The Journal of Arthroplasty 31 (2016) S202–S206

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Complications - Other

# Morbidity and Mortality in Elective Total Knee Arthroplasty Following Surgical Care Improvement Project Guidelines

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ARTICLE INFO

*Article history:*
Received 7 December 2015
Received in revised form
5 February 2016
Accepted 23 February 2016
Available online 15 March 2016

*Keywords:*
arthroplasty
cardiac
complications
surgical care improvement project
knee
elective

ABSTRACT

*Background:* Perioperative myocardial infarctions and cardiac complications are leading causes of mortality after noncardiac surgery. In an effort to improve patient safety, the Surgical Care Improvement Project (SCIP) implemented guidelines concerning administration of β-blockers therapy aimed to reduce cardiac complications.
*Methods:* The Nationwide Inpatient Sample was queried for 759,819 elective total knee arthroplasties performed from 2003 to 2011. Incidence of cardiac complications, mortality, and risk factors for cardiac complications was determined before and after SCIP implementation.
*Results:* The incidence of cardiac events after total knee arthroplasty remained stable at 9%. The incidence and mortality of postoperative stroke, myocardial infarction, and cardiac arrest significantly decreased. Mortality after cardiac complications decreased by 50%.
*Conclusion:* After the implementation of SCIP guidelines, there was a greater than 50% reduction in mortality and a significant decrease in fatal postoperative stroke, heart failure, and cardiac arrest.
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### *Surgical Care Improvement Project*

The Centers for Medicare & Medicaid Services first introduced quality measures in 2001 to assure safe, effective, and patient-centered health care based on evidence-based clinical practice guidelines and in 2006 established the Surgical Care Improvement Project (SCIP) guidelines to improve patient safety and reduce surgical complications. With regard to prevention of cardiovascular complications, SCIP guidelines (ie, SCIP-Card-2 core measure) require administration of β-blocker therapy during the perioperative period (defined as day before surgery through postoperative day 2 with day of surgery being day 0) for patients on β-blocker therapy before arrival (see Table 1 for complete list of orthopedic-related SCIP recommendations).

### *Rationale of β-Blockers*

The rationale for perioperative continuation of β-blocker therapy is that in patients with significant coronary artery disease, elevated heart rates lead to an imbalance between myocardial oxygen supply and demand. This imbalance leads to perioperative myocardial ischemia, which is associated with postoperative cardiac morbidity. Beta-adrenergic sympatholysis through β-blockade is meant to attenuate the stress response and reduce the incidence of myocardial ischemia. However, recent studies have demonstrated that perioperative β-blockade started within 1 day or less before noncardiac surgery reduce nonfatal myocardial infarctions but with concomitant increased incidence of stroke, hypotension, and overall mortality [1]. In addition, other studies have failed to demonstrate any significant difference in patients receiving β-blockers perioperatively leading to recent criticism with respect to the appropriateness of SCIP guidelines in various patient populations [2,3]. Theoretically, sympathetic inhibition secondary to

Carolinas Medical Center institutional review board approval status: Exempt.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to doi: http://dx.doi.org/10.1016/j.arth.2016.02.072.

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http://dx.doi.org/10.1016/j.arth.2016.02.072
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**Table 1**
Orthopedic-Related SCIP Guidelines.

| Core Measure | Description |
|---|---|
| SCIP Inf-1 | Administration of prophylactic antibiotic within 1 h before surgical incision |
| SCIP Inf-2 | Appropriate selection of prophylactic antibiotic for surgical patients |
| SCIP Inf-3 | Prophylactic antibiotic discontinued within 24 h after surgery end time |
| SCIP Inf-6 | Appropriate hair removal for surgical patients |
| SCIP Inf-9 | Urinary catheter removed on postoperative day 1 or 2 with day of surgery being day 0 |
| SCIP Inf-10 | Appropriate perioperative temperature management in surgical patients |
| SCIP Card-2 | Administration of β-blocker during perioperative period for patients on β-blocker therapy before arrival |
| SCIP VTE-2 | Administration of appropriate venous thromboembolism prophylaxis within 24 h before surgery to 24 h after surgery for surgical patients |

SCIP, Surgical Care Improvement Project.

β-blocker administration may lead to perioperative hypotension and bradycardia resulting in ischemic strokes. Under ordinary circumstances, the cardiovascular system is subject to autonomic regulation and has adequate reserve to tolerate blood loss associated with surgery. If these reflex sympathetic responses are blunted by exogenous β-blockade, blood pressure may fail to maintain adequate perfusion resulting in catastrophic organ failure and death.

