A Brief for Hospital Administrators

The Business Case for Implementing Interventions Recommended in the IHI How-to Guide: Prevent Surgical Site Infection for Hip and Knee Arthroplasty

Impact on Patients

Infections following total hip or knee replacement are devastating for the patient and those caring for the patient. Treatment often requires removing the prosthetic joint and replacing it with a spacer device, followed by prolonged systemic antibiotic therapy. In addition to considerable pain and attendant medications, patients experience impaired mobility during treatment; a wheelchair or walker is typically required. Following a second hospitalization of at least several days, patients generally require intensive rehabilitation in a skilled nursing facility or at home, where the burden of care, as well as considerable out-of-pocket expense, falls upon family members. Most patients undergo a third operation 4 to 6 weeks after completion of antibiotics for re-implantation of the joint. This is followed by a period of recuperation of 3 to 6 months to recover from the revision surgery.[1] Clinical outcomes are markedly worse compared to those with uninfected revisions, and permanent debility is possible.[2]

Impact on the Health Care System

In addition to the personal consequences for patients and families and the costs to providers, surgical site infections (SSIs) following hip or knee arthroplasty pose profound risks to the health care system. The grim statistics were summarized well in the APIC Elimination Guide for Orthopedic Surgical Site Infections:[3]

The Agency for Healthcare Research and Quality (AHRQ) reported that more than one million knee and hip arthroplasty surgeries were performed in hospitals in the United States in 2008.[4] The most recent National Healthcare Safety Network (NHSN) report includes data from 2006 to 2008. This report published knee replacement postoperative infection rates ranging from 0.68% to 1.60%, depending on patient risk, and hip replacement infection rates from 0.67% to 2.4%.[5] If these rates were applied to all of the hip and knee replacements done in the US, we could estimate that somewhere between 6,000 and 20,000 SSIs occur annually in hip and knee replacements alone. Estimates of the total number of patients who have SSIs following all orthopedic surgery is somewhere between 31,000 and 35,000.
Given that the number of hip and knee arthroplasties will rise substantially in coming years due to an aging population seeking improved quality of active life,[6] the aggregate impact of SSIs following these surgeries can be expected to grow as well.

Studies have shown an estimated economic impact of one joint space infection to be $100,000 in hospital costs alone after hip arthroplasty and $60,000 after knee arthroplasty; this is three to four times the cost of the initial surgery.[1, 7-11] These excess costs are carried by hospitals, patients, and payers. While infections following hip and knee replacement surgery are not currently included in the Centers for Medicare & Medicaid Services list of hospital-acquired conditions that are denied reimbursement, the emerging consensus is that many of these infections are avoidable and it is likely that their costs will increasingly be borne by providers.

**Interventions to Prevent SSI for Hip and Knee Arthroplasty**

The Institute for Healthcare Improvement (IHI) *How-to Guide: Prevent Surgical Site Infection for Hip and Knee Arthroplasty* recommends implementing three evidence-based interventions to prevent SSI in patients undergoing hip and knee arthroplasty procedures, in addition to two applicable Surgical Care Improvement Project (SCIP) practices.

**Three evidence-based interventions for preventing SSI for hip and knee arthroplasty:**

1. Use an alcohol-containing antiseptic agent for preoperative skin preparation
2. Instruct patients to bathe or shower with chlorhexidine gluconate (CHG) soap for at least three days before surgery
3. Screen patients for *Staphylococcus aureus* (SA) and decolonize SA carriers with five days of intranasal mupirocin and bathing or showering with chlorhexidine gluconate soap for at least three days before surgery

Recent trials suggest that the latter two interventions together could decrease the occurrence of surgical site infections by as much as 65% across multiple types of surgery including orthopedic procedures.[12-15]

**Two applicable SCIP practices:**

4. Appropriate use of prophylactic antibiotics
5. Appropriate hair removal


Implementation Costs

The cost of implementing the recommended prevention approaches will vary from setting to setting. Component costs include the following:

- Screening patients for *Staphylococcus aureus*: Screening costs will depend upon the type of test employed; common tests include standard culture and Polymerase Chain Reaction (PCR) machine. Per the AAOS *Now* March 2009 Issue, a standard culture which gives results in about two days, is approximately $20. A PCR machine gives results in hours and can cost up to approximately $200 per *Staph aureus* test.
- Providing mupirocin to those who test positive for *Staph aureus*: Cost is around $15 per patient; this cost is typically borne by the patient and insurer.
- Providing chlorhexidine gluconate soap or wipes: Cost is around $5 to $8; this cost is typically borne by the patient or the hospital.
- The differential cost of alcohol-based site cleansing agents: Cost is between $1 to $4 per patient.
- In addition, hospitals can expect some additional administrative and clinical staff cost to incorporate these interventions into existing pre-surgical workflows.[1]

