



Postoperative Tachycardia: Clinically Meaningful or Benign Consequence of Orthopedic Surgery?

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Abstract

Objective: To determine the clinical significance of tachycardia in the postoperative period.

Patients and Methods: Individuals 18 years or older undergoing hip and knee arthroplasty were included in the study. Two data sets were collected from different time periods: development data set from January 1, 2011, through December 31, 2011, and validation data set from December 1, 2012, through September 1, 2014. We used the development data set to identify the optimal definition of tachycardia with the strongest association with the vascular composite outcome (pulmonary embolism and myocardial necrosis and infarction). The predictive value of this definition was assessed in the validation data set for each outcome of interest, pulmonary embolism, myocardial necrosis and infarction, and infection using multiple logistic regression to control for known risk factors.

Results: In 1755 patients in the development data set, a maximum heart rate (HR) greater than 110 beats/min was found to be the best cutoff as a correlate of the composite vascular outcome. Of the 4621 patients who underwent arthroplasty in the validation data set, 40 (0.9%) had pulmonary embolism. The maximum HR greater than 110 beats/min had an odds ratio (OR) of 9.39 (95% CI, 4.67-18.87; sensitivity, 72.5%; specificity, 78.0%; positive predictive value, 2.8%; negative predictive value, 99.7%) for pulmonary embolism. Ninety-seven patients (2.1%) had myocardial necrosis (elevated troponin). The maximum HR greater than 110 beats/min had an OR of 4.71 (95% CI, 3.06-7.24; sensitivity, 47.4%; specificity, 78.1%; positive predictive value, 4.4%; negative predictive value, 98.6%) for this outcome. Thirteen (.3%) patients had myocardial infarction according to our predetermined definition, and the maximum HR greater than 110 beats/min had an OR of 1.72 (95% CI, 0.47-6.27).

Conclusion: Postoperative tachycardia within the first 4 days of surgery should not be dismissed as a postoperative variation in HR, but may precede clinically significant adverse outcomes.

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Postoperative tachycardia is a common and largely unexamined occurrence in patients undergoing orthopedic hip and knee surgery. Postoperative sinus tachycardia is often attributed to catecholamine release in response to surgical stress or anemia, and it is theorized that most patients recover without sequelae.¹⁻³ In an institutional algorithm developed by orthopedists, it is recommended that patients with tachycardia not receive any further work-up for pulmonary embolism (PE) unless that patient is hypoxic.⁴

Few investigations have been performed that examine tachycardia in the postoperative period and its relationship to adverse events. An analysis of patients in the Perioperative Ischemic Evaluation trial, who underwent

noncardiac surgery, provides the most data on the predictive value of tachycardia in the perioperative period. In that analysis, each 10-beats/min increase in prerandomization heart rate (HR) was associated with a 31.0% relative increase in the odds of perioperative myocardial infarction (MI). The predictive value of postoperative tachycardia, however, was not examined.⁵

There are additional studies that have looked at the relationship between tachycardia and other adverse outcomes of interest, but these investigations are limited in their generalizability. The RIETE study⁶ of 2858 patients with PE, including surgical patients, found that 19.4% of the study patients had HRs greater than 110 beats/min; however, the

timing of tachycardia and proportion of surgical patients were not specified. In addition, studies⁷⁻¹⁰ have identified increased rates of adverse events in noncardiothoracic surgery patients with postoperative supraventricular arrhythmia.

Pulmonary embolism is an outcome of interest in the postoperative orthopedic population and has been reported to occur at a rate of 2% to 20%.^{11,12} With respect to the association between tachycardia and PE, some guidance comes from the Wells¹³ and Geneva¹⁴ criteria developed for the management of PE. In the derivation of both guidelines, tachycardia was independently associated with the finding of a PE and is included in the final scoring criteria. Neither set of guidelines, however, specifically studied a surgical population, focusing instead on emergency room patients¹⁴ or a mix of inpatients and outpatients.¹³

Given the association between preoperative tachycardia and postoperative positive troponin and MI⁵ and the association of tachycardia with PE and MI in emergency and medical populations,^{14,15} we proposed that postoperative tachycardia in orthopedic surgery patients would likewise have an association with these adverse events. An optimal definition of tachycardia, independently associated with the events of interest, could function as a diagnostic test that helps clinicians determine which patients are at risk and tailor resource utilization appropriately. The primary objective of this study was to determine whether there is an HR above which a postoperative orthopedic surgery patient is at increased risk of PE, myocardial necrosis, MI, and/or infection.

PATIENTS AND METHODS

We performed this study using a retrospective cohort design comparing risk factors for outcomes of interest among patients 18 years or older undergoing hip and knee arthroplasty at the New York University Hospital for Joint Diseases, an orthopedic subspecialty hospital. We collected 2 data sets from different time periods: from January 1, 2011, through December 31, 2011, and from December 1, 2012, through September 1, 2014. Patients older than 18 years admitted for hip or knee arthroplasty were

included. We used the earlier time period to identify the best definition of tachycardia in terms of an association with a composite outcome of MI, PE, and positive troponin (the derivation data set). We used the second (validation) data set to explore the association between this definition of tachycardia and each component of the composite outcome using multiple logistic regression to control for known risk factors.

Patient information from 2011 and 2012 was obtained from the Integrated Clinical Information System, the electronic health record (EHR) used by our health system until December 2012, and patient information from December 2012 and beyond was derived from Epic, the EHR that replaced the Integrated Clinical Information System. Patients were identified by *International Classification of Diseases, Ninth Revision (ICD-9)* procedure codes for hip and knee arthroplasty. Demographic characteristics, vital signs data for the 4 immediate postoperative days, laboratory studies, imaging studies, and other diagnoses were collected.

Outcomes

The adverse outcome of interest for the development data set was a composite vascular outcome, combining patients with PE, patients with myonecrosis (positive troponin), and any additional patients coded with an MI. After assessing the derivation data set, we chose a composite outcome because of the low numbers of individual outcomes. Infection was not included in the composite because of a low number of events in this data set. Patients with MI were identified using *ICD-9* codes in this data set without manual chart review. For the validation data set, the outcomes we chose to evaluate an association with tachycardia were PE, myocardial necrosis (defined as positive troponin), MI, and infection (defined as urinary tract infection [UTI], surgical site infection [SSI], and pneumonia). Patients who had PE were identified in the data set by the presence of *ICD-9* code 415.1x. We also performed chart review of all ordered computed tomography scans of the chest with intravenous contrast to confirm that *ICD-9* coding of PEs was accurate in both study periods. We used our institution's laboratory cutoff of 0.04 ng/mL (to convert to

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