



## The Effect of Implementing a Multimodal Approach on the Rates of Periprosthetic Joint Infection After Total Joint Arthroplasty



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### ABSTRACT

**Introduction:** We examined the efficacy of implementing a multimodal program aimed at reducing the incidence of periprosthetic joint infection (PJI) after total joint arthroplasty (TJA) in a mid-size community hospital.

**Methods:** An infection reduction committee (IRC) was formed at our hospital in November 2010. The IRC consisted of two orthopaedic surgeons, an infectious disease specialist, an internist with extensive experience in perioperative medical management of TJA patients, an anesthesiologist, the hospital infection control nurse, and two additional nurses. Their goals were to 1) evaluate the current incidence of PJI at our institution, compare it with the reported national data, and consider measures already in place directed at preventing PJI; 2) review and routinely evaluate recently published studies or information obtained from continuing medical education events related to PJI to determine if practice changes were warranted (based on intervention efficacy, cost, and safety) and then develop a plan to implement appropriate alterations in perioperative protocols using a multimodal strategy; and 3) evaluate the effect and safety of newly-introduced infection reduction strategies on the incidence of PJI.

**Results:** In 2008, the incidence of PJI at our hospital was 1.0%. By 2013, this rate had reduced to 0.4%. In absolute numbers, in 2009, 20 of 1,150 TJAs developed a PJI in the 12-month period following partial, primary, or revision TJA. In 2013, PJI occurred in only 4 of 1,053 TJA patients.

**Conclusion:** We found that formation of an IRC focused on evaluating and implementing strategies to reduce PJI following TJA can be effective.

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Periprosthetic joint infection (PJI) after total joint arthroplasty (TJA) is a significant complication associated with substantial morbidity and cost [1–5]. There are multiple risk factors that increase a patient's likelihood for developing a PJI: comorbidities, preoperative care, surgical factors, and postoperative factors.

Patients who have certain medical conditions have a higher risk of developing infections. Modifiable risk factors such as obesity (body mass index >35 kg/m<sup>2</sup>), alcohol abuse, smoking, and intravenous drug use have been associated with an increased risk of PJI [6–11]. Nonmodifiable risk factors include age at the time of surgery [4,12] and sex [13,14]. Patients with diabetes mellitus, cardiopulmonary comorbidities, bone cancer, depression, hemophilia, hepatitis C, HIV, malnutrition, hypertension, hypercholesterolemia, renal disease, liver

disease, sickle cell hemoglobinopathies, and psoriasis have a higher risk of developing infection [6,9,11,15–21]. Finally, the presence of infections such as previous infections in the same joint [22,23], previous orthopedic infections [24], methicillin-resistant *Staphylococcus aureus* colonization [11], and urinary tract infections [6,25] may predispose patients to developing PJI. Postoperative factors, such as allogeneic transfusions, postoperative atrial fibrillation, longer hospitalizations, and wound drainage, may contribute to the development of PJI [25]. Wound drainage may develop from hematomas that may be secondary to using anticoagulants such as warfarin [26].

Infection rates after TJA are dependent on many factors including patient comorbidities, operative time, operating room environment, and perioperative risk reduction interventions [3,8,27–36]. Reported rates of PJI after TJA are highly variable and range from 0.5% to 3.3% in the early postoperative period [1,3–5,28,37]. A recent study demonstrated that PJI was the most common reason for early revision after total knee arthroplasty (TKA) [38]. Multimodal strategies have been shown to effectively reduce venous thromboembolic events (VTEs) and improve pain management after TJA [39–42]. The purpose of this study was to determine the efficacy of implementing a program using a multimodal approach aimed at reducing the incidence of PJI in a mid-size community hospital performing a high volume of TJA.

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## Methods and Materials

In an effort to reduce the incidence of PJI after TJA, an infection reduction committee (IRC) was formed at a mid-sized community hospital in November 2010. The impetus behind forming this IRC was a noted increase in the incidence of PJI in 2008 and 2009 (1.0%–1.7%). Combined with the recognized high cost and morbidity associated with PJI, the formation of this committee was strongly endorsed by the hospital administration and supported by the clinical staff that provided care for the TJA patients.

