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Original Contribution

Predicting patients requiring discharge to post-acute care facilities following primary total hip replacement: Does anesthesia type play a role?

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ABSTRACT

Study objective: We sought to develop a predictive model for discharge to post-acute care facilities in patients undergoing unilateral total hip replacement (THR). Furthermore, we sought to determine if the use of neuraxial anesthesia was an important covariate for the predictive model.
Design: Retrospective observational study.
Setting: Preoperative care and operating room at a single institution.
Patients: Patients (n = 960) who underwent an elective primary THR between 2014 and 2016.
Interventions: No intervention was performed.
Measurements: We collected variables that were known preoperatively including age, sex, body mass index (BMI), preoperative opioid use, functional status based on metabolic equivalents (METS), preoperative anemia, thrombocytopenia, osteoarthritis and contralateral osteoarthritis grade, anesthesia type, comorbidities and surgical approach. We then performed multivariable logistic regression to develop a predictive model.
Main results: Female sex, preoperative opioid use, older age, general anesthesia, anemia, hypertension, a psychiatric diagnosis, use of dialysis, metabolic equivalents < 4 and obesity are all risk factors for a post-acute facility discharge. The use of general anesthesia compared to neuraxial anesthesia was associated with increased odds (odds ratio 1.98, 95% confidence interval 1.31–3.00, p = 0.001) for post-acute facility discharge. Model performance was assessed using ten-fold cross-validation - the average area under the receiver operating characteristic curve calculated was 0.794.
Conclusions: We developed a predictive model for post-acute care facility discharge following THR. The use of neuraxial anesthesia was associated with decreased odds for post-acute care facility discharge.

1. Introduction

The U.S. performs over 300,000 total hip replacements (THR) annually, with that number increasing each year as our aging and arthritic populations are burgeoning [1]. Joint replacements are on track to becoming the most commonly performed elective surgery [2]. Due to the prevalence of THR, reductions in direct and indirect costs associated with the operation can have a significant impact on healthcare costs. Post discharge costs play a large role in total costs with skilled nursing home or acute rehabilitation center admissions contributing to over 30% of the total costs [3,4].

One study found that 30% of patients receiving a THR were discharged to post-acute care facilities; that number was closer to 60% when looking at patients who suffered a hip fracture [5,6]. In previous retrospective studies, higher risk patient populations tended to be older, female, have a higher American Society of Anesthesiologists Physical Status (ASA) score, have poor preoperative functional status, have poor home care and have surgery emergently [5,7,8].

Our primary objective was to create a predictive model for discharge location (home versus post-acute care facility) using logistic regression. We focused on both non-modifiable and modifiable variables that may be determined prior to surgery. The model can also help better predict hospital bed and post-acute care facility capacity, and potentially be used to prevent bed shortages for postoperative admissions.

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2. Materials and methods

2.1. Patients

Data were manually collected retrospectively from the electronic medical record system at the University of California, San Diego (UCSD) Healthcare Systems. The resulting dataset remained de-identified and did not contain sensitive patient-health information as defined by the UCSD Human Research Protections Program and, therefore, was exempt from the informed consent requirement by our Institutional Review Board.

We performed a retrospective analysis, looking at patients that received a unilateral primary elective THR between January 2014 and December 2016. Our primary outcome measure was discharge location: home versus post-acute care facility (i.e. skilled nursing facility). Patients were discharged to a post-acute care facility if they did not meet criteria from a physical therapy standpoint to be able to be discharged home safely with home health care. We excluded all patients that were not undergoing their surgery electively, such as those with traumatic fractures. No patients in the study sample received a peripheral nerve block (i.e. femoral nerve block, lumbar plexus block) for postoperative analgesia. We collected variables that were known preoperatively including age (categorized into age ≥ 65 years old versus not), sex, body mass index (BMI) (categorized into BMI ≥ 30 kg/m^2 versus not), preoperative opioid use (i.e. any amount of opioid use prior to surgery), functional status based on metabolic equivalents (METS), preoperative anemia (categorized into hematocrit < 39% for males or < 36% for females), thrombocytopenia (categorized into those with platelets < 150,000 versus not), osteoarthritis and contralateral osteoarthritis grade, anesthesia type (general anesthesia versus neuraxial anesthesia), and surgical approach (posterior, anterior, anterolateral). Neuraxial anesthesia included spinal, epidural, or combined spinal-epidural anesthesia. We also collected comorbidity data via manual chart abstraction including: coronary artery disease (CAD), congestive heart failure (CHF), hypertension (HTN), diabetes mellitus (DM), chronic kidney disease (CKD), patients undergoing dialysis, chronic obstructive pulmonary disease (COPD), asthma, obstructive sleep apnea (OSA), and psychiatric history (including depression, anxiety, and bipolar disease).

