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Original Article

A Bundle Protocol to Reduce the Incidence of Periprosthetic Joint Infections After Total Joint Arthroplasty: A Single-Center Experience

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ABSTRACT

Background: Periprosthetic joint infection (PJI) represents a devastating complication of total hip arthroplasty (THA) or total knee arthroplasty (TKA). Modifiable patient risk factors as well as various intraoperative and postoperative variables have been associated with risk of PJI. In 2011, our institution formulated a “bundle” to optimize patient outcomes after THA and TKA. The purpose of this report is to describe the “bundle” protocol we implemented for primary THA and TKA patients and to analyze its impact on rates of PJI and readmission.

Methods: Our bundle protocol for primary THA and TKA patients is conceptually organized about 3 chronological periods of patient care: preoperative, intraoperative, and postoperative. The institutional total joint database and electronic medical record were reviewed to identify all primary THAs and TKAs performed in the 2 years before and following implementation of the bundle. Rates of PJI and readmission were then calculated.

Results: Thirteen of 908 (1.43%) TKAs performed before the bundle became infected compared to only 1 of 890 (0.11%) TKAs performed after bundle implementation ($P = .0016$). Ten of 641 (1.56%) THAs performed before the bundle became infected, which was not statistically different from the 4 of 675 (0.59%) THAs performed after the bundle that became infected ($P = .09$).

Conclusion: The bundle protocol we describe significantly reduced PJIs at our institution, which we attribute to patient selection, optimization of modifiable risk factors, and our perioperative protocol. We believe the bundle concept represents a systematic way to improve patient outcomes and increase value in total joint arthroplasty.

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Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are successful operations that alleviate pain, restore function, and improve quality of life for patients with degenerative joint disease of the hip and knee. In 2010, the estimated annual incidence of primary THA and TKA in the United States was 293,000 and 655,000, respectively [1]. As our population ages and increasingly desires to remain physically active, utilization of total joint arthroplasty (TJA) is expected to increase exponentially. Projections estimate 572,000

THAs and 3.48 million TKAs will be performed annually in the United States by 2030 [1]. Periprosthetic joint infection (PJI) represents a devastating complication of TJA that is often associated with poor outcomes and significant patient morbidity. PJI after primary TJA has been reported to occur in 1.55%–2.5% of cases [2–4]. Hospital costs related to PJI were previously estimated at \$566 million annually but are projected to rise to \$1.6 billion by 2020 [2]. PJI is associated with higher mortality rates than several cancers, with a mortality rate of 7% between the first and second stages of a revision arthroplasty reported in one study [5].

Modifiable patient risk factors such as uncontrolled diabetes [6–13], obesity [8,14–16], tobacco abuse [8,17,18], malnutrition [18–25], alcohol abuse, poor dentition, anemia [9,26–28], and methicillin-resistant *Staphylococcus aureus* (MRSA) colonization [29,30] have been linked to increased risk of PJI after TJA. Prolonged operative time [3,7,29], extensive soft tissue dissection, presence of unnecessary personnel, disruption of intraoperative laminar

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airflow [31,32], and/or increased door openings in the operative suite may also contribute to PJI [32–34]. Correct timing and dosage of antibiotics [35], early patient mobilization, appropriate anticoagulation, adequate skin preparation, and using dedicated units for TJA patients [36] have been shown to reduce the risk of PJI. Hospital and surgeon volume are inversely related to PJI [37]. The impact each issue has on reducing infection has been examined individually but few studies have looked at combining interventions throughout the perioperative period.

Health care continues to transition to a patient-centered model where adverse patient outcomes, such as deep vein thrombosis (DVT)/pulmonary embolism (PE), readmission, or PJI may result in decreased reimbursement. Progressive research is necessary to help reduce the incidence and economic burden of PJI. The Institute for Healthcare Improvement developed the “bundle” concept aimed at improving healthcare delivery and enhancing outcome quality after medical interventions [38]. A bundle is a set of evidence-based guidelines that, when implemented together, yield improved results while minimizing cost.

In 2011, our institution conducted a comprehensive review of primary TJA cases, which led to creation of a multidisciplinary team focused on formulating a “bundle” to optimize patient outcomes. Our team included 3 fellowship-trained TJA surgeons, anesthesiologists, infectious disease specialists, nurses, physical therapists, and administrative coordinators. The purpose of this report is to describe the “bundle” protocol we implemented for primary TJA patients at our institution and to analyze its impact on rates of PJI and readmission.

Materials and Methods

Our bundle protocol for primary TJA patients is conceptually organized about 3 chronological periods of patient care: preoperative, intraoperative, and postoperative (Table 1).

