted to rise five- to tenfold during the next decade.[5,6] The number of patients with OSA undergoing surgery in the ambulatory surgery setting may be expected to increase commensurate with these estimates; however, there are currently no corroborative studies. Nonetheless, the American Association of Anesthesiology (ASA) Practice Guidelines support the preoperative evaluation of patients for identification of OSA. According to ASA, comparative literature is insufficient to evaluate the impact of preprocedure OSA status identification on outcome but does suggest that OSA characteristics may put a patient at risk for perioperative airway management issues.[7] The guidelines emphasize that patient selection for ambulatory surgery depends on the severity of OSA, coexisting diseases, invasiveness of surgery, type of anesthesia, anticipated postoperative opioid requirements, and adequacy of postdischarge observation.[7,8] The ASA Practice Guidelines include a scoring system that can be used to help determine the appropriateness of ambulatory surgery in patients with OSA.[7]

Cardiovascular Disease

Cardiovascular adverse events are the most common adverse events occurring during ambulatory surgery.[9] A broad range of cardiovascular disease, from hypertension to severe valvular disease, may be encountered.[10] All patients require assessment of the presence of symptoms that could suggest cardiac disease with positive responses addressed according to risk assessment guidelines, such as the guideline by the American Heart Association (AHA) and the American College of Cardiology (ACC). The AHA/ACC guideline suggests that the cardiovascular evaluation of a patient undergoing noncardiac surgery should include an assessment of disease, functional status, and extent of surgery.[10,11] A baseline cardiac assessment is recommended for patients who have known coronary artery disease (CAD) or who have onset of signs or symptoms of CAD. Cardiac conditions that would necessitate evaluation and treatment before noncardiac surgery include significant or new onset arrhythmias (e.g. new onset atrial fibrillation) and severe valvular disease.[11] Patients with unstable coronary syndromes or decompensated heart failure are not considered appropriate candidates for procedures in the ambulatory surgery setting.[12]

Patients with cardiovascular disease require assessment for the presence of a pacemaker.[10] An ASA practice advisory suggests that preoperative evaluation include determining the reason for the pacemaker, the exact type of pacemaker, the patient's underlying rhythm, and medications.[13] Ensuring patient safety and proper maintenance of the device includes a number of considerations, such as whether electromagnetic interference is likely to occur and whether reprogramming of the device is required.[13] Patients also require assessment for the presence of an automatic implantable cardioverter defibrillator (ICD), which must be disabled before and reset after the procedure. The presence of a pacemaker or an ICD requires the immediate availability of backup defibrillation or cardioversion equipment during the perioperative period.[13]

Hyperactive Reactive Airway Disease

Literature related to pulmonary risk following ambulatory surgery is limited; however, hyperactive reactive airway disease has been associated with an increased risk for perioperative complications during outpatient surgery.[14] Chronic obstructive pulmonary disease (COPD) and asthma both involve hyperreactivity of the airway. In a prospective study of preexisting medical conditions in ambulatory surgery, patients with asthma and smokers were identified as having increased risk for postoperative respiratory events.[15] A four-center study of 6,914 patients undergoing ambulatory surgery demonstrated that patients with asthma and COPD had an increased risk of

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bronchospasm.[16] Asymptomatic patients with asthma have been demonstrated to be at low risk for perioperative complications; however, those with asthma symptoms have been shown to have a 50% incidence of postoperative respiratory complication compared with less than 2% of those without symptoms.[17] Smoking cessation for 30 days before surgery and delay of surgery for symptomatic asthma patients has been recommended.[18]

Obesity

Obesity is defined as an excess of adipose tissue or body weight greater than or equal to 20% more than ideal weight or a BMI of greater than or equal to 30 kg/m^2.[19] A recent study evaluated whether obesity is an independent risk factor for unplanned hospital admission or readmission among patients scheduled for ambulatory surgery. Two hundred thirty-five obese patients scheduled for ambulatory surgery in a tertiary medical center were matched to a normal-weight control by age, sex, surgical procedure, type of anesthesia, and date of surgery. Comorbidity was more frequent in the obese cohort. The study demonstrated that obesity is not a significant independent risk factor for unplanned admission after ambulatory surgery.[20] While obesity alone has not been associated with unanticipated admission following ambulatory surgery, obesity has been associated with an increase in intraoperative respiratory events. In a cohort study of 17,638 patients, 2,779 had a BMI of greater than or equal to 30 kg/m^2. Obese patients did not experience increased cardiovascular risk but were at a significantly increased risk of intraoperative events, including desaturation and bronchospasm.[17] Lower respiratory events were more common in obese members of a 7,000 patient cohort undergoing ambulatory surgery.[18]

End-Stage Renal Disease

Patients with ESRD may have one or several other diseases, including coronary artery disease, diabetes, or congestive heart failure, which may place them at risk in the ambulatory surgical setting.[10,12] A patient with ESRD who undergoes an ambulatory surgical procedure requires a detailed history and physical assessment that includes consideration of their underlying disease processes. The most commonly performed procedure in patients with ESRD in the ambulatory surgery setting is hemodialysis vascular access.[12] Important concerns for these patients include fluid and electrolyte balance, particularly potassium.[10,12] Timing of dialysis treatments is important because the patient has relative volume depletion on the day of dialysis. Patients with ESRD are at increased risk for bleeding due to platelet dysfunction. Anemia is also common in this patient population. Gastric emptying may be impaired, placing these patients at risk for aspiration.[10,12]

Risk Assessment

The preoperative assessment process starts when the surgeon or the proceduralist schedules the case. In general, the goal of the preoperative anesthesia assessment is to identify and manage any risks associated with anesthesia and surgery as early in the process as possible. However, the assessment process continues up to the point of surgery.

ASA Physical Status Classification System

Patient conditions that may increase risk during procedures performed in the ASF setting have been identified. However, research has not yet provided clear-cut support to guide patient selection decisions for ASF procedures. Nonetheless, there are guidelines used by anesthesia providers to evaluate a patient's risk for anesthesia and surgery, such as the ASA patient classification system, which is excerpted as follows:[21]

ASA 1. A normal healthy patient.

ASA II. A patient with mild systemic disease.

ASA III. A patient with severe systemic disease.

ASA IV. A patient with severe systemic disease that is a constant threat to life.

ASA V. A moribund patient who is not expected to survive without the operation.

ASA VI. A patient that has been declared brain-dead, whose organs will be removed for donor purposes.

In Pennsylvania, surgery in an ASF is limited to patients that are a physical status (PS)-1, PS-2, or PS-3. Physical status is consistent with ASA physical status classification.[1]

The relationship of ASA classification to patient outcomes following ambulatory surgery has been studied; however, conclusions are inconsistent. A retrospective case-controlled review of 896 ASA III patients demonstrated no significant difference in postoperative complications within the first 24 hours of surgery in ASA III and ASA I and II patients.[22] More than 75% of anesthesiologists surveyed in a Canadian study were willing to include ASA III patients in their selection criteria. In the same study, more than 75% of the respondents found ASA IV patients—including patients with high-grade angina pectoris and congestive heart failure, sleep apnea with postoperative narcotics, morbid obesity with comorbidities, and no patient escort—to be unsuitable for ambulatory anesthesia.[23] Other studies have not found a correlation between ASA classification and outcome.[5] Potential problems related to ASA IV patients undergoing surgery in the outpatient setting include the requirement for invasive monitoring, vasoactive drug infusions, and postoperative ventilator support.[24]

Risk Classification

The ASA classification system has been considered limited unless the risk of the surgical procedure is also considered.[25] A risk classification system developed at the Johns Hopkins University School of Medicine proposed that risk of surgery is a function of several factors, including procedure invasiveness, associated

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blood loss and fluid shift, entry into specific body cavities, postoperative anatomic and physiologic alterations, and need for postoperative intensive care monitoring. Procedures are classified from category 1 (i.e., minimal risk, minimally invasive, with little or no blood loss) to category 5 (i.e., major risk, highly invasive, with blood loss greater than 1,500 ml).[25] The author notes that both the ASA classifications and the Johns Hopkins risk classification system are consensus-driven.

Risk Reduction Strategies

Since current research has not provided clear-cut patient selection criteria, all ASFs need to ensure that their patient selection and assessment criteria will adequately guide the preoperative screening and assessment process. ASFs also need to ensure that reliable methods are implemented to ensure timely and adequate preoperative assessment. Such efforts will help to provide a high level of care and produce the best patient outcomes.

Preoperative Screening

The initial screening process is the first step in identifying any concerns or diseases processes that could potentially cause intra- or postoperative problems. The Association of periOperative Nurses (AORN) has issued a guidance statement for nursing preoperative evaluation in the ambulatory surgery setting.[26] An initial element of a comprehensive preoperative policy and procedure is careful preoperative screening, which can take place by telephone or in a face-to-face interview in a preadmission clinic setting. AORN recommends that a professional registered nurse (RN) conduct the preoperative screening to include assessment of the following:[26]

- A baseline physical assessment
- Allergies and sensitivities
- Signs of abuse or neglect
- Cultural, emotional, and socioeconomic assessment
- Pain assessment
- Medication history, including over-the-counter medications, herbal medications and supplements, and illicit drugs
- Anesthetic history
- Results of radiological examinations and other preoperative testing
- Discharge planning
- Referrals
- Identification of physical alterations that require additional equipment or supplies
- Preoperative teaching, including which medications are to be taken or withheld before surgery, preoperative shower and NPO (nils per os; nothing by mouth) requirements
- Informed consent and/or knowledge of the procedure
- Development of a care plan
- Documentation and communication of all information per facility policy

ASFs can also consider a number of strategies used successfully by other facilities to assist in the gathering of appropriate information during the preoperative screening process. One Pennsylvania ASF with a low surgical cancellation rate (1%) uses a comprehensive preadmission packet and automated preoperative phone calls in its presurgical process.[27] When the decision for surgery is made, the surgeon's office begins completing the packet, which includes the surgical consent, registration forms, health history questionnaire, surgical admission form with orders, and patient instructions. The surgeon completes a history and physical form or dictates it by means of the hospital's transcription service. The anesthesiologists use consensus guidelines for preoperative testing and have agreed on which response on the health history will trigger a call to the patient's physician before the surgery. A nurse practitioner reviews the flagged charts. The preadmission packets are processed by the hospital's presurgical office. The following are elements of the process:[27]

- Secretaries send registration forms to the admissions department and file the rest of the packets by date of surgery, adding test results and other information when received.
- Secretaries flag charts meeting criteria for further review.
- A nurse practitioner reviews the flagged charts for anesthesia issues and orders tests or consults as needed.
- Two days or more before surgery, secretaries begin assembling the chart. A worksheet on the front tracks information. Secretaries follow up on missing information.
- On the day before surgery, an RN reviews the charts and completes the preoperative checklist.
- The master surgical schedule notes any information missing in red.
- Preanesthesia and nursing assessments are conducted on the day of surgery.
- Automated phone calls communicate preoperative information to patients. The calls cover preoperative instructions, arrival times, and follow-up after surgery.
- Staff contact patients who were not reached by the automated call.

Another Pennsylvania ASF considers a close relationship with the primary care physician's office an integral part of the preoperative screening process. (The Patient Safety Authority learned of this screening process through the ASF's interaction with the Authority's Patient Safety Liaison Program.) The ASF sends a history and physical form to the patient's

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primary care physician for completion. The form elicits information about the patient's medical history and current status that the ASF may not otherwise obtain. One to two days before surgery, an RN calls the patient to provide preoperative instructions and completes a preadmission phone call form, which is reviewed by anesthesia services. On the day of surgery a preoperative RN or licensed practical nurse sees the patient and performs an assessment before the patient's admission. If potential issues are identified, an anesthesia provider further screens the patient before admission. The patient is then admitted, and a preoperative and anesthesia form is completed.

Preoperative Nursing Assessment

After the preoperative screening is completed, the preoperative nursing assessment is an opportunity to verify information and obtain missed or forgotten information that may affect patient outcome. The AORN guidance statement recommends that an RN conduct a preoperative nursing assessment on the day of surgery.[26] The data collection process involves the patient and his or her significant other or guardian. Information obtained during the preadmission screening is verified. The guidance statement provides an extensive list of information to be obtained and documented. Additional guidelines address communication of the assessment to surgical team members, formulation of a nursing care plan, and development of a process for reporting and acting on abnormal findings. The following interventions should be considered in the assessment:[26]

- Verification of the patient's identity using two identifiers
- Review of the preadmission screening/assessment
- A baseline physical assessment
- Assessment of NPO status
  - Hypothermia assessment and management
  - Pain scale assessment
- Identification of the presence of an advanced directive
- Identification of the planned procedure by the patient, significant other, or guardian
- Verification of site, side, or level, as applicable
- Implementation of the prescribed surgical preparation
- Assessment for prosthetic devices and implantable electronic devices
- Evaluation of the availability of safe transportation home and aftercare
- Obtaining contact information of the patient's significant other
- Assessment of the patient's understanding of preoperative teaching and discharge planning

Preoperative Anesthesia Assessment

The preoperative anesthesia assessment is the part of the overall preoperative assessment process that identifies issues related to perioperative anesthesia management of the patient.[28] ASA guidelines for ambulatory anesthesia endorse the following as a baseline for preanesthesia patient care:[29]

- Preoperative instructions and preparation
- An appropriate preanesthesia evaluation and examination by an anesthesiologist or before anesthesia and surgery
- Verification of information and repeat of key elements of the evaluation if nonphysician personnel are involved in the process
- Preoperative studies and consultation as medically indicated
- An anesthesia plan discussed with the patient

The following is a summary of the ASA Practice Advisory for Preanesthesia Evaluation recommendations, which are based on a synthesis of opinion surveys, literature, and ASA task force consensus:[30]

- Content of the preanesthesia evaluation includes (1) readily accessible medical records; (2) patient interview; (3) a directed preanesthesia examination, which includes at a minimum, an assessment of the airway, lungs, and heart; (4) preoperative testing as indicated; and (5) other consults as appropriate.
- Timing of the preanesthesia evaluation can be guided by surgical invasiveness and severity of disease.
- Routine preoperative tests, which include tests to discover disease or disorder in an asymptomatic patient, do not make an important contribution to anesthesia preoperative assessment and management.
- Selective preoperative tests, ordered after consideration of information from the medical record, patient interviews, physical examination, and type or invasiveness of the procedure, may assist in preoperative assessment and management.
- Decision-making parameters for the type and timing of preoperative tests cannot be determined based on the current literature. Specific tests and timing should be patient-specific.

