

The Not-So-Hidden Costs of Surgical Site Infections

TODD E. BARNETT, RN, MBA

For the past decade, the health care community has been inundated with announcements from governmental agencies and consumer watchdog groups reporting that tens of thousands of lives are lost each year as a result of avoidable incidents in US hospitals.¹ Reports from around the world show a similar trend as well.^{2,3} Wrong site surgery and surgical site infections (SSIs) have been highlighted in many of these reports.

Surgical site infections are a subset of a larger group of infections known as health care-associated infections (HAIs). Surgical site infections affect many thousands of patients each year and contribute greatly to the morbidity and mortality associated with surgery. Annually, SSIs number approximately 500,000 out of an estimated 27 million surgical procedures. Surgical site infections are the third most commonly reported HAI, and they account for one-fourth of all HAIs.^{4,5} Health care-acquired infections can result in more than \$50,000 in additional health care costs per patient,⁶ and hospitals generally do not receive full reimbursement for costs associated with HAIs. Although surgical services often generate the majority of a hospital's income, the costs associated with SSIs can severely cut into a hospital's profits, so finding ways to reduce HAIs and thus increase profits from surgical services is an important goal for hospital administrators.

Many recent improvements in delivery of perioperative care have been focused on reducing SSIs, including using as many disposable products as is possible in the OR.⁷ One area that has been neglected in the trend toward the use of disposable products, however, is electrocardiogram (ECG) lead wires.

These lead wires often are not sufficiently sterilized between uses, which can lead to HAIs and SSIs caused by contaminated lead wires^{8,9} that can be extremely costly to a hospital. This article explores one option for reducing HAIs and SSIs resulting from contaminated ECG lead wires: using disposable ECG lead wire sets.

FINANCIAL IMPACT OF SSIs

As a whole, HAIs adversely affect patient outcomes and are estimated to cost the health care industry and the general public billions of dollars each year. Recent estimates are that one of every 20 patients acquires an infection as a result of hospitalization, leading to higher costs, longer hospital stays, and a greater risk of death.¹⁰⁻¹²

It has long been known that HAIs in general and SSIs in particular produce longer hospital stays, in part as a result

ABSTRACT

SURGICAL SITE INFECTIONS (SSIs) adversely affect approximately 500,000 patients annually, causing immense human suffering and taking a huge financial toll on patients, hospitals, insurance companies, and the government.

NATIONAL ORGANIZATIONS have made recommendations for reducing SSIs, and many advances have been made in evidence-based practice recommendations that result in fewer SSIs.

REUSABLE ELECTROCARDIOGRAM (ECG) lead wires can be a significant source of infection. One medical center near Richmond, VA, began using a disposable ECG lead wire set and wireless transmitter system and subsequently experienced a 40% decrease in SSIs. *AORN J* 86 (August 2007) 249-258. © AORN, Inc, 2007.

of unscheduled returns to surgery, and result in a correspondingly higher mortality rate.¹³ More difficult to grasp, however, is the true financial impact of these infections. The *Washington Post* reported on March 29, 2006, that within the state of Pennsylvania, 180 hospitals reported infection data as part of a state-wide initiative. Although those hospitals billed \$2.3 billion in 2004 for the costs of treating the HAIs, they actually collected only \$614 million.¹⁴ If hospitals elsewhere in the country had infection rates similar to those in Pennsylvania, Medicare likely was billed approximately \$20 billion in 2004 to cover the cost of treating these infections.¹⁵ The financial repercussions of potentially preventable HAIs, therefore, can be significant.

Surgical site infection costs vary widely depending on the severity of the infection and treatment course. In a recent comprehensive study, the Pennsylvania Health Care Cost Containment Council (PHC4) found that HAIs in 2005 cost \$153,871 in additional charges per infected patient.¹⁵ The average length of stay for an infected patient is 16.1 days longer than for an uninfected patient with the same initial diagnosis.¹⁵ Perhaps even more disturbing is the 10.6% increase in mortality associated with these infections.^{15,16} The report stated that nearly 12,000 Pennsylvania hospital patients contracted infections during their hospital stay in 2004, resulting in an extra \$2 billion in health care costs and causing at least 1,500 deaths.^{15,17}

In March of 2006, the House Energy and Commerce Subcommittee on Oversight and Investigations held a hearing to consider options to reduce the incidence of HAIs.⁶ Data presented to the subcommittee indicated that HAIs cause immense human suffering, killing more people than breast cancer and auto accidents combined, and result in staggering financial losses. Testimony by the Centers for Disease Control and Prevention (CDC) at the hearing highlighted that an estimated 1.7 million HAIs are contracted each year, and 99,000 deaths are associated with these infections. Representatives from the PHC4 stated that results of their study showed that HAIs increased health care costs by \$52,600 per admission.⁶

