Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Predictors of readmission in nonagenarians: analysis of the American College of Surgeons National Surgical Quality Improvement Project dataset

Zachary Hothem, DO,[a,*] *Dustin Baker, MD,*[a] *Christina S. Jenkins, MD,*[a] *Jason Douglas, MD,*[a] *Rose E. Callahan, MS,*[a] *Catherine C. Shuell, RN,*[b] *Graham W. Long, MD,*[a] *and Robert J. Welsh, MD*[a]

[a] *Department of Surgery, Beaumont Health, Royal Oak, Michigan*
[b] *Department of Quality, Safety, Standards and Outcomes, Beaumont Health, Royal Oak, Michigan*

ARTICLE INFO

Article history:
Received 29 August 2016
Received in revised form
5 January 2017
Accepted 16 February 2017
Available online 24 February 2017

Keywords:
Nonagenarian
Nonagenarian readmission
NSQIP
Readmission rate

ABSTRACT

Background: Increased longevity has led to more nonagenarians undergoing elective surgery. Development of predictive models for hospital readmission may identify patients who benefit from preoperative optimization and postoperative transition of care intervention. Our goal was to identify significant predictors of 30-d readmission in nonagenarians undergoing elective surgery.

Methods: Nonagenarians undergoing elective surgery from January 2011 to December 2012 were identified using the American College of Surgeons National Surgical Quality Improvement Project participant use data files. This population was randomly divided into a 70% derivation cohort for model development and 30% validation cohort. Using multivariate step-down regression, predictive models were developed for 30-d readmission.

Results: Of 7092 nonagenarians undergoing elective surgery, 798 (11.3%) were readmitted within 30 d. Factors significant in univariate analysis were used to develop predictive models for 30-d readmissions. Diabetes (odds ratio [OR]: 1.51, 95% confidence interval [CI]: 1.24-1.84), dialysis dependence (OR: 2.97, CI: 1.77-4.99), functional status (OR: 1.52, CI: 1.29-1.79), American Society of Anesthesiologists class II or higher (American Society of Anesthesiologist physical status classification system; OR: 1.80, CI: 1.42-2.28), operative time (OR: 1.05, CI: 1.02-1.08), myocardial infarction (OR: 5.17, CI: 3.38-7.90), organ space surgical site infection (OR: 8.63, CI: 4.04-18.4), wound disruption (OR: 14.3, CI: 4.80-42.9), pneumonia (OR: 8.59, CI: 6.17-12.0), urinary tract infection (OR: 3.88, CI: 3.02-4.99), stroke (OR: 6.37, CI: 3.47-11.7), deep venous thrombosis (OR: 5.96, CI: 3.70-9.60), pulmonary embolism (OR: 20.3, CI: 9.7-42.5), and sepsis (OR: 13.1, CI: 8.57-20.1), septic shock (OR: 43.8, CI: 18.2-105.0), were included in the final model. This model had a c-statistic of 0.73, indicating a fair association of predicted probabilities with observed outcomes. However, when applied to the validation cohort, the c-statistic dropped to 0.69, and six variables lost significance.

Conclusions: A reliable predictive model for readmission in nonagenarians undergoing elective surgery remains elusive. Investigation into other determinants of surgical

* *Corresponding author*. Department of Surgery, Beaumont Health, 3601 W. 13 Mile Rd, Royal Oak, MI 48073. Tel.: +1 248 898 5000; fax: +1 248 551 2947.

E-mail address: zachary.hothem@beaumont.edu (Z. Hothem).

http://dx.doi.org/10.1016/j.jss.2017.02.019

outcomes, including social factors and access to skilled home care, might improve model predictability, identify areas for intervention to prevent readmission, and improve quality of care.

Introduction

Section 3025 of the Affordable Care Act established the Hospital Readmissions Reduction Program, which uses the comparison of observed to expected 30-d hospital readmission as a surrogate for quality of patient care. In 2012, Medicare began decreasing reimbursement payments to hospitals with above-average risk-adjusted readmission rates.[1] These reimbursement penalties were applied when patients were readmitted after admissions for congestive heart failure, acute myocardial infarction, or pneumonia within 30 d of discharge.[2] These reductions in reimbursement have inspired many quality improvement measures specifically related to these diagnoses.