One Pennsylvania ASF's approach to preanesthesia assessment is to conceptualize two goals. First, the patient's condition—whether it is optimal or as good as possible at this point in time—is evaluated, considering all the elements of the history and physical, including the review of systems. The following are also components involved in meeting the first goal:

- Have all indicated and abnormal labs, electrocardiogram, and other diagnostic studies been addressed?
- Is the patient on appropriate medical therapy?
- Is the current medical therapy effective?

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Accompanying Patient Safety Tools

Visit the Pennsylvania Patient Safety Authority Web site (http://www.patientsafetyauthority.org) to view or download the following resources based on this article.

- "Health History," a sample form that may be sent to the primary care physician or the referring physician for completion before the day of surgery at an ambulatory surgery facility (ASF).
- "Nursing Preoperative Screening," a sample form that may be used for nursing preadmis-

Determination of whether medical therapy is effective in patients with chronic disease is usually conducted by their primary care provider. In patients with multiple, serious, or complex medical problems, an appropriate medical specialist may be needed to determine optimization or make recommendations for optimization of the patient's condition before surgery.

The second goal is to determine whether the planned procedure and anesthesia are appropriate for the patient. For example, a patient with an ischemic cardiomyopathy or with renal disease may be an appropriate candidate for an ASF procedure that is performed under minimal or moderate sedation but not for an ASF procedure that requires deep sedation or general anesthesia. It is also possible that outpatient surgery is not appropriate for such a patient.

Conclusion

As the popularity of ASFs continues to grow and increasingly complex procedures are performed in the ASF setting, thorough screening and assessment and preparation of patients before ambulatory surgery are essential to ensure optimal patient outcomes. Although the body of evidence to support that certain comorbidities may make some patients less suitable for surgery in the ambulatory setting is not large, a number of patient comorbidities have been associated with increased risk of intraoperative and postoperative complications. Consideration of these comorbidities during screening and assessment is an important part of a thorough preoperative evaluation.

Notes

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Self-Assessment Questions

The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own.

1. Risk reduction strategies to help ensure timely and adequate preoperative anesthesia assessment include all of the following EXCEPT:
   a. Conducting routine preoperative tests
   b. Conducting a preanesthesia evaluation that is guided by surgical invasiveness and severity of disease
   c. Repeating key elements of the anesthesia evaluation if nonphysician personnel are involved in the initial assessment
   d. Discussing the anesthesia plan with the patient
2. Which of the following statements is inaccurate about preoperative risk assessment in ambulatory surgery?
   a. The relationship of the American Association of Anesthesiology (ASA) classification to patient outcomes has been studied but is inconclusive.
   b. Procedure risk classification systems consider the risk of surgery to be a function of surgical invasiveness, associated blood loss and fluid shift, and the need for postoperative intensive care monitoring.
   c. Potential problems related to ASA IV patients undergoing surgery in the outpatient setting include the need for invasive monitoring, vasoactive drug infusions, and postoperative ventilator support.
   d. Routine preoperative tests make an important contribution to anesthesia assessment and management.
3. All of the following are clinical conditions that have been associated with an increased risk of adverse outcomes in the ambulatory surgical setting EXCEPT:
   a. Patient age greater than 85 years
   b. A BMI (body mass index) greater than 25 kg/m-^{2}
   c. Obstructive sleep apnea
   d. Asthma
4. A 76-year-old patient with end-stage renal disease and new-onset atrial fibrillation is scheduled for the placement of a hemodialysis vascular access in an ambulatory surgical facility (ASF).

   Which of the following statements is inaccurate about the preoperative assessment of this patient before surgery in an ambulatory surgical setting?
   a. Important concerns for this patient include preoperative evaluation of fluid and electrolyte balance, particularly potassium.
   b. The patient's new onset of atrial fibrillation is a cardiac condition that may necessitate evaluation and treatment by a cardiologist before placement of a hemodialysis vascular access in an ASF.
   c. The patient's age is a factor identified in the literature that predicts an increased risk for hospital admission following surgery in an ASF.
   d. The preoperative evaluation of this patient includes, in consultation with the patient's cardiologist as appropriate, determination of the reason for the pacemaker, the exact type of pacemaker, the patient's underlying rhythm, and medications.
5. A comprehensive preadmission screening of a patient before an ambulatory surgical procedure includes all of the following EXCEPT:
   a. Medication history
   b. Allergies
   c. Anesthetic history
   d. Exercise tolerance test

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Medication Errors: Significance of Accurate Patient Weights

ABSTRACT

A patient's weight is important information because it is often used to calculate the appropriate medication dose. When medication errors arise due to inaccurate or unknown patient weights, the dose of a prescribed medication could be significantly different from what is appropriate. Nearly 480 event reports submitted to the Pennsylvania Patient Safety Authority specifically mentioned medication errors that resulted from breakdowns during the process of obtaining, documenting, and/or communicating patient weights. Analysis reveals that 67.2% of the events reached the patient. The unit mentioned most frequently in reports was the emergency department. All the frequently mentioned medications can be dosed based on a patient's weight (i.e., weight-based dosing), and 5 of the top 10 medications are high-alert medications. Breakdowns described in reports most frequently involved failures to obtain accurate patient weight measurements. Once a value was obtained, errors arose from misuse of that value. Examples include problems when patients arrive at a hospital and are not weighed, leading to estimates of patient weights; assumptions that documented weights are current and/or accurate; and documentation breakdowns (e.g., the patient is weighed in pounds, but the weight is erroneously documented as kilograms). Strategies to address these problems include providing all units with the necessary equipment to weigh patients, weighing every patient during triage or admission to facilities, and weighing patients and documenting patient weights only in kilograms. (Pa Patient Saf Advis 2009 Mar;6[1]:10-5.)

Patient information helps practitioners select appropriate medications, doses, and routes of administration.[1] One vital piece of patient-specific information, the patient weight, is especially important because it is often used to calculate the appropriate dose of a medication (e.g., mg/kg, mcg/kg, mg/m^2). A prescribed medication dose can differ significantly from the appropriate dose as a result of missing or inaccurate patient weights.

Oncology, elderly, and pediatric/neonatal patients are at greater risk for adverse drug events because they may be more vulnerable to the effects of an error and their weight may change frequently over a short period of time.[2] Formulas such as the Cockcroft-Gault and the Harris-Benedict formulas rely on knowledge of an accurate patient weight. Both height and weight are needed to use nomograms to determine body surface area and body mass index.

A Look at the Numbers

There is little information in the literature that specifically mentions medication errors that result from missing or inaccurate patient weights. One prospective, cohort study of 1,120 patients in two academic institutions revealed that 3.7% of the institutions' medication errors were due to missing or wrong weights.[3]

Clinical analysts reviewed 479 event reports submitted to the Pennsylvania Patient Safety Authority from June 2004 through the end of November 2008 that specifically mentioned medication errors resulting from breakdowns in the process of obtaining, documenting, and/or communicating patient weights. Further breakdown of these events by harm score, which is adapted from the National Coordinating Council for Medication Error Reporting and Prevention harm index,[4] shows that 67.2% (322) of the events reached the patient (harm index = C to I) and 1.3% (6) of the events resulted in harm significant enough to require additional treatment.

Of the 479 reports, 448 (93.5%) represent the five most common medication error event types, with the most commonly reported event type being wrong dose/over dosage (43.4%) and wrong dose/under dosage (21.3%) (see Table 1).

Table 2 lists events by the top five units in which the event occurred, representing 54% of all reports. The top three units associated with these errors include the emergency department (ED) (20.7%), pharmacy (12.1%), and medical/surgical units (10.9%). A national survey of EDs shows that more than 50% of all patients admitted to a hospital came through the ED. When looking at all the patients in the ED, 12% are admitted to hospitals and 1.3% are admitted directly to an intensive care unit (ICU) setting.[5] Therefore, medication errors that occur because of wrong patient weight may perpetuate throughout a patient's stay in a healthcare facility, if it is assumed that the weight originally obtained and documented by the ED is accurate.

A review of the medications commonly reported reveals two key attributes. First, all the medications

Table 1. Top Five Medication Error Event Types Associated with Wrong Weights (n = 448)

EVENT TYPE	TOTAL	% OF TOTAL REPORTS (N=479)
Wrong dose/ overdosage	208	43.4%
Wrong dose/ underdosage	102	21.3%
Wrong rate (intravenous)	47	9.8%
Extra dose	12	2.5%
Other	79	16.5%

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(see Table 3) can be dosed based on a patient's weight (i.e., weight-based dosing). Second, 5 of the top 10 medications involved, representing 236 (49%) of all reports, are high-alert medications. High-alert medications are drugs that bear a heightened risk of causing significant patient harm when they are used in error.[6]

Further Analysis

The second step in the analysis process included a review of each report's description of the event to determine what specifically went wrong in these reports. The types of errors observed in the data are discussed in Table 4.

Two general themes appeared in this analysis: (1) breakdowns in obtaining an accurate, up-to-date patient weight, and (2) errors that arise from misusing the value.

Obtaining Patient Weights

A variety of problems can occur when healthcare practitioners attempt to obtain a patient's weight. One such problem occurs at the beginning of the patient encounter. There are times when patients arriving at hospitals may not be weighed; for example, if a patient is admitted for an emergency, is not ambulant, or is unable to communicate his or her weight. Care units may also not be provided with appropriate scales to weigh patients. These situations lead to healthcare practitioners estimating patient's weights. According to published studies, estimating weights is inexact.[7-10] Additional examples include the following studies.

In one prospective clinical study in a mixed medical and surgical ICU, 14 patients had their height and weight estimated by 20 members of the medical and nursing staff, and the estimates were compared to the patients' actual weight. The study results showed that staff members' estimation of weight was poor, with 47% of estimates at least 10% different and 19% of the estimates were at least 20% different from the measured weights.[11]

Another prospective study of adult patients presenting to an urban ED assessed the accuracy of estimations of patients' weight by the patients themselves, physicians, and nurses in the ED. The authors found that weight was estimated within 10% of actual weight by 90.6% of the patients, 50.4% of the physicians, and 49.6% of the nurses. The authors concluded that when a patient is unable to be weighed, the patient's own weight estimate should be used.[12]

In a third prospective, descriptive study of trauma patients, healthcare practitioners (physicians, trauma residents, and trauma bay nurses) estimated patients' weights. Patients were then asked to report a value for their own height and weight estimates. Overall, practitioners were 53% correct in estimating patient weights. Patients were more frequently accurate (92%) about their own weight.[13]

Practitioners in Pennsylvania facilities are no different than their colleagues in other states, as reports

Table 2. Units Commonly Involved in Medication Errors Involving Wrong Weights (n = 259)

DEPARTMENT	TOTAL	% OF TOTAL REPORTS (N = 479)
Emergency department	99	20.7%
Pharmacy	58	12.1%
Medical/surgical unit	52	10.9%
Telemetry	27	5.6%
Pediatric unit	23	4.8%

Table 3. Top 10 Medications Involved in Wrong-Weight Medication Error Reports (n = 304)

MEDICATION	TOTAL
Heparin sodium*	110
Enoxaparin (Lovenox®)*	84
Acetominophen (Tylenol®)	20
Dobutamine*	17
Dopamine*	17
Gentamicin sulfate	17
Vancomycin	14
Ibuprofen (Motrin®)	9
Nesiritide (Natrecor®)	8
Propofol (Diprivan®)*	8

* High-alert medications

Table 4. Types of Errors Involving Wrong Weight (n = 479)

CATEGORIES	TOTAL	% OF TOTAL REPORTS
Confusion between pounds versus kilograms	129	26.9%
Documented weight was too high	83	17.3%
Documented weight was too low	48	10%
No weight was available or used	45	9.4%
Incorrect estimated weight	17	3.5%
Mix-up between ideal versus actual weight	11	2.3%
Calculation error	6	1.3%
Mix-up between height/ temperature versus weight	4	0.8%
Others	10	2.1%
Unknown*	126	26.3%

* There was not enough information mentioned in the report to determine what went wrong.

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submitted to the Authority describe events in which practitioners have inaccurately estimated patient's weights.

The patient's heparin infusion was started based on a patient weight of 80 lb. The actual weight of the patient was 162 lb. The patient was never weighed prior to starting the weight-based heparin nomogram.

A patient presented to the ED after having taken an overdose of Tylenol PM. The patient's initial acetaminophen level [about 100] and an acetylcysteine (Mucomyst®) infusion was ordered based on the established pharmacy protocol. The amount of medication infused is based on the patient's weight. An initial weight was given to the pharmacist and the infusion prepared. When the patient reached the floor and was actually weighed, [his or her] weight was found to be 23 kg less than originally stated. The pharmacist was notified, and the infusion rate adjusted based on this knowledge.

A report was given to ICU nurse from the ED. The ED nurse said the patient's weight was 189 kg. This weight was only documented in [the computer system] under the Diprivan® (propofol) medication calculation. Due to patient weight, a bariatric bed was ordered but not available upon transfer. The patient remained on the ED stretcher in the ICU until a bariatric bed arrived. Upon transfer to the bariatric bed, the patient's weight was confirmed at 250 lb and not 419 lb. The patient was on propofol and heparin protocols per weight. Pharmacy was notified so that heparin protocol could be changed. The propofol was adjusted with the new weight. According to the ED, the patient's weight was an estimate because the ED could not weigh the patient prior to administration of the medications. The ED communicated to the ICU the patient's weight on previous admissions. The physician estimated the weight for the infusions. The patient was unable to be weighed due to [his or her] critical status to stand on scale in ED. The ED does not have the capability to weigh patients on a bed.

Patient's initial weight was estimated at 114 kg, due to difficulty ambulating. Heparin protocol was started at that time. After the patient arrived to the floor, [personnel] were able to weigh [the patient, whose] weight was recorded as 91 kg. Heparin rate adjusted appropriately.

Another problem arises when practitioners assume a documented weight is up-to-date and/or accurate. For example, when patients are transferred from facility to facility or within a facility between units, practitioners often assume that the weight documented in the medical record is accurate and up-to-date. They then decide that there is no need to reweigh the patient. One such scenario was reported to the Authority.

A patient was admitted through the emergency room. The demographic sheet obtained from the nursing home, which was used to determine the patient's weight, listed [the weight] at 253 lb. The patient's actual weight was 162 lb. Heparin was administered via drip based on 253 lb. The error was corrected based on correct weight of patient.

