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The Spine Journal 14 (2014) 291–299

THE SPINE JOURNAL

2013 Outstanding Paper Runner-up

Predicting medical complications after spine surgery: a validated model using a prospective surgical registry

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Received 1 February 2013; accepted 21 October 2013

Abstract

BACKGROUND CONTEXT: The possibility and likelihood of a postoperative medical complication after spine surgery undoubtedly play a major role in the decision making of the surgeon and patient alike. Although prior study has determined relative risk and odds ratio values to quantify risk factors, these values may be difficult to translate to the patient during counseling of surgical options. Ideally, a model that predicts absolute risk of medical complication, rather than relative risk or odds ratio values, would greatly enhance the discussion of safety of spine surgery. To date, there is no risk stratification model that specifically predicts the risk of medical complication.

PURPOSE: The purpose of this study was to create and validate a predictive model for the risk of medical complication during and after spine surgery.

STUDY DESIGN/SETTING: Statistical analysis using a prospective surgical spine registry that recorded extensive demographic, surgical, and complication data. Outcomes examined are medical complications that were specifically defined a priori. This analysis is a continuation of statistical analysis of our previously published report.

METHODS: Using a prospectively collected surgical registry of more than 1,476 patients with extensive demographic, comorbidity, surgical, and complication detail recorded for 2 years after surgery, we previously identified several risk factor for medical complications. Using the beta coefficients from those log binomial regression analyses, we created a model to predict the occurrence of medical complication after spine surgery. We split our data into two subsets for internal and cross-validation of our model. We created two predictive models: one predicting the occurrence of any medical complication and the other predicting the occurrence of a major medical complication.

RESULTS: The final predictive model for any medical complications had a receiver operator curve characteristic of 0.76, considered to be a fair measure. The final predictive model for any major medical complications had receiver operator curve characteristic of 0.81, considered to be a good measure. The final model has been uploaded for use on SpineSage.com.

CONCLUSION: We present a validated model for predicting medical complications after spine surgery. The value in this model is that it gives the user an absolute percent likelihood of complication after spine surgery based on the patient's comorbidity profile and invasiveness of surgery. Patients are far more likely to understand an absolute percentage, rather than relative risk and confidence interval values. A model such as this is of paramount importance in counseling patients and enhancing the safety of spine surgery. In addition, a tool such as this can be of great use particularly

FDA device/drug status: Not applicable.

Author disclosures: ***MJL:*** Consulting: Stryker Spine-for work not related to the manuscript (C), AO Spine-Faculty (B); Endowments: Synthesis Spine (F, Paid directly to the institution); Fellowship Support: AOSpine (F, paid directly to the institution). ***AMC:*** Endowments: Synthes Spine (F, Paid directly to the institution). ***DH:*** Endowments: Synthes Spine as the Entity (F). ***JRC:*** Consulting: Synthes USA (B); Speaking and/or Teaching Arrangements: AO Spine (B), Synthes (B); Board of Directors: AOSpine North America (B per year), AOSpine Foundation (B); Endowments: Hans Joerg Wyss Foundation (Total endowment I, Paid directly to the institution); Grants: Medtronic (Fellowship support), Alseres Pharmaceuticals (Research support); Fellowship Support: AOSpine North America (Fellowship E, Paid directly to the institution).

The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

Supported in part by the Spine End-Results Research Fund at the University of Washington Medical Center through a gift from Synthes Spine (Paoli, PA).

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http://dx.doi.org/10.1016/j.spinee.2013.10.043

as health care trends toward pay-for-performance, quality metrics, and risk adjustment. To facilitate the use of this model, we have created a website (SpineSage.com) where users can enter in patient data to determine likelihood of medical complications after spine surgery.

Keywords: Predictive model; Medical complications; Spine surgery; Multivariate analysis; Adverse event; Spinesage.com

Introduction

The possibility and likelihood of a postoperative medical complication after spine surgery undoubtedly play a major role in the decision making of the surgeon and patient alike. High-risk patients are frequently evaluated preoperatively by medical providers for risk stratification and health optimization before undergoing extensive spinal surgery. In the course of preoperative risk assessment, tools such as the widely utilized Revised Cardiac Index can be used to predict the likelihood of cardiac complication [1–3]. To date, there is no risk stratification tool specific to spine surgery.

Previously, we reported risk factors for complication after spine surgery utilizing the Spine End Result Registry (SERR) [4–8]. This registry is a prospectively collected registry for all surgical spine patients at University of Washington and Harborview Medical Center who underwent surgery from January 1, 2003, to December 31, 2004. Medical complications were defined explicitly a priori and extensive demographic, comorbidity, and surgical details were prospectively recorded for each surgical patient for at least 2 years after their surgery. From this registry, we performed multivariate analysis of risk factors for medical complications after spine surgery. We reported risk factor and confidence interval (CI) values for multiple significant risk factors for medical complications after spine surgery. These efforts represent the first step in the analysis of the data to derive a predictive model for medical complication after spine surgery. The purpose of this study was to derive and validate a predictive model for medical complication after spine surgery using the prospectively collected data from the SERR.

Methods

Patient population

This is a retrospective analysis of a prospective cohort of patients who participated in a SERR or a quality assurance/quality improvement database for the purpose of defining and assessing safety and outcomes for any patient undergoing spine surgery at one of two academic institutions. All patients were recruited to participate in the SERR to assess adverse events and provide outcome data, if patients declined to participate in the registry (N=745/1,476; 50.5%) they were followed in the quality assurance/quality improvement study and only their adverse events were tracked. However, some information about their risk factors, such as smoking status and alcohol use, are missing. The data for this group's adverse events were found either by notification of hospital staff or record review of only the adverse event and no other comorbidity or previous risk factor assessment. Those patients in the ''missing'' group can be attributed to those patients who only participated in the quality assurance/quality improvement arm of the study.

Exclusions

There were 1,745 patients enrolled in the study from January 1, 2003, to December 31, 2004. Of those, 269 were excluded because of a missing exposure status (N=16/113; 14%) or exposure status equal to zero (N=97/113; 86%), or because they were younger than 18 years of age (N=38/269; 25%), or because they were diagnosed with a neoplasm (N=118/269; 44%). Exposure status equal to zero included those who did not have surgical intervention, including cast and halo placement and thoracolumbarsacral orthosis (Fig. 1). Patients with a neoplastic diagnosis were excluded from this analysis because it was discovered in the validation model that those with a neoplasm had an inverse relationship with adverse events. It was found that those patients with a neoplasm (primary diagnosis or metastatic disease to the spine) were less likely to have any adverse event, which is opposite the finding in the univariate analysis. Because the intent of this prediction model is to provide predicted probabilities of any adverse event after general spine surgery, we felt it prudent to drop this complicated, neoplastic patient group from this data model. It is our impression that most general practice spine surgery centers refer patients with neoplasms to the spine or metastatic spine disease to tertiary academic institutions or cancer centers for treatment.

Data collection

Classification of predictors, confounders and outcomes

The definition for each adverse occurrence can be found in the attached Appendix 1. Risk factors examined included age, gender, smoking status, alcohol use, diabetes, body mass index, insurance status, surgical approach (posterior, anterior, combined), revision surgery, surgery region (cervical, thoracic, lumbosacral), diagnosis (degenerative, trauma, neoplasm, infection, other), and surgical invasiveness. In addition, the influence of preexisting medical comorbidity (cardiac disease, congestive heart failure [CHF], chronic obstructive pulmonary disease (COPD), hypertension (HYTN), rheumatoid arthritis, renal disease, liver disease, cancer, anemia, bleeding disorder) were also be considered as predictor variables.