Hospitals get very little, if any, reimbursement for HAIs. Current financial data support the

extremely conservative estimate that the costs for the 4% of patients who develop HAIs can wipe out up to 185% of a hospital's operating profits.¹⁸ Using the PHC4 annual report statistics, if one patient in 20 contracts an infection during his or her hospital stay and each infection costs the institution even \$50,000 in nonreimbursed expenses, on average, each hospital loses nearly \$1 million in revenue, which comes directly off the bottom line. In an environment of dwindling hospital profit margins, that is a figure no hospital administrator can tolerate.

The Deficit Reduction Act passed in 2005 will allow the Centers for Medicare and Medicaid Services (CMS), beginning in October 2008, to begin adjusting payments downward for patients with HAIs.¹⁹ This will result in CMS paying hospitals for diagnosis-related groups at the "without complications" rate instead of at the higher rate for conditions "with complications" if the patient acquires an infection while hospitalized. Further, hospitals must report any diagnosis codes representing certain HAIs that could reasonably have been prevented through the application of evidence-based guidelines.¹⁹ Undoubtedly, private insurance carriers will eventually follow suit. As a result of this act and the provisions that become active in 2008, the impact to the financial well-being of hospitals will be considerable.

THE SCOPE OF THE SSI PROBLEM

Compounding the problem of SSIs are two undeniable trends in modern health care. The first trend is the increased acuity of hospital surgical patients, both inpatients and outpatients. Patients are now sicker with more complex comorbidities than ever before.²⁰ The second trend is the increasing numbers of patients with methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and medication-resistant *Streptococcus pneumoniae* organisms.^{21,22} Decreased lengths of stay allowed by insurance companies and the current nursing shortage only add to the complexities presented by these two trends.

The National Nosocomial Infections Surveillance System's (NNIS's) 2004 Annual Report details infection rates considered to be the national average for hospital comparison

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purposes. National rates are based on inpatient data from nearly 300 participating hospitals across the country and are not required to be posted.²³ There has been little change in the incidence and distribution of the pathogens isolated from infections during the last decade, though the ratio of resistant bacteria strains to their nonresistant counterparts has increased sharply in the past few years.^{24,25} The increased appearance of these medication-resistant organisms leads to greater morbidity, mortality, and costs along with the difficult challenge of developing treatment strategies. According to the Institute of Medicine,

Even if the pharmaceutical industry were to step up efforts to develop new replacement drugs immediately, current trends suggest some diseases will have no effective therapies within the next ten years.²⁶

AWARENESS OF THE PROBLEM

Consumers also are becoming more aware of the problem of HAIs. Consumer watchdog groups such as Leapfrog and the Consumers Union, the publisher of *Consumer Reports*, have web sites dedicated to the HAI issue.^{27,28} As consumers become more educated via information freely available on the Internet, the demand for increased patient safety within hospitals has grown from a populous groundswell to a nationwide campaign spearheaded

by state and federal agencies. Six states (ie, Florida, Illinois, Missouri, New York, Pennsylvania, Virginia) now have legislation requiring hospitals to report HAIs to the NNIS, and nearly two dozen states have similar measures pending.²⁹ As of December 2006, lawmakers in 19 states had introduced 32 bills pertaining to hospital acquired infections.³⁰ In addition, a large and ever-growing number of hospitals throughout the country now post their infection rates on their own web sites for consumers to access.³¹

Postoperative infections, however, are seriously underreported.^{32,33} A large number of surgical procedures have moved to the outpatient arena, and reporting of postoperative infections has become the responsibility of the surgeon. If a patient seeks treatment for an infection at a hospital, using an antibiotic, finding a wound culture positive for infection, or performing an invasive procedure such as an irrigation and drainage or removal of hardware will trigger reporting by the hospital infection control nurse. Surgeons in an outpatient setting, however, may not always report SSIs.