Although there are studies that show that a patient's own weight estimate can be more accurate than a healthcare practitioner's, problems can occur when solely relying on a patient's stated weight. One example reported to the Institute for Safe Medication Practices (ISMP) involved an ED patient with deep vein thrombosis who purposely understated her weight as 160 lb because she did not want her husband to know that she actually weighed 180 lb. A short time later, a pharmacist working in the unit asked the patient to step on a scale and an error was averted.

While a 20 lb difference in an adult may not cause a problem, larger discrepancies between a patient's stated weight and a measured weight have been reported to ISMP (up to 100 pounds).[14]

Finally, the patient's weight may not be communicated to appropriate healthcare practitioners. For example, the weight, especially an accurate weight, may not be provided to pharmacy, either on paper or electronically, to calculate or double check weight-based drug doses. In a survey performed by ISMP and the Pediatric Pharmacy Advocacy Group to determine what medication safety practices were in place for pediatric patients in both critical care and noncritical care units, only about half of all respondents reported that the patient's weight is *always* entered into the computer before processing orders to allow the system to warn practitioners about drug doses that exceed safe limits.[15]

Errors with Documenting Weights

Most patients are weighed in pounds, both in their home and in the healthcare organization. But weighing and documenting patients' weights in pounds introduces the need to then *calculate the weight into kilograms*, an error-prone process,[16] for weight-based and other dosing. However, the greater problem is obtaining the weight in pounds then failing to convert *and* document that weight in kilograms, resulting in more than two-fold dosing errors. In fact, more than 25% of the 479 reports mention breakdowns that occurred when the patient's weight, measured in pounds or kilograms, was erroneously documented as the patient's weight in kilograms or pounds, respectively. Reports submitted to the Authority illustrate that this can occur with weights documented in a paper-based patient record or computerized order-entry systems, as well as weights entered into infusion pumps.

A patient's weight was inaccurately reported to the pharmacy using pounds instead of kilograms. The dosage for daptomycin was incorrectly calculated, and the patient received three times the ordered dose.

Patient was ordered dobutamine to infuse at 3 mcg/kg/min. The physician ordered an increase in dobutamine to infuse at 5 mcg/kg/min or 8.9 mL/hr. The intravenous line (IV) was found infusing at 11.8 mL/hr when the nurse went to change rate.

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Another nurse did not convert the patient's weight from pounds to kilograms.

A patient's weight was estimated at approximately 180 lb. The nurse did not convert the pounds into kilograms when drawing up the Lovenox® injection. The nurse administered 180 mg of Lovenox.

A patient in the ED was ordered "fosphenytoin IV stat" for break-through seizures. The resident entered the patient's weight into the CPOE [computerized prescriber order entry] system in pounds instead of kilograms (44 lb versus 20 kg). The patient received an overdose of the medication that resulted in toxicity.

Upon checking IV pump settings, both the weight and kilograms were incorrectly programmed into pump. The infusion pump was set at 180 kg instead of 180 lb. Once the correct weight was programmed into the pump, the dose of dopamine was decreased, which decreased patient's blood pressure, resulting in need to increase dopamine and increase monitoring.

Ideal versus Actual Body Weight

A third, less frequently reported error involving patient weights is the inappropriate use of either ideal body weight or actual body weight given the patient's condition or specific medication. For certain types of patients, medications may be dosed on an ideal body weight instead of an actual body weight. For example, if a patient is dehydrated, his or her actual weight will be lower than his or her ideal body weight, and conversely, a patient who is obese will have an actual body weight that is greater than his or her ideal body weight. Examples reported to the Authority include the following:

Patient was started on a heparin infusion per protocol. A partial thromboplastin time (PTT) level came back from the lab at high panic [greater than] 249. According to protocol, the heparin infusion was stopped for three hours and another PTT drawn. When the second PTT results were reported, the infusion was recalculated and the original calculations were noted to have been made using ideal body weight, when actual body weight should have been used in this case (the actual body weight in this patient was less than ideal body weight). New drip calculations were done and verified with pharmacy, as well as another registered nurse on the unit.

The physician ordered "acyclovir 2 gm IV" based on patient's actual weight of 98 kg. The standard dosing is for this medication is 10 to 15 mg/kg, based on the ideal body weight [emphasis added]. The patient's ideal body weight was estimated at 70 kg. The pharmacy did not clarify the high dose order with the physician.

Risk Reduction Strategies

Obtain Weights

It is vitally important that an accurate weight is obtained when patients arrive at a healthcare facility. Therefore, because so many patients are admitted through the ED, the ED should consider obtaining the necessary equipment to weigh all patients (e.g., stretchers with scales, floor scales that can weigh the patient and stretcher). It would benefit the patient and the entire organization if ED staff were to weigh all walk-in patients during triage.

In addition, facilities should consider establishing a routine procedure for regularly reweighing patients when weight fluctuations are anticipated (e.g., patients undergoing chemotherapy, infants).[14]

Standardize Unit of Measure

Since patient weight is used to calculate most dosing (either as weight-based dosing, body surface area calculation, or other age-appropriate dose determination), all pediatric[17] and adult patients should be weighed in kilograms at the time of admission (including outpatient and ambulatory clinics) or as soon as clinically possible in an emergency situation.

Standardize measurement systems to kilograms throughout the institution.[18] Kilograms should be the standard nomenclature for weight on prescriptions, medical records, and staff communications.[17]

Document Weights

For weight documentation, consider the following:

- Review all locations that allow for the entry of patient weights, including printed order forms, computerized order-entry systems (both physician and pharmacy), and infusion pumps.
- Require an entry of weight in computer systems for pediatric patients (as well as weight-based medication) *before* processing orders. Establish a communication process that facilitates the timely transfer of accurate patient weights from nursing to the pharmacy.[17]
- Build a hard stop for patient weight into CPOE and pharmacy order entry systems. At a minimum, configure the systems to alert staff if the field is empty. Until this is a *required* field, print a daily report of missing information for follow-up by pharmacy staff.
- Build and test maximum and subtherapeutic dose alerts in the order entry system (based on patient age and weight when applicable).[17]
- When recording a patient's weight, include the date. This can help other practitioners recognize older weights and prompt them to reweigh the patient.

Communicate Drug Orders

The organization's medication-use policies should include a provision that weight-based medications are not prescribed, dispensed, or administered (except in emergencies) unless weights are available to and considered by all practitioners.

In a study to evaluate preprinted order forms, a form was designed to guide prescribers through the process of handwriting a complete inpatient prescription by using forcing functions. To assess the effectiveness of this intervention, medication prescriptions were collected for two weeks before and after introduction

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of the new forms and evaluated for compliance with medication prescription guidelines. The introduction of this form increased the inclusion of a patient weight from 57% to 98%.[18] Therefore, for weight-based therapy, consider adding prompts on standard order forms to communicate the patient's weight.[19]

Prescribers need to confirm that the patient's weight is correct for weight-based dosages and write the weight on each order written.[2] Where appropriate, prescribers should include the weight of the patient on the prescription or medication order. The age (and weight) of a patient can help dispensing healthcare professionals in their clinical double-check of the appropriate drug and dose.[20] Prescribers should include the calculated dose and the dosing determination, such as the dose per weight (e.g., milligrams per kilogram) or body surface area, to facilitate an independent double-check of the calculation by a pharmacist, nurse, or both.

Notes

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(See Self-Assessment Questions on next page.)

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Self-Assessment Questions

The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own.

1. Which medication was not involved in medication errors, reported to the Authority, associated with inaccurate patient weights?
   a. Dobutamine
   b. Acetaminophen
   c. Heparin
   d. Cefazolin
2. Which area was associated with the highest number of reports related to inaccurate patient weights?
   a. Pediatric unit
   b. Medical/surgical unit
   c. Emergency department (ED)
   d. Pharmacy
3. All of the following statements about patient weights are true EXCEPT:
   a. Patient weight is important because it is often used to calculate the appropriate dose of a medication.
   b. A prescribed medication dose can differ significantly from the intended dose as a result of missing or inaccurate patient weights.
   c. Oncology, elderly, and pediatric/neonatal patient populations are at an increased risk for adverse drug events because they are vulnerable to the effects of an error.
   d. Formulas such as the Cockcroft-Gault and the Harris-Benedict formulas rely on knowledge of an accurate patient age.
4. All of the following are risk reduction strategies to prevent errors due to inaccurate weights EXCEPT:
   a. Making kilograms the standard nomenclature for weight on prescriptions, medical records, and staff communications
   b. Obtaining and documenting the patient weight in pounds
   c. Confirming that the patient's weight is correct for weight-based dosages and writing the weight on each order
   d. Making patient weights a required field (i.e., hard stop) in computerized prescriber order-entry and pharmacy order-entry systems
5. A patient was transferred from another facility to the ED and was admitted to the hospital with a diagnosis of deep vein embolism. A weight-based heparin infusion protocol was initiated in the patient care area.

   What would be the best approach to dosing this patient, based on his or her weight?
   a. Weigh the patient.
   b. Refer to the weight provided by the previous facility.
   c. Refer to the weight documented in the ED.
   d. Estimate the weight of the patient.

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Safe Intrahospital Transport of the *non*-ICU Patient Using Standardized Handoff Communication

ABSTRACT

The intrahospital transport of the non-intensive care unit (ICU) patient is often performed by unlicensed hospital personnel who frequently encounter patient condition changes requiring immediate intervention. Healthcare organizations have increasingly recognized the benefits of using a standardized handoff process particularly when patients are transported from one care area to another. Of the 2,390 patient transport reports submitted to the Pennsylvania Patient Safety Authority from May 2004 through September 2008, facilities identified patient transport Incidents and Serious Events having problems with communication, intravenous lines, monitoring and other issues in 280 reports. This article will examine risk reduction strategies to ensure the safe intrahospital transport of the non-ICU patient, including but not limited to the development of an intrahospital transport team for the non-ICU patient, standardization of patient handoff communication tools used during transport, and a robust educational program for unlicensed hospital transport personnel as ways to ensure the accurate exchange of patient information, to decrease the number of adverse events, and to promote optimal care. (Pa Patient Saf Advis 2009 Mar;6[1]:16-9.)

Intra- or interhospital transports expose patients to periods of potential instability and increased risk for complications, morbidity, and mortality.[1-5] The Society of Critical Care Medicine (SCCM) and the American College of Critical Care Medicine (ACCCM) developed formal transport guidelines for the intra- and interhospital transport of critically ill patients.[1,2,4,6] These guidelines suggest that critically ill patients be transported typically by a minimum of two highly qualified and specialized critical care team members who focus on monitoring and ventilatory support.[1,4,6,7]

No formal guidelines exist for the intrahospital transport for the *non*-intensive care unit (ICU) patient.[6] These patients are typically transported by unlicensed personnel who lack the clinical qualifications or experience to safely monitor these patients.[6,8] Facilities have had to develop their own intrahospital transport policies for the non-ICU patient.[6] Without practice guidelines, essential elements necessary to complete the safe intrahospital transport of the non-ICU patient may be inadvertently absent from policies, potentially compromising patient safety.

There were 2,390 patient transport-related reports submitted to the Pennsylvania Patient Safety Authority from May 2004 through September 2008. Facilities identified patient transport Incidents (or near misses) and Serious Events having problems with communication, intravenous lines, monitoring, and other issues in 280 reports. More than 40% of these issues indicated the need for improved communication between healthcare providers (see Table). Healthcare organizations have increasingly recognized the benefits of standardized handoff communication processes when patients are transported from one care area to another.

Evidence from the Clinical Literature

Current research and guidelines focus primarily on the outcomes or equipment-related factors in the intra- and interhospital transport for *critically ill* and *pediatric* populations.[1-3,6,9] The clinical literature yields few peer-reviewed articles, guidelines, or standards for intrahospital transport of non-ICU patients.[6] In the absence of specific guidelines for the intrahospital transport of the non-ICU patient, contributing factors to Serious Events relating to transport of critically ill patients may be applied to non-ICU patient transport events. These factors should be considered when facilities develop or revise policies for the intrahospital transport of the non-ICU patient and competency requirements for unlicensed hospital personnel involved in patient transport.

A six-month prospective observational study with a concurrent retrospective chart audit revealed 66 adverse events among 290 intrahospital transports of critically ill patients from the emergency department (ED) to the ICU, including some admissions via the operating room or after a computed tomography (CT) scan.[10] Equipment problems, hypothermia, cardiovascular events, and delays in transport were the adverse events identified.[10] One adverse event that also occurred was the discovery of an incorrect patient identification band during a preoperative check.[10]

A cross-sectional analysis of 176 intrahospital transport reports of critically ill patients, submitted to the Australian Incident Monitoring Study in Intensive Care database between 1993 and 1999, identified 55 serious adverse outcomes that included four patient deaths.[1,9] These adverse events identified system-based problems and human factors as the underlying

Table. Patient Transport Issues Submitted to the Authority, May 2004 through September 2008

TRANSPORT ISSUES	NUMBER OF REPORTS
Communication issues	115 (41%)
Intravenous lines/tubes	93 (33%)
Monitoring/techniques	47 (17%)
Other	25 (9%)
Total	**280 (100%)**

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contributing factors.[1,9] The data taken from this anonymous, voluntary incident monitoring system identified important causes of poor outcomes and contributing factors, while other studies focused on outcomes or equipment-related mishaps.[1] According to Beckmann et al., system-based problems involved battery/power supply, ventilatory equipment and monitors, and medication-delivery systems.[1] The contributing and underlying human factors problems included issues with communication, airway management, vascular lines, patient monitoring, and positioning.[1]

Handoff Communication with Transports

Handoff communication occurs whenever patient information and responsibility is transferred from one care provider to another. Many facilities have developed and implemented handoff procedures, but the Joint Commission requires that each patient handoff communication include a standardized and interactive approach for the safe transfer of a patient from one care area to another.[11] Significant barriers to handoff communication include the lack of national standards for building a handoff communication system.[12] Healthcare providers often perceive handoff communication as a burden, and poor or failed handoff communication is not always apparent to those who perform the handoff.[12] Communication breakdowns can occur between healthcare providers along the continuum of care particularly when recent or anticipated patient condition changes are not communicated. Handoff communication that occurs between licensed providers considers issues related to patient monitoring, assessment, and interventions and differs from communication between—or may not be considered by—unlicensed personnel because they may not understand or be able to act upon the information or monitoring data.

Safety Risks Related to Patient Transport

The following reports were submitted to the Authority from May 2004 through September 2008 and illustrate Incidents and Serious Events associated with the intrahospital transport of non-ICU patients. Several issues identified include patient misidentification, intravenous (IV) lines/disconnection, and personnel who lack the clinical qualifications or experience to safely monitor these patients.

