Improve surgery 100 years ago...or procedures done on the battlefield...What scenes come to mind? Old photographs or movie images that attempt to recreate reality may prompt images of unsanitary conditions, bloody rags, contaminated instruments, ungloved hands washed in dirty water between cases—all potential sources for infection. Many patients developed surgical site infections (SSIs) in those days, and many died from them.

That was an era of no antibiotics and less knowledge than we have today about disease prevention. So, why are some of these techniques not used consistently? And why do so many SSIs still occur?

**The impact**

Hospital-acquired infections (HAIs) are unnecessary and largely preventable; SSIs account for about 40% of all HAIs.\(^1\) From the patient’s perspective, an SSI contributes to...
longer recovery, additional pain, further risk of other complications, and, in some cases, death.

Studies find that surgical patients who develop SSI are twice as likely to die as those who don’t. These patients are also 60% more likely to require an ICU admission, remain in the hospital twice as long, and have a 6 times higher rate of readmission than those with no infection. All of these factors contribute to excess costs incurred by hospitals, on average over $3,000 per case.

The evidence for better care
SSI has been well studied; evidence in the literature regarding techniques that reduce the risk of infection date back to the 1970s. Despite this, these practices haven’t been universally implemented in hospitals. This variation may contribute to differences in SSI rates and mortality of surgical patients seen across hospitals.

Several national organizations recognize the importance of reducing SSI through several key interventions. These groups, including the Joint Commission on Accreditation of Healthcare Organizations, the Centers for Medicare & Medicaid Services, and the National Quality Forum, have developed quality measures based on these key interventions. We have the evidence, we know what works, and we can do better. This is why SSI prevention is a key intervention in the Institute for Healthcare Improvement’s 100,000 Lives Campaign.

Prophylactic antibiotic use.
Appropriate use of prophylactic antibiotics is fundamental in preventing SSI and includes three core elements: appropriate selection, timing of the first dose, and discontinuation postoperatively.

**SELECTION:** To effectively prevent infection, the antibiotic selected must be one that works against the type of bacteria likely to cause an SSI; the selection varies depending on the type of surgery. Clinical expert panels from the American Society of Health-System Pharmacists, the Centers for Disease Control and Prevention, and physician expert groups of clinical specialty boards have developed guidelines for appropriate antibiotic selection. From these guidelines,
hospitals should develop internal protocols based on formulary and local consensus of clinicians. Protocols can help efficiently ensure appropriate selection because they can be developed in advance and executed by pharmacy and nursing staff, removing the need to write a unique antibiotic order (which can be inadvertently omitted or contain an error) for every surgical patient. It’s essential to develop protocols with the input of local experts, i.e., the infectious disease physicians and surgeons within your hospital. A good protocol will contain clear guidance for staff as to substitutions in case of allergies, or criteria as to when a physician should be contacted for a different order. Protocols should be updated periodically, based on availability of drugs and changes to national guidelines.

**TIMING:** The first dose of an antibiotic for SSI prophylaxis should be given prior to the start of surgery (defined as incision time). Studies have shown that the timing of this first dose plays a crucial role in the risk of SSI. In the most frequently cited study from 1992, reviewers studied the medical records of nearly 3,000 surgical patients for timing of the first dose, incision time, and whether an SSI occurred. They found that the lowest rate of SSI occurred in patients who had received the first dose within the 60 minutes prior to incision. Patients who received the first dose either more than 60 minutes before incision or after incision had higher rates of SSI, and the further the dose time was from incision, the greater the rate of SSI.5

Reasons for the differences include tissue perfusion and half-life of the medication in tissues. If the dose is given too early, its peak effect may have already passed before the incision is made, resulting in less protection against SSI. If the antibiotic is given at the time of incision or after, the time it takes for the drug to fully perfuse the surrounding tissues makes the dose too late to provide optimum protection. Here are a few key tips for best use of the first dose to prevent SSI:

—Ensure that the entire dose is fully infused before incision but no more than 60 minutes prior.
(Exception: Vancomycin takes longer to infuse, and 120 minutes is the recommended time frame.)