The Joint Commission reported in 2003 that its patient safety reporting database was receiving a disproportionately low volume of reports on the number of patient deaths from HAIs, "possibly because many health care organizations do not view these events as 'errors.'"³⁴ The Joint Commission, therefore, has made HAIs a focus in its National Patient Safety Goals (NPSGs). In the 2007 NPSGs, Goal 7 is to "reduce the risk of health care-associated infections."³⁵ Further, NPSG requirement 7B is to "manage as sentinel events all identified cases of unanticipated death or major permanent loss of function associated with a health care-associated infection."³⁵

Another national group committed to increasing awareness and reducing the incidence of SSIs is the Surgical Care Improvement Project (SCIP). This national partnership of organizations is focused on improving surgical care by significantly reducing surgical complications. The SCIP steering committee is made up of members from the American College of Surgeons, the American Hospital Association, the Institute for Healthcare Improvement, CMS,

the CDC, the Joint Commission, the Department of Veteran's Affairs, and AORN. The SCIP outcome measures include a focus on reducing SSIs and preventing postoperative pneumonia. Hospitals that follow the SCIP recommendations should experience better overall outcomes for patients. The SCIP goal is to reduce the incidence of surgical complications nationally by 25% by the year 2010.³⁶

AORN also has been a leader in helping bring awareness of evidence-based practice measures to health care providers. As new evidence-based practices have emerged, AORN has continued to update the perioperative community and make recommendations for practice changes. The 2007 edition of AORN's *Standards, Recommended Practices, and Guidelines* contains newly updated recommended practices on the prevention of transmissible infections in the perioperative setting.³⁷

PREVENTING SSIs

The role of the perioperative nurse is critical in the fight against SSIs. Perioperative nurses can affect SSIs in a multitude of ways, beginning at the patient assessment and continuing through a patient's discharge from the OR suite. Proper hand washing is the most essential action perioperative nurses can take to prevent SSIs. In addition, perioperative nurses should ensure that correct antibiotic prophylaxis and dose timing is achieved preoperatively. Intraoperatively, correct performance of the surgical site skin prep is essential to maintain the patient's skin integrity, thereby reducing the possibility of infection. Maintaining room temperature and reducing traffic through an OR also add to a reduction in infection rates. Ensuring that all instruments are sterilized and that the sterile field is maintained are other essential tasks that nurses perform. Postopera-

tively, during the room turnover, the perioperative nurse removes contaminated items and disinfects surfaces within the suite. These actions contribute to a comprehensive infection control plan.³⁸

Perioperative nurses can influence the incidence of SSIs in negative as well as positive ways, however. One report indicated that 16 sternal wound infections during an eight-month

period were directly attributable to an OR scrub nurse with a thumbnail infection. Cultures from the subungual region of the nurse's thumbnail yielded the identical *Pseudomonas aeruginosa* strain that was isolated in the patients' wounds. This outbreak of SSIs was caused by wound contamination from the thumbnail of this single scrub nurse, despite her appropriate use of latex surgical gloves.³⁹ This type of incident is very much the exception to the overwhelmingly positive impact that perioperative nurses historically have had on the prevention of SSIs.

To fight the alarming trend in both the number of patients becoming infected and the huge economic impact of treating these patients, evidence-based practices must be sought out, investigated, and promoted by perioperative nurses.

Evidence-based practice is critical to patients, nurses, health care providers, and the health care system. For perioperative practitioners, the guideline for the prevention of SSIs released by the CDC Hospital Infection Control Practices Advisory Committee in 1999 provides an example of how research is intended to guide clinical practice.⁵ The principle objective of this CDC guideline is to reduce the incidence of SSIs and improve patient outcomes throughout the patient care continuum.

Initiatives to reduce SSIs are not new. Virtually since the beginning of surgical practice, medical practitioners have been tireless in their

The role of the perioperative nurse is critical in the fight against surgical site infections (SSIs); nurses should realize that they can have both positive and negative influences on the incidence of SSIs.

efforts to reduce infection rates. Sterilizing instruments; using surgical drapes, masks, gowns, and gloves; and using antiseptic skin cleansers were some of the early improvements that are now accepted standards. More than 35 years ago, OR nurses began questioning whether skin abrasions caused by shaving might actually increase the risk of postoperative infections, even in clean wounds. In 1971, the *American Journal of Surgery* published research indicating that unseen razor injuries released bacteria into the surgical site.⁴⁰ The use of clippers is now a standard of care, and SSI numbers have dropped as a result. In addition, proper hand washing between patient contacts continues to be one of the most important means of reducing cross contamination.⁴¹

Evidence has shown that using disposable versions of products used in the surgical arena can prevent the spread of infection.