Patient Identification

Central patient transport took [the] wrong patient for chest x-ray. Radiology did not check [the patient's identification] and completed the chest x-ray on the wrong patient.

Disconnect

A patient with elevated creatine phosphokinase and blood pressure on a nitroglycerine [IV] drip was sent to x-ray. The transport technician shut off the [IV] pump, stating it was beeping. The pump was restarted with no problem for the patient.

Scope of Practice

[A] patient sent to [magnetic-resonance-imaging (MRI)] on 3 liters of oxygen and returned on 6 liters with no call to nurse as to why it was changed. [The] transporter told nurse that patient was [short of breath] in MRI so [the transporter] increased [the oxygen rate]. Patient has chronic obstructive pulmonary disease and was unable to tolerate 6 liters.

Patient arrived to unit with blood transfusing, without RN [registered nurse] accompaniment, only with the [transporter]. The transporter personnel [was] unaware they could not transport patient with blood transfusing.

Patient in ED with [complaints of] chest pain. Patient on monitor and EKG [electrocardiogram] done. Patient sent to x-ray department [for a computed tomography (CT) scan] unmonitored [and] accompanied by transport escort. Patient became unresponsive in x-ray waiting area. X-ray staff called emergency room RN. Upon arrival in x-ray waiting area, emergency room RN called [a code] and initiated CPR [cardiopulmonary resuscitation]. . . .upon arrival to CT, [the patient] collapsed, [went into cardiac arrest and died].

Supportive service called floor and stated that the [patient's] chest tube was stuck on the [stretcher] wheels and asked that someone come and help; then reported that they fixed the problem. Patient returned to floor with a large hole noted in the chest [tube drainage system] tubing.

Monitoring

Patient was transported from one telemetry unit to another without a monitoring device or appropriate staff.

Patient transferred to ICU from [patient care unit]. [The patient's] lips [were] blue and legs [were] mottled. [Patient was] unresponsive to any stimuli [and had] inadequate respiratory effort. Patient [was] not on a monitor [and had] no pulse oximetry monitoring. No IV access [because] the IV site in left forearm initiated [was] puffy, unable to flush.

Transport Team Development

The development of a specialized transport team has been explored by many facilities after having identified risk-prone situations in which unstable patients had been transported by inadequately trained personnel. These interdisciplinary transport teams help to reduce patient risk during transport by using standardized protocols and policies, some of which are adapted from the aviation industry.[7,12-14]

The transport team protocols include the development or use of communication standards, coordinated teamwork, defined roles and responsibilities of the team members, and appropriate equipment for a safe and effective transport. It is essential that this process includes an intrahospital transport curriculum consisting of step-wise, competency-based education for professional and unlicensed personnel

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Questions in Assessing Transport Policies and Procedures

Which patients are being transported?

- Focus initial efforts on the most frequent source units and patient types (ages, clinical diagnoses).

To which locations are most patients transported?

- Are these destinations in the main hospital, adjacent buildings, across the street?
- Are there special safety hazards in any of the units (e.g., MRI [magnetic resonance imaging] magnets)?

Pre-transport patient assessments

- What criteria are used to determine patient stability, patient risk, and level of monitoring during transport?
- Who is responsible for this assessment?
- What is the recommended timing for this assessment?
- Do the assessment criteria include risk factor assessment based on the type of procedure/diagnostic, patient positioning during transport, and duration of transport time?
- Does the assessment take into account the possibility of decline in clinical condition and the need for escalating support (e.g., increase in oxygen flow rate and change to NRM [non-rebreather (oxygen mask)] with same oxygen saturations)?
- How is this assessment communicated to the care team, the transport personnel, and the destination personnel?
- Finally, how is compliance monitored?

Transport personnel

- Who transports patients (unlicensed and licensed personnel)?
- What are their specific responsibilities before and during transport?
- What level of training and competency assessment is done related to patient safety during transport?
- Are they required to have Basic Life Support (e.g., CPR [cardiopulmonary resuscitation]) certification (in the case of an arrest, could they initiate the ABCs of CPR)?
- What is the content of their training (does it cover how to get help during transport or how to receive and provide handoff communications)?

Handoff communication

- How are the patient's condition, potential safety risks, and needs communicated?
- Is a checklist used? Is patient identification included?
- What is the responsibility of the sending and receiving providers and/or transporters?

Necessary supplies and equipment for transport

- What equipment is required to accompany the acute care patient during transport (eg, mask with Ambu bag, ECG [electrocardiogram] monitor)?
- Who ensures that therapies (e.g., oxygen, infusions, etc.) are maintained during transport?
- Would the transport personnel know how to use or troubleshoot any accompanying equipment/supplies, if needed?

Transport monitoring

- What basic level of monitoring is expected during transport (e.g., change in level of consciousness, color, respiratory effort, IV [intravenous] pump alarm, etc.)? And are the transporters qualified or adequately trained for this?
- What is the expected level of intervention (e.g., replace an oxygen mask if it falls off, silence an IV pump)?

Reprinted from: Schell H, Wachter RM. Moving pains. Web M&M [online]. 2006 Jul [cited 2008 Oct 27]. Available from Internet: http://webmm.ahrq.gov/case.aspx?caseID=128&searchStr=Hildy+Schell#table1.

that includes but is not limited to intravenous lines, Foley catheters, and oxygen use.[8,15] Many facilities use handoff communication checklists (e.g., SBAR [situation-background-assessment-recommendation], read-back, ticket to ride) to standardize the approach to safe intrahospital patient transport from one care area to another.[12-14] Two facilities have developed separate handoff communication checklists to differentiate between inter- and intrahospital transports.[12,14]

The benefits of implementing a transport team include an increase in patient safety, a decrease in the number of adverse events and in the resource burden, and fewer delays in treatment, which limit interruption of patient care. Still other studies indicate a time-saving benefit, as less time is required to prepare patients for the actual transport and to return the patient to the pretransported status.[7] While evidence suggests that dedicated transfer teams for critically ill patients may reduce patient mortality and morbidity, little research studied specialized transport teams for the intrahospital transport of non-ICU patients.[15] Applying these same transport team protocols for the intrahospital transport of non-ICU patients can provide the professional and unlicensed personnel specific guidelines that promote overall patient safety before, during, and immediately following a transport.

Risk Reduction Strategies

The following risk reduction strategies are based on the SCCM and ACCCM practice standards for the intrahospital transport for critically ill patients, on expert opinion, and on case series in which published

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supporting data are unavailable for the intrahospital transport of non-ICU patients.[1,2,4,6,7]

- Develop a transport team model of care with a clear outline of the specific responsibilities for each team member.[2,4,6-8,15]
- Coordinate pretransport communication between the transporter, nurse, and destination areas.[2,4,13,16] Although patient assessment is completed by the nurse, a time lapse of the assessment greater than two hours involves reassessment.[5] All findings are verbally communicated to the transporter and reviewed in the handoff communication.
- Implement a robust educational and competency program for unlicensed hospital transport personnel to ensure that facilities have staff with optimal qualifications to perform non-ICU patient transports safely.[1,2,4,7,8,13,16] There are no requirements for training or certification of unlicensed personnel who transport non-ICU patients without a nurse or physician.[6] Educational competencies for unlicensed transport personnel should include but not be limited to CPR certification, knowledge of the National Patient Safety Goals, handoff communication, and expected level of intervention for unexpected patient decompensation during transport.[2,8,14,15] It is important for transport personnel to know how to activate the rapid response team or code blue and how to contact the nurse who is caring for the patient should his or her condition change.
- Ensure that essential patient equipment for safe intrahospital transport is functional (e.g., fully charged, filled, in good repair).[2,4,13]
- Provide cardiac monitoring, if warranted, by qualified clinical personnel.[1,2,4,13]
- Provide clear documentation to ensure that all applicable patient information is available and communicated to the next level of care and that an opportunity to ask questions is included in the handoff procedure (see "Questions in Assessing Transport Policies and Procedures").[1,2,13]
- Monitor any Incidents or Serious Events that occur during intrahospital transport of non-ICU patients because this will contribute to the overall improvement in patient safety within your organization.[1,15]

Conclusion

The intrahospital transport of the non-ICU patient is often performed by unlicensed hospital personnel who frequently encounter patient condition changes that require immediate intervention. Risk reduction strategies include the development of an intrahospital transport team for the non-ICU patient. Handoff communication using a specific tool, which includes written information facilitating clear communication before, during, and immediately following transport from the patient care unit to the destination point and back, is suggested. A robust educational and competency program for unlicensed hospital transport personnel is essential to ensure that facilities have staff with optimal qualifications to perform non-ICU patient transports safely. These strategies benefit patients, ensure accurate information exchange, decrease the number of adverse events, and promote overall patient safety during intrahospital transports.

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Safety in the MR Environment: MR Safety Screening Practices

ABSTRACT

Electromagnetic and ferromagnetic materials in close proximity to a magnetic resonance imaging (MRI) scanner can be a hazardous safety risk to any individual near the scanner. To avoid injury from interference and attraction effects, individuals are screened before entering the MRI scan room. The magnetic resonance (MR) screening process typically consists of interviews between MR personnel and patients or other non-MR personnel needing access to the MRI scanner and completion of a questionnaire (MR screening form). The MR screening form contains questions to ask individuals needing access to the MRI scan room in order to identify potential contraindicated objects on or in their bodies, such as an implanted cardiac pacemaker. The magnetic field of the MRI scanner could affect ferromagnetic objects implanted in an individual in such a way as to cause harm. In 2008, the Pennsylvania Patient Safety Authority received approximately 150 reports describing events in which the MR clinical screening process was inadequate and, in some cases, erroneously permitted patients with implanted pacemakers and other ferromagnetic objects into the MRI scanner room. Rigorous MR screening practices will help reduce hazards from contraindicated implants and ferromagnetic objects in close proximity to the MRI scanner. (Pa Patient Saf Advis 2009 Mar;6[1]:20-6.)

Effective screening of patients and nonmagnetic resonance personnel before entering the magnetic resonance imaging (MRI) scanner is an extremely important process in ensuring the safety of individuals in the magnetic resonance (MR) environment. The MR screening process reduces the likelihood of an adverse event while the patient is inside the bore of the MRI system.

In 2008, 148 reports were submitted to the Pennsylvania Patient Safety Authority identifying a variety of problems related to inadequate screening practices of individuals for metal exposure or orders written for MRI scans of patients with MR contraindications (e.g., permanent pacemakers). Most of the reports involved patients with implanted devices such as pacemakers, cardiac defibrillators, and aneurysm clips entering the MRI scanner room or MR personnel realizing just before patients entered the MRI scanner room that the patients had implanted devices. Other reports identified MR screening forms with incorrectly or inadequately answered questions. For inpatient MRI scans, many reports described miscommunication between the referring department (e.g., medical/surgical) and the radiology department about an implant in the patient. For perspective, the following are examples of the narratives of MR screening-related reports submitted to the Authority:

> *An MRI scan of the patient's right knee was ordered; the patient had a pacemaker.*
>
> *Patient was ordered an MRI of the brain. The patient was put on the schedule for 10 a.m. The nurse on the floor called down and said he had a pacemaker. The nurse filled out the [screening] form incorrectly. The physician ordered an MRI on a patient with a pacemaker.*
>
> *A patient required an MRI of the head. A technician screened the patient and asked if there was anything in [patient's] sweatpants pockets, to which the patient replied "no." When the [MRI] magnet was started, a knife was pulled out of the patient's pocket by the magnet. It stabbed [the patient] in the [arm]. The injury required staples.*
>
> *A patient developed pain/tingling, during an MRI scan, where a plate and screw were located [implanted]. The patient had been prescreened.*
>
> *A patient was cleared for metal through family interview per ordering resident. The MRI study was started and a metal artifact was identified. The study was immediately canceled. A CT [computed tomography] scan of the head was done instead of the MRI. [The physician was] notified.*
>
> *A patient had a tissue expander noted on [screening form] checklist, but MRI was started. Upon review of initial images, a metal artifact was noticed and the scan was stopped.*
>
> *Patient [was] ordered [an] MRI brain [scan]. The floor [staff] called to verify that patient [was] screened and was told the patient was screened. [The] patient arrived for test, and [staff] found that patient has a pacemaker; a contraindication for the MRI. Patient did not receive MRI.*
>
> *Patient was having an MRI of the left shoulder. [The patient] was wearing a long-sleeve sweater, and during the course of the scan complained of a warm feeling on the right arm. Patient's arm was repositioned away from scanner and a sponge was placed. After the scan the patient showed the right arm [to a registered nurse (RN)], which had a 2-inch by 1-inch red patch with a slightly blistered area in the center. The CT RN looked at the arm and put ice on it. On inspection of the sweater, it [was noted that] it had a makeup of 18% metallic thread.*

Sixty-eight reports (approximately 46%), by far the most frequently reported MR-screening-related event related to implanted clinical devices with ferromagnetic content received by the Authority, described patients with implanted cardiac devices getting past the safeguard of the screening process and entering the

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MRI scan room or being stopped from entering the scan room by the final screening process. The next most frequently reported events included five reports of patients with aneurysm clips and four reports of patients with imbedded bullets or BB pellets entering the scan room or being stopped by the screening process before entering the scan room. Data could not be gleaned from 49 of the 148 total reports (approximately 33%) because the reports only indicated that patients were improperly screened. For a comprehensive list of types and frequency of ferromagnetic items reported to the Authority, see the Table.

In the majority of reports, MRI scans were ordered for patients with some type of ferromagnetic or potentially ferromagnetic medical implant. MRI scans are typically contraindicated for patients with ferromagnetic implants because of the potential for injury from forces exerted on the implant by the magnetic field of the MRI scanner and/or magnetic field interferences with the electromechanical operation of the active implant. Another reason for the contraindication is due to radio-frequency (RF) electromagnetic energy used during the scan process inducing electrical currents in electrically conducting implants. The electrically induced currents may result in heating of the implant. Since MRI scans were ordered for those patients, one apparent process breakdown may have been staff not conducting or inadequately conducting patient histories or inadequately reviewing medical records to determine patients' metal exposure histories (e.g., implants). Another breakdown may be in miscommunications between clinicians of patients' histories.

In addition to the reports of implants, one reported event of interest that may not be typically considered by clinical or MR technical staff involved a patient wearing a sweater containing 18% metallic thread. According to the report, the patient experienced erythematous skin with blistering in the center of the mark. While it would be impractical to inspect the clothing of all patients before performing an MRI scan, it may be prudent to perform a quick visual check of patients' clothing for anything out of the ordinary and/or have patients with suspect garments change into gowns or scrubs for their MRI exam.