2.2. Statistical analysis

R, a software environment for statistical computing (R version 3.3.2), was used to perform all statistical analysis. The study population was divided into two cohorts (those who were discharged home versus those discharged to a post-acute care facility). Covariates were compared between both cohorts, in which Pearson chi-square test was utilized to calculate statistically significant differences between categorical variables. Initially, a univariable logistic regression model was performed to assess the association of each covariate with the response variable. Variables were selected for the initial model building if they met a significance level of $p < 0.2$ from the univariable analysis. A multivariable logistic regression was then built using a combination of forward selection and backwards elimination based on the Akaike Information Criterion (AIC). We only included covariates in the final model with a $p < 0.05$. Odds ratios (OR) and their associated 95% confidence interval (CI) were reported for each covariate in the final regression model. Model performance was evaluated with area under the receiver operating characteristic curve (AUC) for discrimination and the Hosmer-Lemeshow (HL) test for goodness-of-fit. An AUC of 1.0 represents perfect discrimination, whereas an AUC of 0.5 represents no discrimination [9]. Calibration curves were also developed to examine the fit of the model. The predicted risk was plotted against the observed risk for each of the 10 risk percentiles created from the dataset. Calibration was evaluated with the HL goodness-of-fit test with χ^2 test using deciles of predicted risk. We then calculated performance with k-folds cross-validation (k = 10) and calculated the average AUC and HL-test p-value. The entire study population was divided into 10 equal parts. The final model was built on a training set (9 parts) and the AUC and HL-test p-value was calculated on the validation set (10th part). Ten iterations were performed until all parts were used as a validation set.

3. Results

There were 1018 patients that received an elective unilateral primary THR between 2014 and 16. Fifty-eight patients were removed due to missing data for the covariates; therefore 960 patients were included in the final analysis. Fig. 1 illustrates the inclusion and exclusion criteria of the study. There were 162 (17.4%) patients discharged to a post-acute care facility. The average hospital length of stay was 3.08 days (standard deviation = 1.35 days). For patients that did not require post-acute care facility discharge, their average hospital length of stay was 2.81 days (standard deviation = 1.91 days). For patients requiring post-acute care facility discharge, their average hospital length of stay was 4.38 days (standard deviation = 3.14 days). The demographics of both cohorts (home discharge versus post-acute care facility discharge) are displayed in Table 1. Supplementary Table 1 lists the frequency of general anesthesia and post-acute care facility discharge based on the three surgeons included in this analysis (surgical approach was unique to each surgeon). The reasons for having a hospital length of stay longer than expected (3 days at our institution) were due to waiting for post-acute care facility placement (23.2%), inadequate pain control (16.5%), pending physical therapy goals (36.0%), acute blood loss anemia (2.6%), social issues (5.6%), other medical complications/needs (11.2%), and unknown (19.9%) (of note, some patients may have multiple reasons).

A univariable logistic regression was performed on each covariate to determine its association with discharge location (Table 2). Covariates retained in the final multivariable logistic regression are listed in Table 3. Ten covariates were included in the final model (sex, age, hypertension, use of dialysis, METS < 4, anemia, psychiatric diagnosis, obesity, preoperative opioid use, and anesthesia type). General anesthesia (versus neuraxial anesthesia) was associated with increased odds for discharge to a post-acute care facility (OR 1.98, 95% CI 1.31–3.00, p = 0.001). Three of the variables were non-modifiable: age, gender and use of dialysis. The use of dialysis had the greatest odds (OR 14.62, 95% CI 2.69–79.60, p = 0.001) for requiring post-acute care facility discharge. The AUC of the final model applied to the entire sample set was 0.806 (95% CI 0.771–0.841) (Fig. 2A). A calibration curve was also developed, which demonstrated adequate goodness-of-

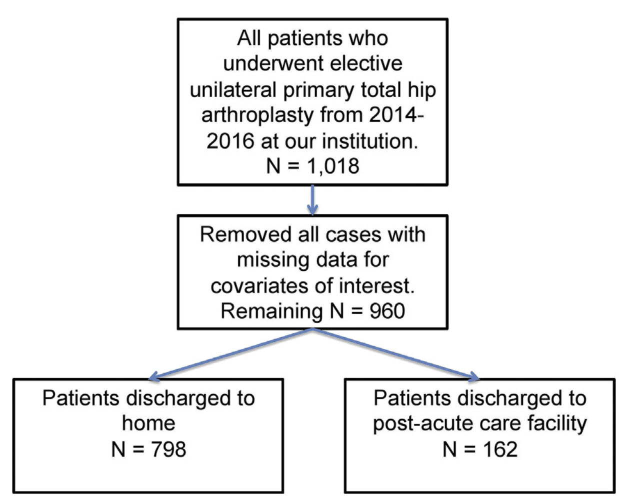

Fig. 1. Inclusion and exclusion methodology.