Similar changes in reimbursement policy by Medicare were extended in 2015 to surgical patients undergoing elective total hip or total knee arthroplasty who are readmitted within 30 d of surgery. Extrapolating these patterns further, it seems reasonable to conclude that these reimbursement criteria will be extended to encompass many, if not all, elective surgical patients with Medicare coverage in the near future.

Moreover, in addition to the financial implications, unplanned readmission after surgery decreases patients' quality of life and places them at higher risk for additional hospital-acquired infections and occurrences.[3] Surgeons are responsible for selecting appropriate patients for surgery and for the stewardship of available resources. Identifying patients at high risk for readmission and implementing perioperative interventions to reduce these occurrences are an integral part of that stewardship.

Risk prediction models like the American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) risk calculator predict the risk of postoperative complications and mortality. However, risk calculators specific to 30-d readmission generally focus on medical patients, not surgical patients,[2] and have only moderate predictive abilities at best.[1,3] In addition, surgical risk calculators have been designed for specific surgical procedures or very broad groups like "all general surgical patients," but not for specific high risk groups, such as the very elderly. In regards to the elderly, there are conflicting reports on whether age is an independent predictor of readmission postsurgery or if frailty and/or other measures should be used instead.[4-6]

Objectives

Our primary objective was to identify significant predictors of 30-d readmission in nonagenarians (patients aged ≥90 y) undergoing elective surgery, and secondarily to use these factors to develop and validate a model for predicting 30-d readmission in this group.

Methods

This was a retrospective review of prospectively collected data from the ACS-NSQIP participant use data files (PUF) which was undertaken after approval from the institutional review board. This database collects information in a standardized format from surgical patients from member hospitals for quality improvement purposes. The data include patient demographics, surgical indications, 30-d outcomes, preoperative risk factors, and details regarding their procedures.[1] All nonagenarians undergoing elective surgery between January 2011 and December 2012 at NSQIP-participating hospitals were included in the study. Readmission rates were examined in selected patients as defined by ACS-NSQIP which includes both planned and unplanned readmissions within 30 d of surgery. We excluded patients undergoing emergency procedures and those who had in-hospital death or an operation to discharge time greater than 14 d (insufficient time to capture readmissions within 30 d of surgery). We also excluded patients transferred to a different acute care hospital because their readmission data were not available. Preoperative comorbidities, operative details, 30-d postoperative occurrences, mortality, and readmission data were collected for analysis. Readmission rates were stratified by subspecialty and discharge destination. In total, 7092 (N) patients met the inclusion criteria. Of these, 798 were readmitted within 30 d of surgery, with 6294 not being readmitted based on the ACS-NSQIP database.

Univariate analysis was performed using Chi square and Fisher exact tests to determine significant differences between the readmission and no-readmission cohorts. We randomly selected 70% ($n = 4549$) of the readmission cohort and 70% of the no-readmission cohort for the derivation group. The remaining 30% ($n = 2087$) in each cohort were part of the validation group for predictive model creation.

Multivariate step-down logistic regression was performed on the variables found to be significant in univariate analysis to determine independent predictors of readmission. All significant factors after multivariate regression were used to develop readmission prediction models. Two-way interactions between significant variables were examined and included in the prediction model if found to be significant. Each model was applied to the validation cohort to test model reliability. The c-statistic, or concordance statistic, was used to assess the models "goodness of fit" which corresponds to the area under the receiver–operator curve which ranges from 0.5 to 1, with a value of ≥0.7 indicative of a good model, 0.8 indicating a strong model, and 0.5 being equivalent to chance and a value <0.5 indicating a very weak model. A value of 0.7 was used as a cutoff for demonstrating a significant predictive model. A P value cutoff of 0.05 was used to define statistical significance. All statistical analysis was performed using SAS statistical software (SAS for Windows 9.3; SAS Institute, Cary, NC).