It should be noted that 74 of 148 reports demonstrated that patients with MR contraindications were identified during MR screening processes and stopped from entering the MRI scan room, potentially preventing injuries.

The information in this article is not comprehensive but is presented as a guide for MR imaging facilities and departments in developing effective MR screening practices. This article will discuss the boundaries and restrictions of the MR environment as they relate to the safety of individuals entering that environment. The article will also discuss the need for and the process of screening individuals for metal exposure, including the clinical implantation of objects or devices that may be ferromagnetic, before entering the MR environment, and the hazards associated with inadequate screening processes. The article will also provide guidance in developing effective MR screening practices.

Table. List of Ferromagnetic Items and Frequency of Reports

FERROMAGNETIC ITEM	NUMBER OF REPORTS
Pacemaker/implanted cardiac device/ heart valve	68*
Aneurysm clip	5
Bullet/BB pellet/gunshot wound	4
Hearing aid/ear implant	3
Orbit (eye) metal	3
Abdominal aortic aneurysm stent	2
Acupuncture needle	1
Inferior vena cava filter	1
"House-arrest" ankle bracelet	1
Knife	1
Metal artifact	1
Metal buckle	1
Metal plate/screw	1
Pain pump (implanted)	1
Sweater (with 18% metal fabric)	1
Tattoo	1
Tissue expander	1
Face mask (with metal nose piece)	1*
Unknown implant	1
Total	**97****

* These two items were recorded on the same Authority report.
** This total number of reports excludes the 49 reports received with descriptions of only improper screening and 2 reports concerning pregnant patients scheduled for MRI scans (148 - 49 - 2 = 97).

MRI Technology

MRI is a noninvasive imaging technology used to image anatomy in multiple planes or slices.[1] An MRI scanner creates cross-sectional images using electromagnetic fields, not ionizing radiation (x-rays) such as in CT scans. MRI scans can image structures that contain air and are not hindered by bone. The MRI scan is conducted with the anatomic structure of interest placed into the center of the bore (i.e., the opening) of the MRI system. The MRI system exposes the subject to electromagnetic fields, then constructs the images by interpreting tissue reactions from the area of interest to the applied magnetic and RF fields.[1] The strength of the static magnetic field of clinical MRI systems is typically between 0.064 and 3 tesla (T), which is measured at the center of the bore of the magnet. However, some MRI systems used for research can have field strengths as high as 9.4 T (Earth's magnetic field varies depending on the proximity to the magnetic poles but averages approximately 0.00005 T, or 0.5 gauss (G) in North America and continental Europe).

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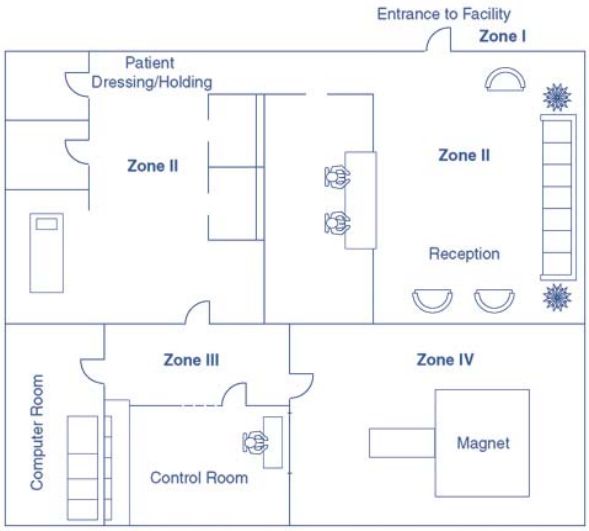
Due to the strong magnetic field of the MRI scanner, ferromagnetic objects external to the body can be pulled into the magnet bore of the scanner, known as the projectile effect. Additionally, the magnetic field can also affect implanted ferromagnetic objects (e.g., permanent pacemaker), applying attractive force even though the object is in the subject's body. The magnetic field may exert forces on an implanted object, potentially causing the object to move in the body, which could result in serious harm to an individual. (A more detailed discussion of the projectile effect will be discussed in an article in an upcoming issue of the *Pennsylvania Patient Safety Advisory*.) MRI systems also incorporate RF electromagnetic fields as part of the scanning process. The RF electromagnetic energy can potentially generate heat in conductive materials in or on the body. (For more information on the hazards during MRI scans, see the section "MR Hazards Associated with Ferromagnetic Implants.")

MR Suite Safety Boundaries

The American College of Radiology (ACR), through the formation of a blue ribbon panel on MR safety, developed the "ACR Guidance Document for Safe MR Practices." The latest revision of the ACR document was published in 2007. While the 2007 ACR MR guidance document is not a regulatory standard for MR safety,[3] at the time of this publication, it is widely used as an industry metric. Among the performance criteria identified by the ACR panel is the designation of a four-zone model of integrated screening and access controls in the MR suite. Each zone in the model represents a different safety level of static magnetic field exposure for the general public. The ACR panel defined the four zones as follows (also see Figure 1):[2]

- Zone 1:
  - All of the areas, outside of the MR environment, that are freely accessible to the general public (e.g., corridors and entrances just outside the MR environment).
- Zone 2:
  - The area between the public accessible zone 1 and the more strictly controlled MR environments (zones 3 and 4). Zone 2 areas typically include reception, waiting, and patient dressing and holding rooms. The general public is generally not free to move throughout zone 2 without the supervision of MR personnel.
- Zone 3:
  - The area in which free access by unscreened non-MR personnel or ferromagnetic objects or equipment is restricted. Serious injury or death could result in zone 3 due to interactions between the individuals, objects, or equipment and the MR environment's static and magnetic fields. Supervision is under the control of the appropriate MR personnel. Access to zone 3 should be physically restricted from the general public through the use of a locking system (e.g., key lock, electronic access control).
- Zone 4:
  - The area containing the MRI scanner (magnet) and is associated with the strongest magnetic fields. Zone 4 should be clearly marked as being potentially hazardous due to the strong magnetic fields. Zone 4 should also be marked with a red light and lighted sign stating "The Magnet Is On."

Figure 1. Model MR Facility Zone Configuration



Sample floor plan illustrating various safety level zones in a typical magnetic resonance suite.

(Reprinted with permission from the American Journal of Roentgenology.)

Figure 2 demonstrate examples of MR zone-level signage. Through colors and text, the signs indicate the level of hazard within each zone.

The boundary in the MR system at which the static magnetic field has diminished sufficiently to pose no physical threat to the general public, but more specifically for individuals with implanted pacemakers, is known as the 5 G line. The 5 G line, which can extend in three dimensions around the magnet bore, defines the boundary of the area at which the magnetic field strength of the MRI system is above or below 5 G (see Figure 3). The strength of the magnetic field increases exponentially approaching the magnet bore. For example, the magnetic field strength at the center of a 1.5 T magnetic bore would be 15,000 G (1 T = 10,000 G). Within a few feet of the magnet bore, some objects could be pulled into the magnet* or may not operate properly.[1] The line may not be limited to the MRI scan room and may vertically extend to the floors directly above and below the MRI system.[1] The 5 G line from the MRI system will

* The topic of ferromagnetic objects and the compatibility of medical equipment in the magnetic resonance imaging environment will be discussed in an article in an upcoming issue of the *Pennsylvania Patient Safety Advisory*.

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Figure 2. Examples of MR Zone-Level Signage

Reprinted with permission from Newmatic Medical, Petaluma, California.

vary depending on the type of MRI system, the field strength of the magnet, and the presence, amount, and configuration of magnetic shielding.[1]

MR Environment Site Access and Restrictions

According to the ACR guidance document, individuals in the MR environment are categorized as either MR personnel or non-MR personnel. MR personnel are individuals working in, at least, zone 3 of the MR environment who have successfully completed MR safety lectures or presentations approved by the MR medical director. MR safety training should be conducted annually and should include documentation upon successful completion of the program by each individual. According to the ACR guidance document, individuals that have not successfully completed the MR safety training within the previous 12 months shall be referred to as non-MR personnel.

MR personnel can further be broken down into level 1 and level 2 subcategories. Level 1 MR personnel are individuals who have passed minimal MR safety training education to ensure their own safety when working in zone 3 of the MR environment. Level 2 MR personnel undergo more extensive MR safety education in broader aspects of MR safety. For example, level 2 personnel will learn issues related to the potential for thermal loading or burns and direct neuromuscular excitation from rapidly changing gradients.

All non-MR personnel, patients, and visitors must undergo a MR safety screening process before being permitted to enter zone 3 of the MR environment. The safety screening should be performed by level 2 MR personnel only.

MR Safety Screening Process

The MR screening process is typically a multilevel process consisting of the following: a preliminary question-and-answer interview via a telephone call when the appointment is scheduled; an MR screening form filled out by the patient, or patient representative in the event the patient is nonresponsive, impaired, or unable to complete the form (e.g., a child) in the MR reception area at the time of the appointment; and a further screening by level 2 MR personnel before the patient enters the MRI scanner room. The form contains questions to determine the medical history and metal exposure history of the patient in relation to the MRI scan. If the patient's history cannot be obtained, and if the MRI scan cannot be rescheduled until such information can be obtained, then the patient should be physically examined by level 2 MR personnel for signs, scars, or other marks that might be indicative of an implant. If a question exists regarding an implant or potential implant, the MR safety director should decide whether to proceed with the MRI scan. The

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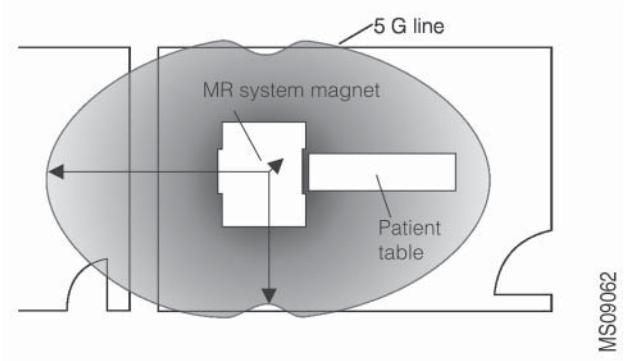
Figure 3. Illustration of 5 G Line in MRI Scanner Room



Simplified illustration of an MRI scanner room showing the location of the 5 G line for a typical MRI system. While the illustration is two dimensional, it should be noted that the area of the 5 G line extends in three dimensions around the magnet bore.

(Reprinted with permission from ECRI Institute, Plymouth Meeting, Pennsylvania.)

following are examples of the types of questions that may appear on a typical MR screening form:

- Have you ever had a prior diagnostic imaging study or examination (e.g., MRI, CT, x-ray)? ☐ Yes ☐ No
- Have you ever experienced any problem related to a previous MR procedure? ☐ Yes ☐ No
- Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel)? ☐ Yes ☐ No

Facilities can refer to the sample MR screening form available from the Pennsylvania Patient Safety Authority Web site at http://www.patientsafetyauthority.org as a guide in developing a comprehensive MR screening form. All questions on the screening form should be answered completely to avoid confusion or misunderstanding as to the metal exposure history of the patient. The completed screening form should be reviewed with the patient (or patient's representative) by two separate MR personnel to verify completeness and accuracy.

Ferromagnetic detectors (capable of distinguishing between ferromagnetic and nonferromagnetic material), designed specifically for pre-MR screening, may also be used as an adjunct to the MR screening process but should *not* be used in place of the screening process. Ferromagnetic detectors should only be used for detecting ferromagnetic objects external to patients before they can be brought into zone 4. At present, ferromagnetic detectors have not been approved for detecting ferromagnetic objects internal to the patient. Ferromagnetic detectors can be handheld devices, free-standing doorway portals, or pillar systems. Conventional metal detectors (unable to distinguish between ferromagnetic and nonferromagnetic materials) should not be used for several reasons, including the following:

1. Ferromagnetic materials contained in nonferromagnetic metal enclosures may not trigger conventional detectors' alarms.
2. Metals such as aluminum and titanium, which are considered MR-safe, would trigger conventional detectors' alarms.
3. Ferromagnetic objects on the patient could be missed by conventional detectors when the patient is in close proximity to an MR-safe metal such as that found on an MR-safe stretcher.

The ACR guidance document and ECRI Institute recommend against using conventional metal detectors. The ACR guidance document does recommend the use of ferromagnetic-only detectors specifically designed for pre-MR screening.

Before entering zone 3, any individual undergoing an MRI scan must remove all readily removable metallic personal items and devices on or in his or her body (e.g., watches, jewelry, pagers, cell phones, body piercings [if removable], contraceptive diaphragms, metallic drug delivery [transdermal] patches).[2] All metallic items that individuals cannot (or will not) remove before the MR scan must be positively identified for both ferromagnetic and thermal risks before the MR scan. (For more information on patients undergoing MR scans while wearing transdermal drug delivery patches, see the September 2006 Pennsylvania Patient Safety Advisory article "Foiled Again! Risk from Transdermal Patches in MRI Procedures" [http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2006/Sep3(3)/Pages/18.aspx].) All patients, visitors, and non-MR personnel with a history of potential internal ferromagnetic foreign objects must undergo further investigation before being permitted entrance to zone 3.[2] Acceptable methods of screening for internal ferromagnetic objects include patient history, plain x-ray films, prior CT or MR scans of the anatomic area in question (radiography can only identify radiopaque material and cannot characterize its ferromagnetic or nonferromagnetic properties), or access to written documentation as to the type of implant or foreign object that might be present.[2] Any patients with a history of orbit trauma by a potential ferromagnetic foreign body that required medical attention (or occupational exposure to metal-working) should have their orbits cleared by plain x-ray films.[2] After identifying the presence and type of implant or foreign object in the patient, an evaluation should be undertaken to determine the relative MR safety of the implant or object as it pertains to the particular patient, exam, MRI scanner, and scan parameters. This evaluation should be conducted by level 2 MR personnel, a MR radiologist, or the MR medical director.