This mid-size community hospital has 185 beds, and more than 1000 TJA procedures are performed annually, with more than 90% of these procedures done by 1 of the 2 fellowship-trained adult reconstructive surgeons. The IRC consisted of 2 orthopedic surgeons, an infectious disease specialist, an internist with extensive experience in perioperative medical management of TJA patients, an anesthesiologist, the hospital infection control nurse, and 2 additional nurses who manage the operating room and postoperative orthopedic units. At the initial meeting of the IRC, the committee tasked itself with 3 issues:

- 1 Evaluate the current incidence of PJI at our institution, compare it with the reported national data, and consider measures already in place directed at preventing PJI.
- 2 Review and routinely evaluate recently published studies or information obtained from continuing medical education (CME) events related to PJI to determine if practice changes were warranted (based on intervention efficacy, cost, and safety) and then develop a plan to implement appropriate alterations in perioperative protocols using a multimodal strategy.
- 3 Meet quarterly to evaluate the effect and safety of newly introduced infection reduction strategies on the incidence of PJI and respond accordingly.

Periprosthetic joint infection incidence was carefully monitored by the infection control nurse. Any patient presenting within 1 year of the index arthroplasty with a PJI was categorized as a hospital-acquired infection. Periprosthetic joint infection was defined according to the criteria proposed by the Musculoskeletal Infection Society [43]. The incidence of PJI after partial, primary, and revision total hip arthroplasty or TKA was documented for each year from 2009 to 2014. Confidence intervals (CIs) and *P* values were calculated using logistic regression.

after the first IRC meeting in December 2010, it was determined that the baseline strategies for reducing PJI already in place at our hospital consisted of timely administration of prophylactic antibiotics, expeditious performance of TJA, routine use of body exhaust suits, and limiting operating room traffic. In addition, surgeries were postponed in cases of active symptomatic urinary tract infections or active dental disease [43].

At this first meeting, the IRC agreed that staff education regarding contributing factors to infection was needed. In-service training followed, and emphasis was placed on further minimizing the operating room traffic (eg, all needed items were made available in the room before incision, no intraoperative staff breaks, etc). In addition, eliminating lint producing materials (eg, cloth surgical caps) and unnecessary items (backpacks, briefcases, purses, etc) was implemented.

Before December 2010, the routine postoperative TJA surgical dressing consisted of a betadine-impregnated petroleum strip over the incision, gauze, and foam tape, which was routinely removed on postoperative day 2. A new dressing was applied if copious drainage was present. The IRC recommended changing the postoperative dressing to an occlusive antimicrobial dressing (Aquacel; Convatec, Bridgewater Township, NJ) left in place until postoperative day 5. This decision was based on a contemporaneous literature analysis [44–46].

Analysis of the data from a community hospital affiliated with ours suggested that the combined use of preoperative cephalosporin and vancomycin may reduce PJI and associated morbidity if PJI did occur.

This analysis was later reported and published by a coauthor of this paper [37]. Combined antibiotic use was implemented in June 2011. Preoperative decolonization of nares and skin with mupirocin ointment and chlorhexidine wipes, respectively, has been reported to be effective for reduction of PJI [47–49].

Beginning in December 2011, after IRC approval, both of these strategies were introduced. Preoperative patient instruction included a recommendation for patients to use mupirocin nasal ointment and decolonize with chlorhexidine wipes for 3 days before surgery. Screening for the presence of nasal methicillin-resistant *S aureus* was not performed, and the use of mupirocin was recommended for all patients. Compliance was not monitored, but the importance of performing these tasks was emphasized.

The IRC agreed in September 2012 that wound hematoma and bleeding after TJA could be an independent risk factor for PJI. Literature published at that time supported this opinion [50]. Therefore, postoperative bleeding reduction strategies were considered and implemented after a risk-benefit analysis [51]. Routine administration of intravenous tranexamic acid was already in place at our institution and became part of the standard protocol in July 2010. Before September 2012, standard pharmacologic VTE prophylaxis consisted of low-dose warfarin, but at this time, the IRC recommended a transition to aspirin prophylaxis after TJA for low- to moderate-risk patients. This was done by concurrently monitoring VTE incidence. By January 2013, greater than 95% of all patients receiving TJA also received with aspirin for postoperative VTE prophylaxis.

The use of dilute betadine irrigation at the completion of TJA has been reported to reduce the incidence of subsequent PJI [52]. In December 2012, the IRC recommended the routine use of dilute betadine irrigation at the completion of surgery, and this practice was instituted.

Finally, in September 2013, based on cumulative literature available at that time, the IRC advocated postponing surgery for patients at high risk for PJI (hemoglobin A1c > 7.5, body mass index > 40, and laboratory evidence of malnutrition). These patients subsequently had TJA only after modification of risk factors or a proven effort to do so.