Research within the last 10 years has shown that delivering antibiotics to a patient within one hour before the surgical incision is made can dramatically decrease surgical site infection rates.⁴² The National Surgical Infection Prevention Collaborative, through the sponsorship of the CMS, led the way for this improvement, and now antibiotic administration within one hour of surgery is the recognized standard of care within perioperative nursing.^{43,44}

More recently, attention has been placed on normothermia, hyperoxygenation, and glucose control as additional means to further reduce SSIs.⁴⁵ Preoperative and intraoperative warming, either by systemic means (eg, warmed IV fluids, warmed inhalation agents) or extrinsic means (eg, forced-air warming blankets, heating pads), decreases the SSI rate in both clean

surgical procedures and in colorectal procedures.⁴⁶ Maintaining core temperatures above 36.5° C (97.7° F) optimizes oxygen pressure at the surgical site. Administration of high concentrations of oxygen increases wound oxygen tension, allowing for more effective neutrophil function and the potential for reduced infection rates.⁴⁶ Glucose control in the perioperative period also can lower SSI rates. One research study showed that cardiac patients whose postoperative glucose levels were above 200 mg/dL had twice the risk of SSI regardless of whether they were diagnosed with diabetes.⁴⁷ Half of all hyperglycemic episodes occurred in patients without diabetes, and it has been shown that undiagnosed and untreated hyperglycemia is very common in general medical and surgical patients.⁴⁷ Undoubtedly, maintaining normothermia, administering supplemental oxygen, and controlling glucose in the perioperative environment soon will be added as standards of care in perioperative nursing.

In its 1999 guideline for the prevention of SSIs, the CDC recommended the use of disposable patient care items whenever possible to minimize cross contamination of multiple medication-resistant microorganisms.⁵ During the last decade, a tremendous percentage of products used in the surgical arena in particular have moved from reusable to disposable, in part because of the CDC recommendations. Nearly everything that comes into contact with the patient now is disposable, including blood pressure cuffs, stethoscopes, the anesthesia breathing circuit, the prep kit, and pulse oximetry devices. Often, the sheets the patient lies on are disposable as well.⁷ Even the mop head for cleaning the room is disposable in most cases. None of these items usually comes in contact with the surgical wound or even the skin around it, and yet evidence has shown that by using disposable versions of these items, the spread of infection can be prevented.⁷

ECG LEAD WIRES AND SSIs

There is one marked exception to the disposable usage evidence-based trend: ECG lead wires. The ECG lead wires used on every monitored patient in nearly 99% of hospitals across the nation still are reusable. These reusable

wires can harbor infectious organisms, in large part because they are difficult at best to sanitize, and generally there is no process to routinely sterilize them.⁸ The ECG lead wires are in close proximity to many surgical wounds and are usually found in direct contact with the dressing of most open heart surgery patients. All too frequently, the lead wires are found draped across the anesthesia machine or monitor after having been picked up off of the floor when the patient has left the OR suite or postanesthesia care unit (PACU). At best, only gross visible contamination is wiped off, and the lead wires are placed back into service.

Contaminated lead wires attached to a new patient can result in colonization and invasive infection.⁹ A single patient may come into contact with multiple sets of ECG lead wires during his or her stay in a health care facility. For example, a trauma patient who arrives in the emergency department (ED) may end up with ECG electrode pads attached to as many as eight different sets of lead wires connected to a variety of monitors, including the

- ambulance transport monitor;
- ED monitor;
- portable transport monitor for transferring the patient to the computed tomography department;
- monitors in the preoperative holding area, OR, and PACU;
- transport monitor for transferring the patient to the intensive care unit (ICU); and
- ICU monitor.

If this patient has an infection, the lead wires for each of these monitors may become contaminated and may not be sufficiently cleaned before they are used for the next patient.

In one study conducted at the University of Wisconsin Hospital and Clinics, Madison, ECG lead wires were suspected to be a source of a significant infection rate. The nursing staff members were told that the lead wires were going to be cultured, and before the cultures were taken, the ECG lead wires were thoroughly cleaned following the manufacturer's guidelines. Of the 100 lead wires cultured, a staggering 77% of the wires tested positive for at least one highly resistant organism, including MRSA and VRE.⁹

In another study, a Texas burn ICU had an outbreak of VRE that was directly linked to contaminated lead wires. The lead wires previously had been cleaned and the unit had been closed for terminal cleaning. The outbreak was caused by a single biological strain of VRE that was traced back to one organism that persisted for 13 weeks on an ECG lead wire.⁴⁸

With this evidence that ECG lead wires can harbor infectious organisms, it seems reasonable to postulate that eliminating the use of reusable ECG lead wires could reduce the incidence of SSIs. In an effort to reduce sternal wound infections, three separate hospitals began using disposable ECG lead wires in their ICUs. In all three hospitals, the frequency of sternal wound infections decreased by more than 90%, a result that hospital administrators largely attributed to the use of disposable ECG lead wires.⁴⁹

IMPLEMENTING A WIRELESS ECG LEAD WIRE SYSTEM

At a newly constructed hospital near Richmond, Virginia, an ICU and telemetry unit avoided reusing ECG wires by adopting cutting-edge technology. They began using a disposable ECG lead wire set with a wireless transceiver system, which connects disposable ECG electrode pads and lead wires to a patient transceiver that relays the ECG signal to the patient monitor using short-range, wireless communication technology. The entirely wireless system transmits the ECG signal directly from the patient to the existing monitoring system.