Objects That May Be Present on or in the Body

Many ferromagnetic and nonferromagnetic objects could be present on or in the body. Some types of implants and other objects on or in the patient's body that may be encountered in the MR environment include the following (the list is not comprehensive):[4]

- Aneurysm clips

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- Biopsy needles
- Breast tissue expanders and implants
- Bullets
- Cardiac pacemakers and implantable cardioverter defibrillators
- Cochlear implants
- Coils, stents, and filters
- Heart valve prostheses
- Orthopedic implants
- Tattoos, permanent cosmetics, and eye makeup
- Transdermal patches

In his book *Pocket Guide to MR Procedures and Metallic Objects: Update 2001*, Frank G. Shellock, PhD, lists more than 900 objects by specific brand, model, and in some cases size that have been evaluated for safety in the MR environment.[4] The list contains objects such as those listed above, the highest magnetic field strength of the MRI system used for testing, and the status of the object when subjected to that magnetic field. The status designations include safe, conditional, and unsafe with substatus designations for conditional and unsafe. The pocket guide is designed as a reference source for MR personnel to ascertain the safety of exposing patients or non-MR personnel with implants, devices, or materials to the MR environment.[4, *]

MR Hazards Associated with Ferromagnetic Implants

Within the MRI system's static magnetic field, ferromagnetic and other magnetic materials can be influenced by rotational (torque) and translational forces. These forces could be dangerous for strongly ferromagnetic implants (e.g., aneurysm clips) by moving or dislodging the implant from its location in the patient. This movement could result in damage to the tissues surrounding the implant, potentially leading to ruptured blood vessels[1] and death. The effect of the rotational force is to align the ferromagnetic, or magnetic, object parallel to the static magnetic field, which results in rotational movement. The amount of the rotational force on an object depends on the object's size, shape, and magnetic properties and on the magnitude of the static magnetic field of the MRI system.[1] The rotational force is greatest at the geometric center of the magnet bore, where the magnetic field strength is greatest. Translational force is a linear force (linear movement), which can draw an object into the magnet's bore. The amount of translational force on an object depends on the object's size, shape, and composition and the static magnetic and spatial gradient fields at the location of the object.[1]

The amount of these forces may change (e.g., potentially increase) with movement of the patient within the magnetic field of the MRI scanner. The rate of change of the forces depends on the rate of motion of patient movement within the field; the greater the patient movement through the magnetic field, the greater the forces acting of the implanted device. Therefore, when removing the patient from the magnet's bore, immobilization of the device and a deliberately slow, cautious, rate of removing the patient may reduce the amount of the forces on the implant.[2]

RF Heating Effect

RF electromagnetic energy, such as that produced during use of an RF coil during MRI scans, can induce electrical currents in electrically conductive materials (e.g., pacemaker lead wires) whether in or on the patient. These induced currents can heat the conductive material, potentially leading to thermal injury where the material is in contact with the patient. The likelihood of thermal injury increases with increasing RF energy and/or with higher-field-strength MRI systems. The heating effect also depends on the distance between the RF coil and the conductive material—for example, the closer the distance is between the RF coil and the conductive material, the greater the likelihood of the patient experiencing thermal injury. Additionally, thermal injury to the patient can occur if the patient is in direct contact with the wall of the magnet bore or the RF coil. Positioning the patient within the magnet bore is such a way as to avoid contact when possible, or positioning conductive leads and cables to avoid contact with the bore can greatly reduce the risk of thermal injury.

MR Image Artifact

Extraneous image information that distorts the accurate depiction of the scanned anatomy is called image artifact. This distortion in image quality affects the diagnostic value of the image. Artifacts typically appear in images as distortions, unwanted signals or patterns, or areas of signal loss, known as signal voids.[1] For accurate image reconstruction, the static magnetic field of the MRI system must be uniform (homogeneity). Disruption in the uniformity of the MRI system's static magnetic field can occur when ferromagnetic materials, and some nonferromagnetic materials—typically less severe—are present near the scanned anatomy.[1] This disruption occurs because ferromagnetic materials will distort the magnetic field of the MRI system.

Distortion can also result from RF energy pulses present in the scanned region, inducing electrical eddy currents in electrically conductive materials, similar to the currents induced in the RF heating phenomenon. Signal voids can be seen in the MR image as a blacked-out portion of the scanned anatomy in the area of the implant. A signal void could be misinterpreted or misdiagnosed as pathologies if the radiologist is unaware of the implant or other conductive material.[1] Signal

* A recent reference publication on MRI safety, implants, and devices is available from Shellock titled *Reference Manual for Magnetic Resonance Safety, Implants, and Devices: 2009 Edition.* However, this reference was not reviewed for this article.

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voids are typically a concern with high-field MRI systems (e.g., 3 T). The level of artifact observed on an MR image depends on the magnetic field strength of the MRI system and on the shape, orientation, and position of the material in the body.

Conclusions

Ferromagnetic materials, especially implants, in the presence of the magnetic field generated by an MRI scanner can pose a serious risk to the patient undergoing the MRI procedure. The magnetic field could potentially cause the implant to move or dislodge from its location in the patient, which may result in ruptured blood vessels. Conducting a proper and thorough MR screen for potential ferromagnetic materials of each patient or other individuals entering the MRI scan room will greatly reduce or eliminate the likelihood of adverse events in the MR environment.

As part of a risk reduction strategy to reduce or eliminate adverse events related to MR safety screening processes consider the following:

- Share this article with all staff involved with MR safety.
- Review your facility's MR-related Incident and Serious Event reports to address potential shortcomings in MR screening processes that could affect the safety of individuals entering the MR environment.
- Talk with appropriate staff to identify barriers to effective screening practices.
- Compare your facility's MR screening form against the sample MR procedure screening form, available from the Pennsylvania Patient Safety Authority Web site at http://www.patientsafetyauthority.org, to identify content that current forms may omit.

Notes

1. ECRI Institute. The safe use of equipment in the magnetic resonance environment [guidance article]. *Health Devices* 2001 Dec;30(12):421-44.
2. Kanal E, Barkovich A, Bell C, et al. ACR guidance document for safe MR practices: 2007. *Am J Roentgenol* 2007 Jun;188(6):1447-74.
3. Gilk T. Ferromagnetically naked. Patient Saf Qual Healthc [online]. 2008 Jul-Aug [cited 2009 Jan 6]. Available from Internet: http://www.psqh.com/julaug08/mri-safety.html.
4. Shellock F. *Pocket guide to MR procedures and metallic object: update 2001*. Philadelphia: Lippincott Williams & Wilkins; 2001.

Self-Assessment Questions

The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own.

1. The magnetic resonance imaging (MRI) system static magnetic forces' influence on ferromagnetic objects that are implanted or imbedded in individuals includes all of the following EXCEPT:
   a. Radio-frequency heating
   a. Rotational movement
   c. Translational movement
2. Which of the following mechanisms causes heating of conductive objects in or on an individual in the MRI scan room?
   a. Static magnetic field
   b. Radio-frequency electromagnetic field
   c. Gradient magnetic field
3. The magnetic resonance (MR) screening process is a multilevel process and typically consists of all of the following EXCEPT:
   a. Preappointment phone interview
   b. Interview by level 2 personnel before the patient enters the MRI scan room
   c. MR screening form completed by the patient or patient representative
   d. Interview by level 1 MR personnel while the patient is positioned on the MRI scan table by level 2 MR personnel
4. Conventional metal detectors should not be used to scan objects before entering the MRI scan room because of which of the following?
   a. Ferromagnetic materials contained within nonferromagnetic metal enclosures may not trigger conventional detectors' alarms.
   b. Metals such as aluminum and titanium (considered MR-safe) would trigger conventional detectors' alarms.
   c. Ferromagnetic objects on the patient could be missed by conventional detectors when the patient is in close proximity to a MR-safe metal such as a MR-safe stretcher.
   d. All of the above.
5. An inpatient is scheduled for an MRI scan of his brain. The patient arrives in the MRI department. During the MRI screening process, it is discovered that the patient has an implanted pacemaker.
   The following is a list of statements about the appropriateness of the MRI scan for this patient. Select the statement that promotes the best outcome for the patient.
   a. The MRI scan is of the patient's brain, so there is no risk to the patient from, or damage to, the pacemaker.
   b. The pacemaker can be deactivated or reprogrammed without harm to the patient during the MRI scan.
   c. MRI scans are contraindicated for patients' with implanted pacemakers.
   d. If the pacemaker's programming is altered by the magnetic field, the pacemaker will revert back to original programming once the patient is out of proximity with the field.

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Successful Reduction of Healthcare-Associated MRSA Infection Rates

Introduction

Approximately 70% of healthcare-associated infections (HAIs) in the United States are caused by antibiotic-resistant bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA), which is one of the most predominant and virulent pathogens in healthcare today. The Centers for Disease Control and Prevention (CDC) estimates that more than 126,000 hospitalized patients are infected with MRSA annually, with approximately 5,000 deaths. Hospitalized MRSA patients experience an increased length of stay approaching 9.1 days, associated with roughly $30,000 in additional costs per patient infection.[1] Data from a study conducted by Davis et al. revealed that approximately 19% of patients with MRSA colonization at admission and 25% who acquire MRSA colonization during hospitalization actually become infected.[2]

During 2006, the Association for Professionals in Infection Control and Epidemiology (APIC) conducted a national MRSA prevalence study on inpatients at U.S. healthcare facilities. The results suggest that approximately 70% of MRSA isolates were most likely acquired in the hospital rather than brought in from the community.[3]

The Pennsylvania Health Care Cost Containment Council released a research brief in August of 2006, highlighting the incidence of MRSA in Pennsylvania hospitalizations for 2004. While the data does not distinguish between community-acquired and healthcare-associated infections, it does provide an in-depth look at the issues related to MRSA in the hospital setting throughout the state. The brief includes data on hospitalizations with MRSA by body system, summarized by condition, age group, and geographic location. The MRSA infection rate for 2004 was similar in hospitals of all sizes.[4]

An article in the December 2007 *Pennsylvania Patient Safety Advisory* discusses the fact that prompt identification and effective communication of the status of patients may result in a reduction of MRSA.[5]

A number of U.S. healthcare facilities have significantly reduced rates of MRSA transmission and associated infections. Success in transferring best practices to and replicating positive changes in other units or hospitals has been limited. In contrast, for more than two decades, MRSA infections have been significantly reduced or even eradicated in several European healthcare systems, compared to a far smaller number of U.S. healthcare facilities.[6] These European countries achieved success through implementation of aggressive programs such as transmission-based control policies that included active surveillance cultures to identify colonized patients followed by strict isolation precautions for those patients. These contrasting results likely represent a difference in culture rather than a knowledge deficit.

In Pennsylvania, some healthcare systems have successfully implemented system-based strategies to achieve cultural change. This article discusses two healthcare systems that have reduced and sustained a reduction in MRSA-related HAIs.

The VA Pittsburgh Healthcare System

The VA Pittsburgh Healthcare System (VAPHS) is an integrated three-division system consisting of 692 operational beds serving a veteran population of more than 58,869 unique patients. Services include acute care, long-term care, and behavioral health, as well as tertiary services such as cardiac surgery and solid organ transplantation.

In October 2002, VAPHS made a firm commitment to reducing HAIs. Its initiative, "Getting to Zero," was developed with the goal of MRSA prevention. Working in partnership with the Pittsburgh Regional Healthcare Initiative and CDC, VAPHS designed and implemented the MRSA Prevention Initiative. A number of principles based on the Toyota Production System (TPS) (see "The Toyota Production System Approach") were incorporated to identify specific organizational structures and processes related to HAI and MRSA transmission.[7] The primary aim was to transform the organizational culture to improve compliance with hand hygiene and isolation procedures and thus reduce MRSA transmission and infection. The MRSA Prevention Initiative was initially implemented with dedicated supportive nursing and educational resources on a 36-bed general surgical unit over a four-year period, expanding to an 11-bed surgical intensive care unit in 2003, and followed by facilitywide implementation in 2005. Support from the medical center's executive team was critical in achieving the goals. Key content and procedural strategies were identified using evidence-based guidelines proposed by the Society for Healthcare Epidemiology of America, APIC, and CDC.[8]

The following strategies were implemented and maintained:

- MRSA surveillance cultures were obtained. Nares swabbing was conducted on every patient on admission, discharge, or transfer, followed by notification to the unit staff in a timely fashion of positive results.
- Prompt isolation precautions were instituted, which were applicable to staff and visitors. Contact precautions were initiated for colonized and infected patients. This included wearing gowns and gloves when providing care and masks if the patient had MRSA pneumonia. Visitors were also instructed to adhere to hand hygiene protocols on entry and exit to the patient's room but were not required to wear gowns and gloves. Red tape was strategically placed on the floor in the patient's

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room to alert staff and visitors that contact precautions were in place.

- Weekly MRSA briefings were conducted, which included the executive team, unit staff (e.g., nursing environment management), and infection prevention and control, to share the unit's successes and to identify resources and barriers needing administrative intervention.
- Aggressive hand hygiene protocols before and after patient contact were instituted. A hospitalwide education campaign on hand hygiene was developed for the benefit of staff and visitors. Posters were visibly placed on each unit.
- Barriers to hand hygiene were removed. Alcohol handrub dispensers were placed at the entry/exit of patient rooms and other staff-identified locations.
- Staff were provided with hand hygiene training in the form of in-services and online tutorials to increase awareness.
- Hand hygiene compliance was observed. Staff monitored usage patterns of alcohol hand sanitizer on the units and performed visual observation of hand hygiene practices.
- Executive management support for resources (equipment and supplies) was obtained.
- Systems for terminal cleaning of all the patient's rooms and adequate disinfection of shared equipment were implemented.
- Formal reporting of MRSA and HAI transmission rates to staff and hospital management was maintained.
- Ancillary departments such as physical therapy were provided with updated lists of colonized/infected patients for the purpose of appropriate scheduling of patients to prevent transmission.

The ultimate goals of this initiative were realized through changing workflow patterns, eliminating impediments to compliance with established infection prevention and isolation procedures, and enlisting committed staff and senior executive support for cultural transformation. As a result of the sustained and significant reduction in MRSA-related infections, the MRSA Prevention Initiative expanded to include

The Toyota Production System Approach

The Toyota Production System (TPS) approach is a systems engineering strategy used in manufacturing. The central principle is that all work processes are controlled experiments continuously being improved by the people doing the work. TPS relies on the workers controlling the change, thereby allowing more work efficiency and success. The TPS model holds that people are the most significant corporate asset and that investments in their knowledge and skills are necessary to build competitiveness. Managers are expected to be able to perform the jobs of everyone they supervise and also to teach their workers how to solve problems according to the scientific method. The leadership model applies as much to first-level team leader supervisors as it does to those at the top of the organization. This evolves into a cascading pathway for teaching, which starts with managers delivering training to each employee.