## Results

A timeline that schematically depicts the institution of each PJI reduction modality is shown in Fig. 1. In 2008, the incidence of PJI at our hospital was 1.0%. In 2009, the incidence increased to 1.7%, and this prompted the recommendation for an institutional IRC. The incidence of PJI after TJA subsequently decreased annually as noted in Fig. 2. In 2013, the incidence of PJI reduced to 0.4%. In absolute numbers, in 2009, 20 of 1150 TJAs developed a PJI in the 12-month period after partial, primary, or revision TJA. In 2013, PJI occurred in only 4 of 1053 TJA patients.

When infections were divided into primary and revisions, both had a significant decrease each year. The rate of primary total joint infection dropped from 1.4% in 2009 (95% CI, 0.77%–2.33%) to 0.37% in 2014 (95% CI, 0.10%–0.95%). During that same period, the rate of revision total joint infection dropped from 6.58% (95% CI, 2.17%–14.69%) to 0% (95% CI 0%–3.93%). The infections in primary operations declined with an odds ratio of 0.730 (95% CI, 0.603–0.872) per year and revision operations declined with an odds ratio of 0.439 (95% CI, 0.236–0.705) (Fig. 3).

## Discussion

Periprosthetic joint infection is a complication after TJA that is expensive to manage and associated with significant patient suffering and morbidity [1–5]. The evolving paradigm in health care has emphasized the need to reduce hospital acquired infections [30]. Importantly, because of very high procedural volume, particular focus has been placed on PJI after TJA [1–6,28,29,32,53,54]. Recognition of this changing environment prompted the creation of an IRC at 1 mid-sized

IRC Formed	Antimicrobial Dressing & Staff Education	Combined Antibiotics	Nasal/Skin Decolonization	VTE Prophylaxis Modification	Dilute Betadine Irrigation	Pre-Op Patient Optimization
↓	↓	↓	↓	↓	↓	↓
November 2010	December 2010	June 2011	December 2011	September 2011	December 2012	September 2013

Fig. 1. Timeline for implementation of IRC recommendations.

community hospital in 2010. Because of the large volume of TJA performed at our institution, the committee directed its attention to reducing PJI after these procedures. Initial meetings led to the IRC choosing to adopt an approach for reducing PJI based on frequent literature reviews and CME-reported information with subsequent implementation of strategies likely to be cost-effective and safe. The IRC then reviewed all protocol changes on a continuous basis to determine efficacy. The safety of each intervention was considered, and efficacy was monitored after institution of each particular strategy.

Based on a review of data on PJI at our institution, it appears that the cumulative protocol modifications recommended and then implemented by the IRC had a measurable positive effect on the incidence of PJI at our hospital. In 2008, the incidence of PJI after TJA at this facility was 1.0% (10 of 1045 patients). In 2009 and 2010, the incidence of PJI increased to 1.7% (20 of 1150 patients) and 1.3% (16 of 1204 patients), respectively. In 2012 and 2013, the incidence of PJI reduced to 0.6% (7 of 1167 patients) and 0.4% (4 of 1053 patients), respectively.

This study has several weaknesses. Because it is a retrospective investigation, the possibility exists that other factors, separate from those implemented by the IRC, positively affected PJI incidence noted

in this investigation. However, most TJAs performed at our hospital are performed by only 2 surgeons who routinely used standard and identical protocols for perioperative patient management after TJA. Although other factors could have influenced PJI incidence, none were readily apparent to the authors.

In addition, the cost efficacy and potential risk of each intervention were considered but not analyzed by scientific methodology. Nonetheless, these issues were routinely discussed during IRC meetings. The cost of each intervention is relatively small when compared to the cost of PJI management, which has been reported to be as high as \$100,000 per case [55]. In this context, an intervention that costs \$50 per case would be effective if it reduced the incidence of PJI by only 0.1%. This contention is even truer when the substantial morbidity associated with PJI is considered.