Surgical Site Infection Costs

Postoperative surgical site infection is a costly complication of orthopedic procedures. Attributable costs include the following:[16, 17]

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<tr>
<th>Direct Costs</th>
<th>Indirect and Intangible Costs</th>
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<tr>
<td>Prolonged hospital length of stay</td>
<td>Opportunity cost of staff and surgeon’s time spent on follow up, revision surgery</td>
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<td>Hospital readmissions</td>
<td>Lost productivity of the patient and family members</td>
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<td>Additional surgical procedures (often removal and re-implantation of implanted hardware)</td>
<td>Unreimbursed out-of-pocket expenses for patients and families</td>
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<td>Convalescent or nursing home care between procedures</td>
<td>Decreased patient satisfaction</td>
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<td>Significant increases in direct hospital costs (e.g., prolonged antibiotic therapy)</td>
<td>Decreased referrals</td>
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<td>Increased litigation</td>
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Bozic and Ries reviewed 29 patients who underwent revision arthroplasty following total hip replacement between 2001 and 2004.[1] Total length of stay for patients with infections in all hospitalizations was 22 days longer than for patients in a comparison group that experienced an uninfected procedure (28 versus 6 days). They underwent an average of 3.6 surgeries, versus 1 for the comparison group, and had 37 additional outpatient visits. Total excess hospital costs averaged $74,512 (about $86,000 in 2010 dollars) with large variation. Total excess outpatient charges were $39,829 (about $46,000 in 2010 dollars).[1] Hebert and colleagues analyzed 20 cases of infected total knee replacements performed between 1990 and 1993. Excess hospital charges averaged $62,083 (about $93,000 in 2010 dollars).[10]

Kurtz and colleagues analyzed data from the Nationwide Inpatient Sample database to assess the impact of infection for hip and knee replacement surgeries between 1990 and 2004. Over that period, the infection rate increased from 0.66% to 1.23% for hip surgeries, and from 0.63% to 1.21% for knee surgeries. While length of stay (LOS) decreased for both groups over the years, average LOS for revision surgeries was 9.7 days for patients with infected hip replacements, and 7.6 days for infected knee replacements.[8]

The Evidence

Avoiding attributable excess cost due to SSI hinges on reducing their occurrence. While it is impossible to estimate the precise number of SSIs that will be avoided by adopting the interventions recommended in the How-to Guide: Prevent Surgical Site Infection for Hip and Knee Arthroplasty, it is possible to outline the link between the approaches and a reduced incidence of infection.

- Using an alcohol-containing preoperative skin prep agent instead of a traditional povidone-iodine prep (without alcohol) may reduce the risk for developing surgical site infections due to all types of bacterial pathogens (including Staph aureus) by 40%, based on a recent study.[12]

- Screening all patients scheduled for hip or knee arthroplasty for Staph aureus to identify patients at heightened risk for surgical site infections and decolonizing the subset of patients who screen positive for Staph aureus with a combination of intranasal mupirocin and bathing with chlorhexidine gluconate soap may decrease the risk of infections due to Staph aureus by 60%, based on recent studies published in the New England Journal of Medicine[13, 18] and The Journal of Arthroplasty.[15] A study by Perl and colleagues found that among patients who suffered SSIs following a variety of procedures, 84.6% of Staph aureus infections were
caused by bacterial strains identical to those found in the patients’ nares,[19] which suggests that most SSIs are caused not by hospital-acquired pathogens but by patients’ endogenous flora.

- A recent Cochrane review identified seven trials — with over 10,000 patients undergoing a variety of procedures — that tested use of skin antiseptics containing chlorhexidine against use of normal soap or no presurgical washing, and found no clear evidence that the use of chlorhexidine solution was better than non-antiseptic wash products at preventing surgical site infections.[20] However, there is good evidence that chlorhexidine bathing/showering lowers bacterial counts on skin, and this can theoretically reduce the risk of postoperative infection.[21] Two other studies of the use of chlorhexidine wipes prior to knee and hip arthroplasty that compared patients who complied with the regimen with control groups found a positive effect on infection rates.[22, 23] A sensitivity analysis of the economic value of CHG wipes conducted by Bailey and colleagues concluded that presurgical wipes are cost effective even at low rates of compliance.[24]

The impact of these interventions will also depend on the completeness and consistency of the processes used to implement them. The actual predicted reduction in SSI occurrence thus depends on the base rate of colonization in the incoming patients, their relative risk of infection, the reliability of decolonization, and the decreased relative risk of infection after decolonization.

**Conclusion**

Most US hospitals have made considerable progress over the past several years in implementing precautions to reduce surgical site infections. The to SSI prophylaxis for hip and knee surgeries described in the *How-to Guide: Prevent Surgical Site Infection for Hip and Knee Arthroplasty*[25] represents an important, evidence-based step that hospitals can take toward further reducing the institutional, financial, and personal risks associated with these very serious infections.
References