The main objectives of the TPS approach are to design out excess work and inconsistency and to eliminate waste. The challenge with TPS is to facilitate a culture change so that staff adopts the TPS approach and related interventions as a component of the traditional work process. A cultural transformation allows an organization to reach its goals, anchor the changes in practice, and sustain ongoing compliance. Since TPS relies on the workers controlling the change, staff are engaged, empowered, and provided resources to be successful. Shared decision making improves staff satisfaction.

The principles of TPS include using a rigorous problem-solving process that requires a detailed assessment of the current state of affairs and a plan for improvement that is, in effect, an experimental test of the proposed changes. Managers who employ TPS do not tell workers and supervisors specifically how to do their work. Rather, they use a teaching and learning approach that allows their workers to discover the rules as a consequence of solving problems. Identifying problems is just the first step. In order for people to consistently make effective changes, they must know how to change and who is responsible for making the changes. TPS explicitly teaches people how to improve and does not expect them to learn strictly from personal experience. TPS creates ownership by holding staff accountable.[1]

The Four Rules of TPS

1. All work shall be highly specified as to the content, sequence, timing, and outcome.
2. Every "customer supplier" connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.
3. The pathway for every product and service must be simple and direct.
4. Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

Note

1. Spear SJ, Bowen HK. Decoding the DNA of the Toyota Production System. *Harv Bus Rev* 1999 Sep-Oct;77(5):97-106.

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other VAPHS units, and ultimately, a national Veterans Health Administration (VHA) directive was instituted.

Rationale/Motivation for Instituting the Initiative

VAPHS employed TPS in order to make the necessary system changes, which enabled the healthcare worker to implement active surveillance and appropriate precautions. The challenge was to facilitate a culture change so that nursing staff employed TPS and related interventions as a component of the traditional nursing process. This cultural transformation was regarded as necessary to achieve the goal, as well as to anchor the changes in practice and sustain ongoing compliance. Since TPS relies on the workers controlling the change, nursing staff were immediately engaged, empowered, and provided with the resources to be successful. One aspect of TPS was to change work to be more efficient. Staff satisfaction increased in the area of shared decision making. Specifically, in comparison to all VAPHS acute inpatient units, the nurses working on the piloted 36-bed general surgical unit had the highest rating for shared decision making.

In 2005, the initiative expanded to all units within the acute care and long-term care facilities. VAPHS developed a living document, outlining the plan of action and conducted focus groups with staff members to assess existing knowledge and attitudes regarding MRSA. Allowing for ongoing evaluation and change helped sustain the cultural transformation.

In addition to TPS, VAPHS adopted the use of positive deviance (PD), an approach to behavioral and social change that has proven effective in solving health-related problems in countries outside the United States.[9,10] (For more information, see "The Positive Deviance Approach.")

Evidence of Nursing Leadership

A nurse coordinator was selected to lead the "Getting to Zero" initiative, educate staff, and implement changes. Nursing leadership supported the dedicated nurse coordinator and the changes recommended by

The Positive Deviance Approach

Positive deviance (PD) is a development approach based on the premise that solutions to community problems already exist within the community. PD differs from traditional needs-based or problem-solving approaches in that it does not focus primarily on identification of needs and the external inputs necessary to meet those needs or solve problems. Instead, it seeks to identify and optimize existing resources and solutions within the community to solve community problems.[1]

Traditional models for change within an organization frequently do not work. Permanent solutions can be achieved from within and not brought in from the outside. If an external agent brings new resources and ideas into an organization to fix a problem, once the external agent leaves, the problem may return because the recipients did not assume ownership of the solution. Handing problems to a group and allowing them to discover things for themselves can attain far greater results than bringing the solution to the group and expecting behavioral change. The late Jerry Sternin, the "father of PD," described positive deviants as "people whose behavior and practices produce solutions to problems that others in the group who have access to exactly the same resources have not been able to solve."[2]

The Plexus Institute, a nonprofit organization that helps people use PD, bases its definition on the observation that in most communities there are certain individuals or groups (positive deviants) whose special practices/strategies enable them to find better solutions to prevalent, seemingly intractable problems than their peers who have access to the same resources. PD projects can sustain themselves because they are founded on the already-present capacity of people to discover and implement home-grown solutions to long-standing problems.[3]

The PD approach has six steps:

Define. The group begins its work by defining the problem and describing what success would look like—the inverse of the problem statement.

Determine. The group determines whether there are individuals who have already achieved success (i.e., positive deviants).

Discover. The group discovers the uncommon but demonstrably successful behaviors and practices used by the positive deviants to solve the problem.

Design. The group designs an intervention, which enables its members to practice those demonstrably successful practices.

Discern. The group discerns the effectiveness of the intervention, which is determined by ongoing monitoring and evaluation.

Disseminate. The group makes the intervention accessible to a broader constituency.

Notes

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staff. The coordinator engaged all interdisciplinary team members associated with patient care on the unit, including environmental services, management, physical therapy, and laboratory personnel. Through the engagement of surgical staff, collaborative rounds were established, which helped achieve a decreased length of stay from 6 to 4.5 days. Management supported by providing resources and/or removing barriers (modified hospital systems) when needed. During expansion of the initiative to all acute and long-term care units, VAPHS dedicated a new, full-time MRSA prevention coordinator position to long-term care.

In transitioning to PD, focus group discussions inspired a core group of interdisciplinary volunteers to solve problems. Select long-term care residents assisted with changing the behavior of fellow veterans (e.g., performing hand hygiene). Referencing guidelines from Partners in Care,[11] staff and residents discussed how imperative hand hygiene is to preventing infections and created a hand hygiene educational pamphlet for fellow veterans. This approach, coupled with the Joint Commission National Patient Safety Goal 7 (compliance with World Health Organization and/or CDC hand-hygiene guidelines),[12] made VAPHS successful in achieving its goals for "Getting to Zero."

Scope of Initiative

VAPHS adapted TPS as a strategy to reduce the transmission of MRSA infection on a 36-bed general surgical unit over a four-year period, expanding to an 11-bed surgical intensive care unit for the last 18 months of the initiative. Implementation was accomplished by changing workflow patterns, identifying and eliminating impediments to compliance with established infection prevention and isolation procedures. Regular reporting of MRSA HAIs and transmission rates to staff and hospital management was a key component of change. These changes were sustained over time to improve compliance with isolation procedures and reduce MRSA infection rates. This initiative has been sustained throughout the organization for approximately six years—as evidenced by a reduction in MRSA HAI, a sustained increase in the use of personal protective equipment (PPE), and improved hand hygiene compliance rates.

The VAPHS results serve as a model for MRSA reduction efforts regionally, nationally, and internationally. Of particular note are the collective campaigning efforts with the U.S. Department of Veterans Affairs, which resulted in a rollout of the initiative to all 165 VHA facilities in the United States in March 2007.

Impact

Process Improvement. The key process monitors were hand hygiene and contact precaution compliance. Staff ownership of the process drove both the clinical and systems improvement of this initiative. Active surveillance culture compliance rose significantly in both acute and long-term care settings. Observation data from March 2007 reflected a significant improvement in hand hygiene compliance rates for both acute and long-term care. This data includes a 63% compliance rate with entry hand hygiene and 88% with exit hand hygiene in comparison to March 2006, whereby the entry hand hygiene compliance rate was reflected as 48% and exit hand hygiene at 76%. With the heightened awareness of MRSA and infection precautions, the use of PPE also increased.

Nursing-Sensitive Quality Indicators. The outcome measures were MRSA HAIs and MRSA transmissions. From 2004 to 2008, the infection rate in acute care decreased from 0.94 per 1,000 bed-days of care (BDOC) to 0.25 per 1,000 BDOC (see Figure 1). Long-term care rates decreased from 0.54 per 1,000 BDOC in 2005 to 0.33 per 1,000 BDOC in 2006 (See Figure 2).

Figure 1. VAPHS Acute Care Campus MRSA Healthcare-Associated Infections, 2004 through 2008 Fiscal Years

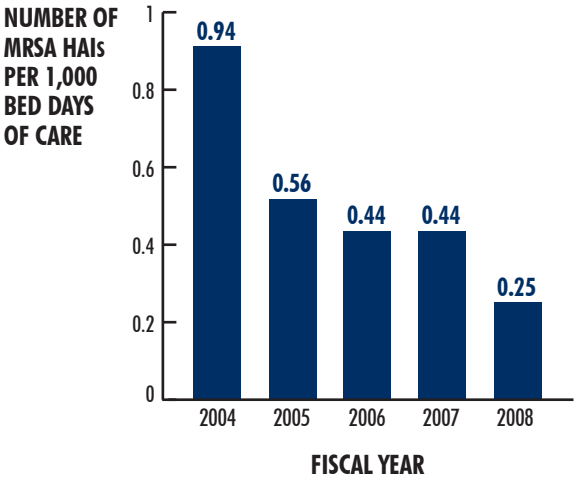

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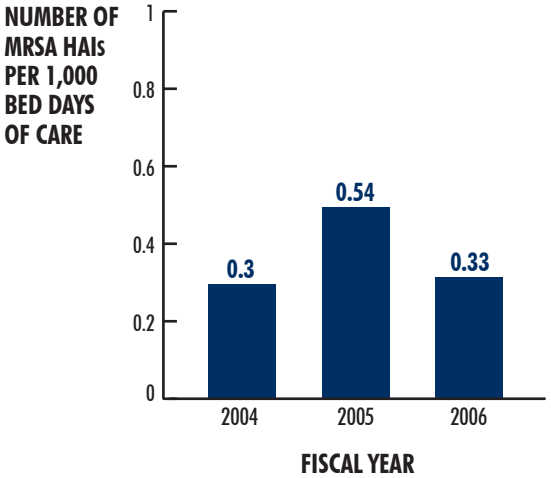
Figure 2. VAPHS Long-Term Care Campus MRSA Healthcare-Associated Infections, 2004 through 2006 Fiscal Years



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A systemwide impact has been sustained to date because of the quality of care delivery and healthcare cost avoidance. Examples of tangible costs include the following:

- Twenty-two MRSA cases at $34,369 per case = $756,118.
- Cost of MRSA screening 2,536 total cases at $21.84 for 2 lab cultures = $110,772.
- Opportunity savings valued at $756,118 - $110,772 = $645,346.

Albert Einstein Healthcare Network

Albert Einstein Healthcare Network (AEHN) is a 1,200-bed integrated delivery network serving the communities of North Philadelphia and Montgomery County, Pennsylvania. The network provides healthcare services through the Albert Einstein Medical Center and Einstein at Elkins Park hospitals, MossRehab and Belmont Behavioral Health divisions, Germantown Community Health Services, Willow Terrace (a nursing home), Willowcrest (a center for subacute care), outpatient facilities such as Center One and Einstein Neighborhood Healthcare, and a network of primary care and specialist practices throughout the community.

During 2006, 107 patients developed MRSA-related HAIs at the medical center. These patients had an 8.3% higher mortality, an increase in average length of stay of 19.75 days, and an increase in average variable costs of $33,347 compared to matched patients who had not acquired a MRSA-related HAI. The percentage of clinical isolates of MRSA steadily increased over the years and was approaching 70% in 2006. No surveillance cultures were being performed for MRSA, and hand hygiene compliance was variable, averaging 40% to 60%. PPE was often unavailable upon entry to isolation rooms.

In May 2006, driven by concern for the increasing incidence of MRSA together with unacceptable compliance rates of hand hygiene, the medical center took steps to develop and implement a MRSA reduction program known as SMASH (*S*top MRSA *A*cquisition and *S*pread in our *H*ospital) by using the PD approach. PD encourages the kinds of cultural changes that help people consistently adhere to practices known to control infections. The staff at Einstein rapidly took ownership of developing the initiative. Pilot projects began on the brain injury unit at MossRehab, a surgical intensive care unit, a 20-bed oncology and transplant unit, and a "step-down" unit. Multidisciplinary teams of hospital staff began to examine their own roles in preventing infections.

Risk reduction strategies similar to those of the VAPHS program were instituted, using evidence-based guidelines for preventing transmission and acquisition of MRSA. Of note at the medical center were the dedication and devotion of staff members to sustaining the program for the benefit of patient safety. The medical center held regular and spontaneous meetings, employing the "discovery and action dialogues" approach. The Plexus Institute provided PD consultants to the medical center.

Results one year later revealed that PD is "about people in the community identifying the problems you can't see from the outside, and coming up with novel ideas that work for them, right there," according to a key player in the SMASH initiative. "It's about community ownership because [when] solutions are community-driven, they are likely to be accepted. People don't reject their own solutions."

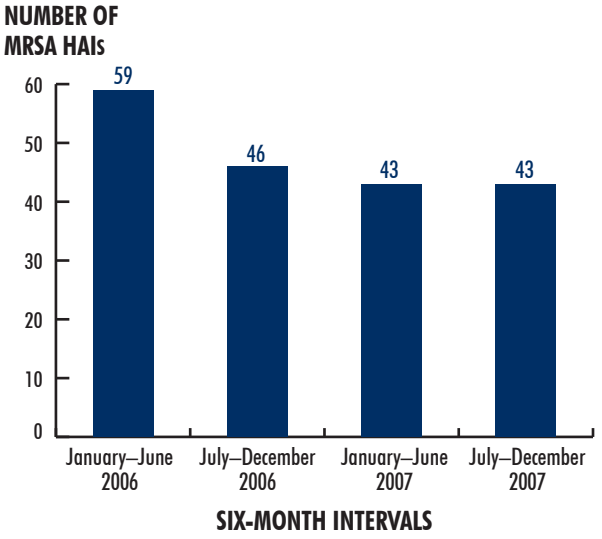
During 2006, a rate of 0.535 infections per 1,000 patient-days was reported. Sixty-five cases of alcohol-based gel and 33,000 gowns were used per quarter.

By 2007, the number of MRSA-related HAIs had decreased to 0.408 infections per 1,000 patient-days. In the first quarter of fiscal year 2008, the rate decreased by 27%, or 0.39 infections per 1,000 patient-days (2008 data not reflected in Figure 3). Alcohol-based gel use had increased to 125 cases, and 80,000 gowns were used per quarter. Based on the decreasing HAI rates and increasing compliance with hand hygiene and isolation precautions, the PD approach was expanded to all the units.