Potential intervention risks were also considered at IRC meetings. For example, aspirin prophylaxis was implemented only after the committee believed that the safety of this intervention was reasonably demonstrated in the published literature [51]. In addition, VTE prophylaxis slowly transitioned over a 6-month period from routine use of low-dose warfarin to aspirin for appropriate patients. Venous

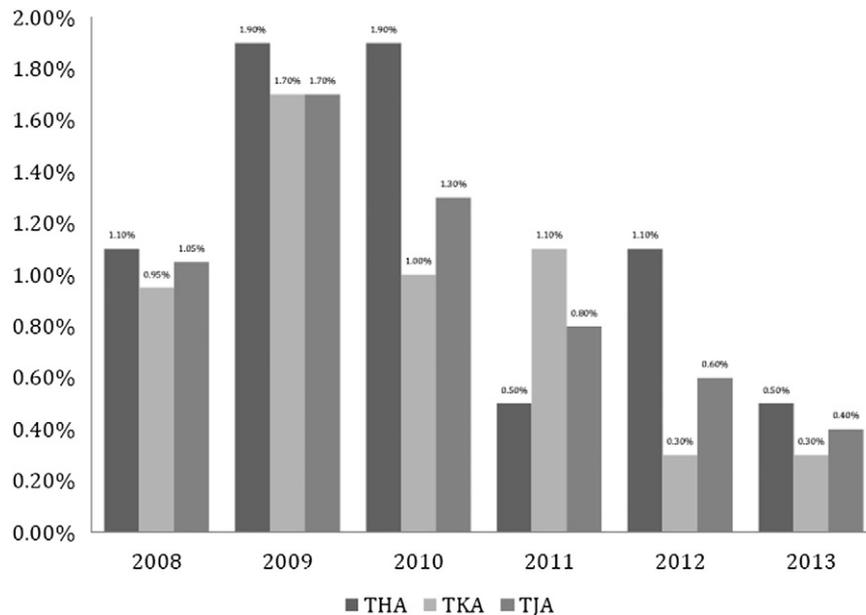


Fig. 2. Yearly PJI incidence for total hip arthroplasty, TKA, and combined TJA.

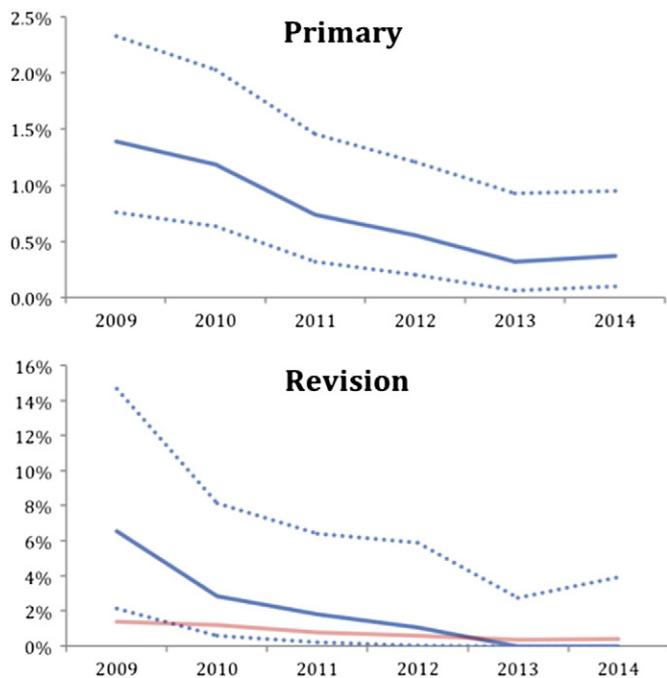


Fig. 3. Graphical representation of the infection rates of primary and revision TJA from 2009 to 2014.

thromboembolic event rates were closely monitored during this time and did not appreciably change. These issues demonstrate the importance of organizing a committee with participation from all specialties providing services surrounding the TJA episode of care. There is concern for selection of vancomycin for routine prophylaxis due to vancomycin-resistant organisms, and we do not strongly recommend its routine use until clear safety parameters can be established. Widespread participation allows for the concerns of each provider to be addressed and then subsequent buy-in from all participants. Furthermore, the number of interventions and relatively low incidence of PJI does not allow for meaningful statistical analysis of the impact of each intervention. However, the cost and risk of each reduction strategy are generally considered low. Therefore, given the absence of data to refute the efficacy of this method of reducing PJI, it seems logical to adapt a multimodal approach to reduce the incidence of this complication. Further study could be performed as a prospective multicenter design.

In summary, this study demonstrated that formation of an institutional IRC focused on evaluating and implementing strategies to reduce PJI after TJA can be effective. Our data further suggest that using the existing literature and CME-reported information as a basis for decision making to create a multimodal approach is a useful strategy for reducing PJI. Importantly, the members of the IRC should represent the multiple providers who contribute to the patient's care. This will ensure that concerns about efficacy, cost-effectiveness, and safety are appropriately considered.

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