—Administer the dose via rapid infusion so that start time of the dose is very close to end time.
—If a cuff will be applied to the patient near the surgical site, ensure that the dose is fully infused prior to cuff inflation, otherwise the cuff will prevent the full dose from reaching the site.
—Adjust the dose for patient weight; large patients may require a higher dose in order to achieve the same therapeutic level.
—Redose for longer surgeries (greater than 4 hours); a second dose may be necessary to prevent SSI if the surgical site is open for long periods of time.

Many hospitals have worked on improving this aspect of antibiotic prophylaxis. It’s challenging, but improvements have been made by changing processes. The first step is to designate responsibility for the antibiotic administration. In some organizations, anesthesiologists handle it; in others, circulating nurses; and in others, preoperative holding area nurses. Clearly define an owner of the process, the one who will work locally. Remember to designate responsibility for documentation of dose and incision time as well. Otherwise it’ll be impossible to measure progress.

A few techniques that take into account human factors (how human beings function and recall information) can help drive success. Standardize whenever possible, such as by using protocols. Eliminate steps, perhaps by storing the antibiotics contained in the protocol in ready-to-administer doses in the operative areas. Take advantage of habits and patterns by designing the process so that the start of the dose coincides with something that staff members are already doing. One hospital improved antibiotic timing by linking the start of the dose to opening a door. When the OR was ready for the patient, staff had to wheel the patient through a set of doors that required a button on the wall to be pushed for opening. When one hit the button to open the doors, the antibiotic (already hanging) started. Staff were able to easily remember because it was linked to a step they already did routinely.

**DURATION:** If you’re continuing prophylactic antibiotics postoperatively, only do so for 24 hours or less. Studies found one preoperative dose may be all that’s needed in certain types of surgery, as the infection rate wasn’t higher in patients who had one dose than those who received orthopedics. In orthopedic surgery, SSI risk is often very serious, so post-op doses are generally administered but still shouldn’t exceed 24 hours. There’s no literature to support continued administration, even if drains or catheters are still in place. In fact, continuing antibiotics that are unnecessary may contribute to the growing problem of antibiotic resistance. The only exception beyond 24 hours is in cardiac surgery, based on recent recommendations that antibiotics for prophylaxis are warranted for 48 hours post-op.

Protocols and standard order sets can be effective tools for ensuring that antibiotics are discontinued in a timely fashion. If physicians want to have a specific number of doses (three post-op doses in orthopedics is common), design the protocol so that the doses are spaced over time by nursing or pharmacy staff based on surgery end time. This works better than individual orders with times that may exceed the 24-hour limit or place a patient on a hospital standard dosing schedule that may start hours later. As long as the number of doses physicians want are given, many will accept a protocol that sets timing.

Consider designing these protocols or order sets so that physicians must “opt out” rather than “opt in.” When standard approaches are optional and merely encouraged (the opt-in approach), they aren’t as successful as when they’re required. Charleston Area Medical Center in West Virginia has designed a post-op order set for orthopedic surgery that utilizes the opt-out approach. Patients receive three post-op doses of antibiotic, with administration times set by nursing based on surgery end time. If the physician wants to continue the antibiotics beyond the three doses, he or she must check a box on the bottom of the order form and indicate as such, with the number of additional doses and frequency, as well as the reason. Common reasons for continuing an antibiotic, such as urinary tract infection or fever, are listed so that they can be quickly checked off if applicable (in which case the antibiotic is being administered for infection and not as prophylaxis, and the 24-hour rule no longer applies). The choice to opt out must always be provided to allow for flexibility based on unique clinical circumstances.

♦ **Appropriate hair removal.** For many years, the standard practice
was to “shave and prep” the patient prior to surgery. Even in cases where the surgical incision would be a few inches in the abdomen, patients were often shaved from the neck to the groin on the evening before surgery. This practice has largely disappeared (especially since patients are rarely admitted the day before surgery now), but in a number of places razors are still used to shave hair around the intended surgical site, sometimes immediately before the procedure. This occurs despite a study published in 1971 reporting that patients whose hair was either removed with a depilatory or not removed at all had a 90% lower rate of infection than those patients whose hair was shaved.\(^9\)

More recently, a 1992 study reported that SSI was more than 50% lower in cardiac surgery patients whose hair was removed with clippers \(^9\)—Use clippers to remove hair if necessary, but be sure to train staff on their proper use. Clippers in an untrained hand can cause as much or more damage to skin than a razor. Vendors who supply the clippers will often provide on-site training.

