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The Spine Journal 14 (2014) 1247–1255

THE SPINE JOURNAL

Clinical Study

A predictive model of complications after spine surgery: the National Surgical Quality Improvement Program (NSQIP) 2005–2010

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Received 26 February 2013; revised 23 July 2013; accepted 20 August 2013

Abstract

BACKGROUND CONTEXT: There is increasing scrutiny by several regulatory bodies regarding the complications of spine surgery. Precise delineation of the risks contributing to those complications remains a topic of debate.

PURPOSE: We attempted to create a predictive model of complications in patients undergoing spine surgery.

STUDY DESIGN/SETTING: Retrospective cohort study.

PATIENT SAMPLE: A total of 13,660 patients registered in the American College of Surgeons National Quality Improvement Project (NSQIP) database.

OUTCOME MEASURES: Thirty-day postoperative risks of stroke, myocardial infarction, death, infection, urinary tract infection (UTI), deep vein thrombosis (DVT), pulmonary embolism (PE), and return to the operating room.

METHODS: We performed a retrospective cohort study involving patients who underwent spine surgery between 2005 and 2010 and were registered in NSQIP. A model for outcome prediction based on individual patient characteristics was developed.

RESULTS: Of the 13,660 patients, 2,719 underwent anterior approaches (19.9%), 565 corpectomies (4.1%), and 1,757 fusions (12.9%). The respective 30-day postoperative risks were 0.05% for stroke, 0.2% for MI, 0.25% for death, 0.3% for infection, 1.37% for UTI, 0.6% for DVT, 0.29% for PE, and 3.15% for return to the operating room. Multivariate analysis demonstrated that increasing age, more extensive operations (fusion, corpectomy), medical deconditioning (weight loss, dialysis, peripheral vascular disease, coronary artery disease, chronic obstructive pulmonary disease, diabetes), increasing body mass index, non-independent mobilization (preoperative neurologic deficit), and bleeding disorders were independently associated with a more than 3 days' length of stay. A validated model for outcome prediction based on individual patient characteristics was developed. The accuracy of the model was estimated by the area under the receiver operating characteristic curve, which was 0.95, 0.82, 0.87, 0.75, 0.74, 0.78, 0.76, 0.74, and 0.65 for postoperative risk of stroke, myocardial infarction, death, infection, DVT, PE, UTI, length of stay of 3 days or longer, and return to the operating room, respectively.

CONCLUSIONS: Our model can provide individualized estimates of the risks of postoperative complications based on preoperative conditions, and can potentially be used as an adjunct in decision-making for spine surgery. © 2014 Elsevier Inc. All rights reserved.

Keywords: Cervical spondylosis; Lumbar spondylosis; Anterior approach; Posterior approach; Corpectomy; Spinal fusion; Risk prediction; NSQIP

FDA device/drug status: Not applicable.

Author disclosures: ***KB:*** Nothing to disclose. ***AD:*** Nothing to disclose. ***SFB:*** Nothing to disclose. ***SM:*** Nothing to disclose.

KB and SM contributed equally to this work and are coprimary authors.

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http://dx.doi.org/10.1016/j.spinee.2013.08.009

EVIDENCE & METHODS

Context
Identification of risk factors for complications following spine surgery is prognostically important. The authors assessed risk factors using the NSQIP database.

Contribution
The group found that age, larger surgeries, significant medical problems, obesity, problems with mobility, and bleeding disorders are associated with increased risk of significant complications such as stroke, MI, death, infection, and PE.

Implications
The findings are commensurate with most surgeons' experience and the available literature. Assuming that the data within NSQIP is representative of the spine surgery population as a whole, the model provides some numbers regarding risk that might be used to better inform patients, hospitals and payers regarding potential complications.

—*The Editors*

Introduction

There is a national trend for accountable care and rationalization of the decision-making process in all areas of medicine [1]. The exponential increase in spinal procedures performed throughout the United States in the past 20 years [2] is making this field particularly attractive as a potential target for cost savings [1]. The parallel trend for negative financial incentivization of complications is necessitating the benchmarking of spine surgery outcomes and the identification of modifiable patient-level risk factors for complications [1]. Although several risks of the procedures are recognized by practicing surgeons, the justification of the decision-making process on individual patient characteristics is frequently arbitrary.

There have been several studies attempting to identify such modifiable risk factors. Most of these have been retrospective analyses of single-institution experiences [3–9], demonstrating results with limited generalization given their inherent selection bias. The interpretation of other multicenter studies [10–13] is equally limited given their focus on regional or subgroup data and administrative registries. The latter has been heavily criticized [14] for not been independently validated and underreporting patient comorbidities and procedural complications.

These limitations are largely addressed by the American College of Surgeons' National Quality Improvement Program (NSQIP) database, which contains prospectively collected data from more than 180 private and academic hospitals across the country. It allows for the unrestricted study of the patient population in question, through high-quality and reliable data sets [15]. Using this database, preoperative comorbidities associated with postoperative stroke, myocardial infarction (MI), death, wound infection, urinary tract infection (UTI), deep vein thrombosis (DVT), pulmonary embolism (PE), prolonged length of stay, and return to the operating room in patients undergoing spine surgeries were identified. Based on these data, a risk factor–based predictive model for negative outcomes in spine surgery was developed.

Methods

NSQIP database

All patients undergoing spine surgeries in the American College of Surgeons (ACS) NSQIP database between 2005 and 2010 were included in the analysis. ACS-NSQIP is a prospective database with more than 180 academic and private centers participating. The ACS-NSQIP prospectively collects data on more than 200 variables pertaining to patient characteristics, comorbid conditions, operative details, and 30-day postoperative outcomes for a variety of surgical procedures. The latest interrater reliability audit for participating sites has revealed an overall disagreement rate of 1.99%. More information about ACS-NSQIP is available at http://www.acsnsqip.org.

Cohort definition

To establish the cohort of patients, we used Current Procedural Terminology codes (Supplemental Material) to identify patients in the registry who underwent surgery of the spine between 2005 and 2010. To ascertain whether certain, more complex procedures affected the likelihood of complications, patients with codes for anterior surgery, corpectomy, and fusion were noted and the presence of this was included as a baseline variable (Fig. 1).

Variables

The primary outcome variable was the 30-day postoperative risks of stroke, MI, death, UTI, DVT, PE, deep surgical site infection, return to the operating room, and length of stay ≥3 days for patients registered in NSQIP-ACS undergoing spine surgeries. The effect on the outcomes of the pertinent exposure variables was examined in a multivariate analysis. The variables were continuous for age and body mass index (BMI). Gender, diabetes mellitus (DM), smoking, alcohol consumption, chronic obstructive pulmonary disease (COPD), hypertension, peripheral vascular disease, dialysis, heart disease, altered mental status at presentation, preoperative neurologic deficit, bleeding disorder, weight loss, fusion, corpectomy, and anterior approach were categorical variables.

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