In the first 18 months after the new system was put in place, not a single central line infection or instance of ventilator-associated pneumonia was reported.⁴⁹ The relatively low cost of the disposable lead wire set as well as the fact that no costly modifications to the existing patient monitoring systems were necessary facilitated the acceptance of this initiative by senior administrators. In addition, this hospital has begun its journey toward Magnet recognition, making the implementation of evidence-based practices even more compelling. Also important is that converting to the disposable, wireless ECG system, with the dramatic infection control gains it achieved, did not require a

physician's order as do some other evidence-based practices (eg, administering prophylactic antibiotics⁵⁰).

The ICU's infection control success then was shared with the surgical services department. After reviewing published studies and seeing the excellent results the ICU had achieved, the surgical services department adopted the disposable ECG wires and the wireless system for both the OR and PACU. The director of anesthesia, who also was the chief of the hospital Quality Committee, fervently believed that the OR and PACU should adopt the system, and nearly the entire perioperative nursing staff became champions for the conversion. The SSI rate had been very good before the wireless ECG system began to be used in the OR, but after the first four months of using the system, the SSI rate dropped 40% without any changes being made to any other infection prevention practice. The decrease in the total number of infections and the corresponding costs that were avoided as a result of implementing this new wireless and disposable system paid for the system in the first two months of use.

THE BOTTOM LINE

Surgical services have long been the economic engine of most institutions, generating the majority of each hospital's income and, ideally, profit. The revenue generated by the surgery department helps fund many departments throughout the hospital. Departments such as the ED, ICU, and labor and delivery historically do not generate revenue but are critical to a hospital's survival as well as essential to the community the hospital serves. Although surgery is one of the main revenue generators, it also is one of the largest users of that revenue. It is imperative that surgical services continue to generate money, in part so that capital equipment can be purchased to keep up with costly new technologies and improvements to the standards of care. Perioperative nurses can directly influence their hospital's bottom line by continuing the quest to eradicate SSIs, thereby reducing the huge financial drain that these infections cause the hospital.

Surgical care can be improved through ad-

herence to evidence-based practice recommendations and by designing systems of care using nationally recognized best practices and procedures. Despite a large body of evidence describing care processes known to reduce the incidence of SSIs, however, many still are underutilized in practice, resulting in the occurrence of preventable SSIs.

The use of disposable pads and wireless lead wires is a measure that should become a new standard of care. The question that administrators and perioperative leaders should ask is not "Can we afford to adopt a new evidence-based product and best practice to reduce infections?" The real question should be "Can we afford not to?" — **AORN** —

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Todd E. Barnett, RN, MBA, is a clinical sales representative at LifeSync Corp, Ft Lauderdale, FL. He was the administrative director for surgical services at St Francis Medical Center, Midlothian, VA, at the time this article was written.

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Neonates Fare Better in High-Level Intensive Care Units

Infants with very low birth weight are significantly more likely to survive if they are delivered in hospitals with high-volume, high-level neonatal intensive care units (NICUs), according to a May 23, 2007, news release from the National Institutes of Health. High-level NICUs are those that provide such specialized services as mechanical ventilation and even major surgery, and those considered high-volume provide care to at least 100 very low birth weight infants per year. Very low birth weight infants weigh less than 1,500 g (ie, about 3.3 lbs) at birth and are highly vulnerable to medical complications. Although only 1.4% of infants born in 2000 were very low birth weight infants, 51% of infant deaths occurred in this population.

Researchers analyzed birth certificates, discharge records, and fetal and infant death certificates from more than 48,000 very low birth weight infants born in

California between 1991 and 2000. They found that hospitals with lower-volume, lower-level NICUs had a significantly higher newborn death rate for these infants compared to hospitals with high-level, high-volume NICUs. Although the survival rate for very low birth weight infants cared for in high-level, high-volume NICUs has increased, a growing number of high-risk infants are receiving care in low-volume, mid-level NICUs, many of which see only a few very low birth weight infants per year. According to the researchers, ensuring that more very low birth weight infants are born at hospitals with high-level, high-volume NICUs may reduce the rate of infant mortality.

Small infants have greater survival rate in high level intensive care facilities [news release]. Rockville, MD; National Institutes of Health; May 23, 2007.