Summary of VAPHS and Einstein Programs

The nurse-led interdisciplinary projects at both the VAPHS and AEHN programs demonstrate that initiatives to control healthcare-associated MRSA can lead to a significant, sustained reduction in MRSA infection in medical facilities in which MRSA had become highly endemic. Lessons learned include the ability to introduce a change in culture by empowering staff to take ownership of the initiative. By taking ownership, staff developed the ability to change the behavior

Figure 3. AEHN MRSA Healthcare-Associated Infections, 2006 through 2007



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around infection control practices. Staff ownership has far more of an impact than the traditional educational programs alone. The TPS approach empowered VAPHS staff to change systems and processes. Through the PD approach, both VAPHS and AEHN created and implemented staff-owned and -operated MRSA prevention programs that are efficient, measurable, and sustainable. In addition, the success at both VAPHS and AEHN is also credited to support from the health system administration teams, who diligently supported the housewide initiatives and took great pride in attaining their HAI reduction goals.

Notes

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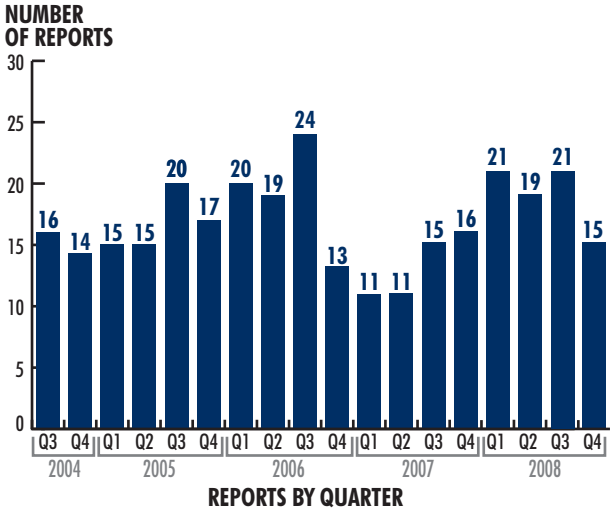
Quarterly Update on the Preventing Wrong-Site Surgery Project

The most recent update from the Pennsylvania Patient Safety Authority shows another 15 wrong-site surgeries reported during the fourth quarter of 2008 (see Figure). As before, minor adjustments have been made in prior quarters to reflect new information. Encouraging trends are appearing, however. The Health Care Improvement Foundation's Partnership for Patient Care Wrong-Site Surgery Prevention Program is a regional collaboration with the Authority to prevent wrong-site surgery. Begun in March 2008, it has not had a wrong-site operative procedure in any of its 30 participating facilities in three months and has not had a wrong-site anesthetic procedure in eight months. Authority analysts will continue to monitor the progress and are planning to replicate the initiative in another region. One characteristic of the collaborative is that facilities discussed with each other how they would prevent various scenarios (based on reports submitted to the Authority) from happening and how they would respond if the scenarios did occur.

Figure. Pennsylvania Patient Safety Authority Wrong-Site Surgery Reports by Quarter



Survey on Surgical Site Marking Pens and Techniques

Authority analysts will disseminate a survey, to be communicated through the Patient Safety Officers of Pennsylvania hospitals and ambulatory surgical facilities, in which operating room (OR) managers can share their good and bad experiences related to the use of various marking pens and techniques for marking surgical sites. (For more information about surgical marking pens, see the article "Surgical Site Markers: Putting Your Mark on Patient Safety" in the December 2008 issue of the *Pennsylvania Patient Safety Advisory*.) Others will be encouraged to contribute by downloading an online copy of the survey and submitting their experiences to the Authority.

The Time-Out Script Competition

The editors have received *five* script entries for the Time-Out in the OR Competition (depicted on next page). For the first round, the editors will accept open-ended review and comment from all who wish to do so. The editors may publish some of the critiques in the second round, but will not identify any reviewers. The reviewers may make a general comment on any script or comment on any parts of any scripts, positively or negatively, but should specifically consider at least three issues: (1) compliance with the time-out elements of the Joint Commission Universal Protocol for Preventing Wrong Site, Wrong Procedure and Wrong Person Surgery™ intended to prevent wrong-site surgery; (2) active participation of all the important members of the operating team; and (3) efficiency. Efficiency will be defined as the length of time involved in performing the script.

During the regional collaborative to prevent wrong-site surgery, mentioned above, OR managers at 27 facilities noted the durations of the time-outs. The median for 227 observations was 1 minute and the mean was 90 seconds. Atul Gawande, MD, has stated that the aviation industry has a rule of thumb that, to maintain effectiveness, a routine checklist addressing a single task should take less than 90 seconds to perform (personal communication). Please note that the Time-Out in the OR Competition includes only the parts of a time-out script that identify the patient, procedure, and side or site of the procedure. Implant availability, antibiotic administration, allergies, and other additions to the Universal Protocol not related to preventing wrong-site surgery have been eliminated from the time-out scripts. Elements of the time-out that involve confirmation or documentation not based on conversation have also been eliminated. Please send your reviews and comments on any or all components of any or all scripts electronically to the editor at jclarke@ecri.org. An electronic copy of the scripts can be obtained online from the Pennsylvania Patient Safety Authority's Web page on preventing wrong-site surgery (see below). Please ensure that you link comments to specific scripts by their numbers. This is your chance to help shape robust scripts for time-outs.

The Pennsylvania Patient Safety Authority remains committed to preventing wrong-site surgery and welcomes any comments, suggestions, and specific inquiries from facilities with specific problems or questions concerning wrong-site surgery. Communications should be directed to John Clarke, MD, FACS, clinical director of the Pennsylvania Patient Safety Authority at ECRI Institute, by telephone at (610) 825-6000 or by e-mail at jclarke@ecri.org.

(continued on page 35)

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Scripts for Mary Jones (DOB 01/01/1921, MR# 007) Left Total Hip Replacement (Supine Position)

Script #1

Circulating nurse, holding the informed consent and preoperative checklist (to the anesthesia provider): "What is the patient's name and date of birth?"

Anesthesia provider, reading from the patient label on the anesthesia record after it has been confirmed with the patient's identification bracelet: "Mary Jones, January 1, 1921."

Surgeon: "I concur that this is Mary Jones. I am doing a left total hip replacement in the supine position."

Circulating nurse (to the scrub technician): "Do you agree?"

Scrub technician: "Yes."

Circulating nurse (to the anesthesia provider): "Do you agree?"

Anesthesia provider: "Yes."

Script #2

Circulating nurse (to all members of the operating team): "It's time for the time-out."

Circulating nurse (to the anesthesia provider): "What is the patient's name and date of birth?"

Anesthesia provider, reading from the armband: "Mary Jones and her date of birth is January 1, 1921."

Circulating nurse (to the surgeon): "What is the intended procedure?"

Surgeon: "A total hip replacement."

Circulating nurse: "That information matches the consent."

Circulating nurse (to the surgeon): "What side is to be done?"

Surgeon: "The left side."

Circulating nurse: "That information matches the consent."

Circulating nurse (to the surgeon): "Is the site mark visible?"

Surgeon: "Yes."

Circulating nurse (to the surgeon): "Do we have the correct position?"

Surgeon: "Yes."

Circulating nurse (to the surgeon): "Are relevant x-rays available, labeled, and displayed?"

Surgeon: "Yes."

Script #3

Circulating nurse (to all members of the operating team): "Let's do our time-out."

Circulating nurse, after checking around the room to see that all members of the operating team involved in the patient's care have stopped what they are doing and are paying attention: "This is Mary Jones (looking at the name bracelet); her date of birth is January 1, 1921."

Circulating nurse, reading directly from the surgical consent: "Left total hip replacement."

Circulating nurse (to all members of the operating team): "Do you agree?"

Other individual members of the operating team: "I agree."

Circulating nurse: "The left hip is in the supine position and has been marked."

Script #4

Surgeon (to all members of the operating team): "Let's do the time-out."

Circulating nurse—after all members of the operating team have stopped what they are doing, have turned off any music, and are paying attention—reads from the informed consent: "This is Mary Jones; date of birth January 1, 1921; total hip replacement; left side; supine position."

Anesthesia provider, referring to the visible site marking and available documents: "I verify that we are doing a left total hip replacement on Mary Jones, medical record number 007."

Scrub technician, referring to the visible site marking: "I see the mark on the left hip. I have set up for a left total hip replacement."

Surgeon, referring to the visible site marking: "I agree that I am doing a total hip replacement on the left side. Available x-rays confirm the left side. I can see and verify the mark. Knife please."

(continued on page 35)

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Script #5

Circulating nurse (to all members of the operating team): "It's time for the time-out."

Circulating nurse, looking at consent (to the surgeon): "Please give me the patient's name."

Surgeon, from memory: "The patient is Mary Jones."

Circulating nurse, looking at consent (to the anesthesia provider): "What is the name and date of birth on the wristband?"

Anesthesia provider, reading from wristband: "The wristband says 'Mary Jones, January 1, 1921.'"

The circulating nurse checks that the surgeon's and anesthesia provider's responses match the consent before proceeding to the next question.

Circulating nurse, looking at consent (to the scrub technician): "What procedure are you set up to do?"

Scrub technician: "I'm set up for a total hip replacement."

Circulating nurse, looking at consent (to the surgeon): "What procedure do you intend to do?"

Surgeon, from memory: "Total hip replacement."

Circulating nurse, looking at consent (to the anesthesia provider): "What procedure is listed on the schedule?"

Anesthesia provider, reading from OR schedule: "Total hip replacement."

The nurse checks that the scrub technician's, surgeon's, and anesthesia provider's responses match the consent before proceeding to the next question.

Circulating nurse (to the surgeon): "Please indicate on the x-ray the side the pathology is on."

Surgeon, pointing to the fracture on the x-ray image: "The pathology is on the left."

Circulating nurse (to the anesthesia provider): "What position is the patient in?"

Anesthesia provider: "The patient is in the supine position."

Circulating nurse (to the surgeon): "Please indicate the side the mark is on."

Surgeon, pointing to mark: "The mark is on the left."

Circulating nurse, looking at consent (to the anesthesia provider): "Which side is listed on the schedule?"

Anesthesia provider, reading from schedule: "The schedule says 'the left.'"

The nurse checks that the surgeon's and anesthesia provider's responses match the consent.

Surgeon (to all members of the operating team): "If anyone has a concern, please speak up."

(continued from page 33)

The Pennsylvania Patient Safety Authority devotes a Web page to educational tools for preventing wrong-site surgery. Its resources include all the Authority's publications on the subject, including *Advisory* articles, self-assessment tools, sample forms and checklists, educational posters and videos, illustrative figures and tables, patient-education brochures, and links to companion online information from other organizations. The Authority's Web page is http://patientsafetyauthority.org/EducationalTools/PatientSafetyTools/PWSS/Pages/home.aspx.

Also highly recommended is the Minnesota Hospital Association SAFE SITE Web site at http://www.mnhospitals.org/index/tools-app/tool.370?view=detail.

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Data Snapshot: Iatrogenic Burn Injuries

A recent article in the *Wall Street Journal*[1] led Pennsylvania Patient Safety Authority analysts to query the PA-PSRS database for burn reports submitted in 2007.* The search was designed to yield reports of actual or proximal harm to the patient by burns, singes, or sparks occurring in the healthcare facility that reported the burn. Reports involving events before the patient received care at the reporting facility were not considered. Also excluded were reports of events involving cigarettes, candles, and other flammable items not usually found in a healthcare setting.

There were 224 reports of burns, two-thirds of which were thermal in nature. More than half the submitted burns were reported to have been caused by instruments or devices used in procedures, including cautery units, light sources, and cords for these devices. Nine percent of the reported burns were attributed to therapeutic heat sources, such as heating pads or hot packs; a further 5% were reported following magnetic resonance imaging procedures. Almost 14% of reported burns were attributed to food preparation or distribution. These reports include hot liquid spills and handling hot containers.

Overall, reports of burns account for 0.11% of all reports submitted to the Authority in 2007. Based on additional figures from the Pennsylvania Health Care Cost Containment Council, an estimated 11.9 burns occur per 100,000 admissions in Pennsylvania.[2]

* 2007 was selected for comparison against data obtained from the Pennsylvania Health Care Cost Containment Council, for which 2007 was the last full year of available admission data at the time of publication.

Notes

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Table. Causes and Types of Burns Submitted to the Authority in 2007

CAUSE	CHEMICAL	ELECTRICAL	MECHANICAL	RADIATION	THERMAL	UNKNOWN/ UNSTATED	TOTAL	% OF TOTAL
PROCEDURAL INSTRUMENT/ DEVICE	**0**	**14**	**5**	**0**	**98**	**0**	**117**	**52.2%**
Cautery device		6			53		59	
Device cord		1			13		14	
Light source					6		6	
Other instrument		7	5		26		38	
SECONDARY TO PROCEDURE	**15**	**10**	**2**	**1**	**22**	**0**	**50**	**22.3%**
Heat therapy					20		20	
Magnetic resonance imaging burn		9			2		11	
Solution	14						14	
Other	1	1	2	1			5	
OTHER	**0**	**0**	**2**	**0**	**32**	**2**	**36**	**16.1%**
Food					31		31	
Other			2		1	2	5	
UNKNOWN/ UNSTATED			**2**	**1**		**18**	**21**	**9.4%**
TOTAL	**15**	**24**	**11**	**2**	**152**	**20**	**224**	
%	6.7%	10.7%	4.9%	0.9%	67.9%	8.9%		

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Online Resources Associated with Patient Safety Advisories

Patient Safety Officers have expressed their interest in distributing educational resources within their healthcare facilities. The Pennsylvania Patient Safety Authority provides a growing collection of resources related to *Pennsylvania Patient Safety Advisory* articles to help increase situational awareness and patient safety within healthcare facilities. Examples include sample policies, educational videos and posters, brochures, interactive learning graphics, and reference materials.

This collection of resources is available online at http://www.patientsafetyauthority.org. Topics addressed include the following:

- Preventing wrong-site surgery
- Verbal orders
- Contrast-induced nephropathy
- Expressed breast milk
- Hospital bed safety
- Skin tears
- Color-coded wristbands
- Common hazards in the behavioral health patient room

More improvement comes from improving a system than improving the performance of individuals within an existing system.

PATIENT SAFETY AUTHORITY

An independent agency of the Commonwealth of Pennsylvania

Whether you would like to learn more about the topics described above, or you need tools to help you meet other challenges, these educational resources can help.

If you would like additional information, please contact us at (866) 316-1070, or e-mail support_papsrs@state.pa.us.

PENNSYLVANIA PATIENT SAFETY ADVISORY

THE PENNSYLVANIA PATIENT SAFETY AUTHORITY AND ITS CONTRACTORS

The Pennsylvania 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 Authority, 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 Pennsylvania Patient Safety Authority, see the Authority's Web site at http://www.patientsafetyauthority.org.

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 nonpunitive approach and systems-based solutions.