—Remove razors from the entire hospital. This is challenging, but can be done and requires other methods for removing hair prior to performing an ECG or I.V. insertion.

—Involve the purchasing and supply departments so that they know not to reorder razors or deliver them to the surgical areas.

—Use briefings and training in teamwork to improve communication so that if a surgeon wants to use a razor in the OR, staff will feel comfortable speaking up and suggesting alternatives.

**Normothermia.** One of the most common complaints from people who have surgery is being cold—in the holding area, the OR, and the PACU. It’s uncomfortable and unnecessary (other than when it’s planned and necessary in specific procedures to reduce risk of other more serious complications), and also has been shown to contribute to increased risk complications, including SSI.\(^12\)

When a person becomes hypothermic, the following physiologic changes occur: decreased oxygen tension from vasoconstriction, reduced leukocyte superoxide production, and increased risk of bleeding.

In 2001, a published study reported that colorectal surgery patients who had either local or systemic warming during surgery had SSI rates more than 50% lower than those who had none.\(^13\)

The initial work of the 100,000 Lives Campaign focuses on this population, with the goal of ensuring that all colorectal surgery patients are normothermic on arrival to the PACU. Hospitals working on this endeavor have found that the best approach is to prevent hypothermia from occurring preoperatively and intraoperatively, and as it takes greater effort to increase a patient’s temperature if it falls below 36°C than it does to prevent hypothermia in the first place.

**Glycemic control.** The prevalence of obesity and diabetes continues to rise, along with reports of associated adverse health outcomes. In 2001, two separate studies were published reporting higher rates of SSI, as much as two times greater, in cardiac surgery patients when glucose levels were greater than 200 mg/dl in the immediate postoperative period. This was true for patients who were known diabetics as well as those previously undiagnosed.\(^14,15\)

Successful methods for maintaining serum glucose postoperatively have frequently relied on the use of sliding scales for insulin administration and protocols. The Portland Protocol, developed at Providence Heart and Vascular Institute, Everett, Wash., has...
been adopted by many hospitals and provides guidance to staff on doses of insulin based on serum glucose levels.16 Similar protocols have been developed at other places, such as the one from Luther Midelfort–Mayo Health System, Eau Claire, Wisc., which provides dose guidelines for intravenous insulin infusion.17

Many clinicians do recommend that intravenous insulin infusions should be limited to the intensive care setting. Glucose control is likely to become increasingly important in the future as a method not only for decreasing SSI, but other adverse outcomes as well. A recent study reported lower rates of mortality in the intensive care setting for patients with controlled glucose levels.18

Putting it all together

One of the keys to making all of this work is to approach it as a team. It isn’t the sole responsibility of any one person or department. If that attitude persists, you won’t achieve success. Everyone involved in the surgical process, including patients, must work together. Use simple techniques to promote the concept of a team, such as a preprocedural briefing during which all members of the surgical team verify that all of the correct steps have occurred, or use a white board in the OR to note key information, including names of team members and time of antibiotic dose.

Involve patients and families in the process. No one has greater interest in the prevention of an SSI than the patient. Educate patients about their role in prevention by not using a razor or by dressing warmly when they come to the hospital on a cold day. Use the published literature to support the case to everyone involved. And always remember: If you or a member of your family were the patient, what would you want done to prevent an SSI? NM

REFERENCES

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About the IHI

Founded in 1991 and based in Cambridge, Mass., the Institute for Healthcare Improvement (IHI) is a not-for-profit organization, cultivating innovative concepts for improving patient care and implementing programs for putting these ideas into action. The 100,000 Lives Campaign is a nationwide initiative of the IHI to radically reduce morbidity and mortality in American healthcare. Building on the successful work of healthcare providers all over the world, the Institute introduced proven best practices across the country to extend or save as many as 100,000 lives. The IHI and its partners in this work believe it’s possible to achieve this goal by June 2006. To learn more about this effort, contact the IHI at 1-866-787-0831 or http://www.ihi.org.

About this series
This series examines the IHI’s suggested 100,000 Lives Campaign interventions from a managerial perspective. It concludes next month with a discussion of ventilator-associated pneumonia.