Preoperative Bundle

The bundle begins during a patient's initial clinical visit. A checklist of 15 literature-supported patient-specific risk factors that influence the outcomes of TJA was assembled and implemented into our electronic medical record (EMR) system. Each arthroplasty surgeon completes the checklist during the initial evaluation of the patient (Table 2) to formulate a medical optimization plan and assign a level of infection risk before the operation. These factors

Table 1
Wake Forest Bundle Protocol by Operative Period.

Preoperative	Intraoperative	Postoperative
Body mass index <40 kg/m ²	Hair clipping in holding room	Dedicated total joint unit
Hemoglobin A1c <7.0%	Chlorhexidine wash	24 h of antibiotics
Tobacco smoking <0.5 packs/day	Isopropyl alcohol wash	Standard wound care
Chlorhexidine wash instruction	Minimize OR traffic	Chlorhexidine wash
MRSA screen	Exchange gloves before implanting	Aspirin for low-risk patients
Risk factor labs	No “flushed” instruments	Follow-up instruction phone call
Preanesthesia appointment	Dilute povidone-iodine solution wash	
Surgeon risk factor assessment	Silver-impregnated dressing	

OR, operating room; MRSA, methicillin-resistant *Staphylococcus aureus*.

Table 2

Surgeon Checklist Used During Initial Patient Evaluation As Part of Bundle Protocol.

Surgeon risk factor assessment	
Surgical candidate based on examination and imaging	Yes/no
Patient factors to determine complication risk after TJA	
Poor dentition	Yes/no
History of metal intolerance	Yes/no
BMI (<40 kg/m ²)	Yes/no
Diabetes mellitus	Yes/no
Latest hemoglobin A1c (<7.0%)	Yes/no
Inflammatory arthritis (SLE, RA, psoriasis)	Yes/no
Gender	Male/female
Smoking	Yes/no
Prior skin infections or open wounds	Yes/no
Previous TJA complication	Yes/no
History of MRSA infection/colonization	Yes/no
History of progressive neurologic disease	Yes/no
Current anticoagulation use (coumadin, plavix, etc.)	Yes/no
History of obstructive sleep apnea	Yes/no
History of venous thromboembolism	Yes/no
Surgical risk of complications	Minimal/low/moderate/high

TJA, total joint arthroplasty; BMI, body mass index; SLE, systemic lupus erythematosus; RA, rheumatoid arthritis; MRSA, methicillin-resistant *Staphylococcus aureus*.

include modifiable and nonmodifiable risk factors that have been shown to contribute to poor outcomes following TJA.

Modifiable risk factors include poor dentition [30,39,40], body mass index (BMI) >40 kg/m² [8,15,16,29,41], diabetes mellitus, hemoglobin A1c (HbA1c) [7,8,10–13,42,43], tobacco abuse [8,17,18,29], history of MRSA infection/colonization [44–46], history of or current open wounds, current use of anticoagulant, diagnosis of obstructive sleep apnea (OSA), and history of DVT/PE. Non-modifiable risk factors include history of metal sensitivity/allergy, inflammatory arthritides (systemic lupus erythematosus, rheumatoid arthritis [47–51], psoriatic arthritis [47,51], ankylosing spondylitis [47,51], previous TJA complication [52], and progressive neurologic disease.

Candidates with modifiable risk factors represent an opportunity for optimization before arthroplasty. Patients with poor dentition are referred to a dentist for evaluation and management. Obese patients with BMI >40 kg/m² are referred to their primary care physician (PCP) and asked to work with a nutritionist to develop a weight management strategy before surgery. Occasionally, patients are referred to a bariatric surgeon for evaluation; however, evidence is mixed related to the impact of bariatric surgery improving outcomes after TJA [53–56]. Serum HbA1c is used to screen for diabetes mellitus. Patients with values greater than 7.0%

Table 3

Prosthetic Joint Infection Incidence by Year Before and After Bundle Implementation.

Fiscal Year	THA PJI	TKA PJI	Bundle Compliance	Readmission
2012	2.22% (7/314)	2.10% (8/380)	—	15 (<30 d)
2013	0.92% (3/327)	0.95% (5/528)	—	8 (<30 d)
Bundle starts				
2014	0.00% (0/300)	0.19% (1/515)	83.8%	1 (<90 d)
2015	1.06% (4/375)	0.00% (0/375)	92.5%	3 (<30 d)
				1 (<90 d)

THA, total hip arthroplasty; TKA, total knee arthroplasty; PJI, periprosthetic joint infection.

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