### *True Impact of SCIP*

Despite limited evidence from randomized trials, perioperative treatment with β-blockers is now widely advocated. No study has assessed the clinical significance of SCIP guidelines on an orthopedic-specific population. The purpose of this study is to determine the national incidence, mortality, and potential risk factors for perioperative cardiac complications associated with elective total knee arthroplasty (TKA) and evaluate change following implementation of the SCIP guidelines in 2006.

## Materials and Methods

### *Study Population*

The Healthcare Cost and Utilization Project (HCUP)—National Inpatient Sample (NIS) is currently the largest longitudinal all-payer, inpatient database in the United States. Unweighted, the NIS is a representative sample of approximately 20% of the annual nationwide inpatient hospital admissions, which accounts for nearly 7 million patients annually from approximately 1000 participating US community hospitals. Weighted, the NIS estimates more than 35 million hospitalizations nationally. The NIS contains resource utilization as well as clinical information (eg, demographics, comorbidities, as well as International Classification of Disease, Ninth Revision diagnosis and procedure codes). Because the NIS contains entirely deidentified medical record data, this study was given exempt status by the institutional review board at our institution.

### *Data Collection*

The HCUP-NIS database was used to collect a retrospective cohort of all patients undergoing elective TKA between 2003 and 2011 (excluding 2006) [4]. Inclusion criteria included all patients in the HCUP-NIS database who underwent an (1) elective (2) TKA (primary procedure code 81.54). Outcomes were compared for patients undergoing elective TKA between pre-SCIP (2003-2005) and post-SCIP eras (2007-2011). Data from 2006 were excluded to remove the transition year for which hospitals were variably implementing the new clinical practice guidelines.

### *Data Analysis*

Rao-Scott chi-square statistical tests with weighted proportions based on HCUP-NIS guidelines were used to compare the rates of complications between pre- and post-SCIP eras as well as patient demographics, comorbidities, and outcome-related mortality. Multiple logistic regression was used to identify independent predictors (ie, odds ratio [OR]) of nonfatal and fatal cardiac complications adjusting for the complex sampling design and relevant patient confounders that differed between the 2 eras. All tests were 2-sided ($\alpha = 0.05$) and all analyses were conducted using SAS Enterprise Guide version 6.1.

## Results

A total of 759,819 patients undergoing elective TKA were identified between 2003 and 2011. Except where specifically noted, only statistically significant values are noted in the following sections. Please refer to Tables 2-5 for the complete data set.

### *Demographics*

Patients in the post-SCIP era were significantly more likely to be male (35.0 to 36.7%) and have a history of diabetes mellitus (17.9%-21.4%), substance abuse (10.9%-16.6%), obesity (12.6%-20.8%), hypertension (62.9%-67.1%), congestive heart failure (0.02%-0.28%), and end-stage renal disease (0.23%-3.52%). (see Table 2). Substance abuse was defined as patients diagnosed with history of alcohol abuse or dependence, cocaine dependence or nondependent abuse, and nicotine dependence or personal history of nicotine abuse.

### *Cardiovascular Complications*

The national incidence of cardiac complications remained relatively stable with no significant change from the pre-SCIP to post-SCIP era at approximately 9 events per 100 cases (pre-SCIP 9.06% vs post-SCIP 9.33%). Although postoperative hypotension (0.8%-1.7%) and acute heart failure (0.01%-0.11%) increased, there

**Table 2**
Demographic Characteristics of Patients Underoing Elective Total Knee Arthroplasty During the Pre- (2003-2005) and Post-SCIP Eras (2007-2011).

| Demographics | 2003-2005 (n = 226,786) | 2007-2011 (n = 533,033) |
|---|---|---|
| Age (median y) | 66.7 | 65.3 |
| Female (%) | 65.0 | 63.3[a] |
| Caucasian (%) | 84.5 | 83.4 |
| Diabetes mellitus (%) | 17.9 | 21.4[a] |
| Substance abuse (%) | 10.9 | 16.6[a] |
| Obesity (%) | 12.6 | 20.8[a] |
| COPD (%) | 5.3 | 5.2 |
| Hypertension (%) | 62.9 | 67.1[a] |
| History of CAD (%) | 12.9 | 12.7 |
| History of CHF (%) | 0.02 | 0.28[a] |
| History of ESRD (%) | 0.23 | 3.52[a] |

SCIP, Surgical Care Improvement Project; COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease; CHF, congestive heart failure; ESRD, end stage renal disease.

[a] Indicates statistical significance ($P < .05$).

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