BJA

British Journal of Anaesthesia, 118 (4): 544–50 (2017)

doi: 10.1093/bja/aex025
Clinical Practice

Objective model using only gender, age and medication list predicts in-hospital morbidity after elective surgery

J. D. Blitz[1,*], K. S. Mackersey[1,2], J. C. Miller[3,4] and S. M. Kendale[1]

[1]Department of Anesthesiology, Perioperative Care and Pain Medicine, New York University School of Medicine, 550 1st Avenue, TH 552, New York, NY 10016, USA, [2]Department of Anesthesiology, New York Presbyterian Hospital, New York, NY, USA, [3]New York University School of Medicine, New York, NY, USA and [4]Department of Anesthesiology, Icahn School of Medicine at Mount Sinai, New York, NY, USA

*Corresponding author. E-mail: jeanna.viola@nyumc.org

Abstract

Background. Most current surgical risk models contain many variables: some of which may be esoteric, require a physician's assessment or must be obtained intraoperatively. Early preoperative risk stratification is essential to identify high risk, elective surgical patients for medical optimization and care coordination across the perioperative period. We sought to create a simple, patient-driven scoring system using: gender, age and list of medications to predict in-hospital postoperative morbidity. We hypothesized that certain medications would elevate risk, as indices of underlying conditions.

Methods. Two Logistic regression models were created based on patient's gender, age, and medications: GAMMA (Gender, age and type of medications to predict in-hospital morbidity) and GAMMA-N (Gender, age and number of medications to predict in-hospital morbidity). A logistic regression models predicting in-hospital morbidity based on ASA score alone was also created (ASA-M). The predictive performance of these models was tested in a large surgical patient database.

Results. Our GAMMA model predicts postoperative morbidity after perioperative care with high accuracy (c-statistic 0.819, Brier score 0.034). This result is similar to a model using only the ASA score (c-statistic 0.827, Brier score 0.033) and better than our GAMMA-N model (c-statistic 0.795, Brier score 0.050).

Conclusions. The combination of a patient's gender, age, and medication list provided reliable prediction of postoperative morbidity. Our model has the added benefit of increased objectivity, can be conducted preoperatively, and is amenable to patient-use as it requires only limited medical knowledge.

Key words: logistic models; morbidity; perioperative period; risk

Perioperative physicians, including anaesthetists and surgeons, recognize the need for an objective, customized risk-evaluation tool[1–6] for planning elective surgery. Such a tool allows both the patient and physician to appreciate the potential risks of surgery and anaesthesia, aid informed consent and potentially improve safety by early identification of patients at high risk for adverse outcomes.[1–4 7–11] Most current surgical risk models are driven by input that requires physician assessment, contain many variables, contain esoteric variables, or include variables obtained intraoperatively.[1 2 12–16] We aimed to create an objective predictor of in-hospital postoperative morbidity that was simple to use preoperatively and amenable to inclusion in a patient-driven risk model. We utilized data that is available to most patients: gender, age, and list of medications; avoiding the need to access complex diagnoses or laboratory results.

Editorial decision: December 5, 2016; **Accepted:** January 13, 2017

Editors key points:

- Preoperative risk stratification can be used to plan and optimize perioperative care.
- The authors created simple models based on routinely collected patient characteristics data.
- The ability of these models to predict postoperative morbidity were tested using a large surgical patient database.
- A model comprising age, gender and medication list predicted outcome with high accuracy.

We hypothesized that a patient's gender and age, combined with medication list, could provide information about postoperative morbidity. Furthermore, we hypothesized that certain medications would elevate risk, as indices of underlying conditions. Lastly, we sought to simplify the scoring system by testing the hypothesis that the number of medications, combined with gender and age, could predict in-hospital postoperative morbidity.

Methods

Design and ethical considerations

Institutional review board approval was obtained and signed patient consent was waived because no care interventions were mandated and all protected health information was deidentified.

This was a retrospective database study of 26629 adult surgical encounters at a single centre, over a two yr period. Of these encounters, 22108 (83.02%) were separate patients and 4521 (16.98%) included >one surgery on the same patient. All-comers on an administrative database for adult (>18 yr) surgery (including cardiac and elective obstetric) between the dates of June 2011 and July 2013 were included. Anaesthesia techniques included general, neuraxial, regional or monitored anaesthesia care. The database was newly available since the institution of electronic medical records (Clarity, EPIC Systems, Verona, WI) and specifically allowed access to new ICD-9 codes that the patient did not have on admission. ASA scores, as determined by the originally assigned anaesthetist, were extracted from this database. The database allowed analysis of specific postoperative complications: atrial fibrillation, pulmonary embolism, myocardial infarction, venous thromboembolism, congestive heart failure, respiratory failure and acute kidney injury. The morbidity outcome was in-hospital morbidity, the presence of any one of these postoperative complications while hospitalized for the surgical admission. As a result of administrative ICD-9 coding limitations, certain important complications were unavailable for analysis: haemorrhage, sepsis, and cardiac arrest. A secondary, expanded database was formed that included 46 selected medications (Supplementary Appendix 1), and the presence or absence of that medication in each patient's record – medications were those already prescribed to a patient upon admission (taken from a list available in the preoperative admission area) and do not reflect restraints of the hospital formulary.

Setting

The hospital is a large, quaternary-care academic urban institution in New York City. The facility includes a large in-patient location and several off-site ambulatory locations – representative of the increasing role of anaesthesia in the ambulatory surgery setting.[17–19] The study population is representative of patients with a moderate to high level of access to USA healthcare, undergoing elective surgery at an urban, academic institution.

Inclusion and exclusion criteria

Within the database of 26629 adult patient encounters exclusions were made as follows for models for prediction of morbidity: emergency surgery, ASA score unavailable on computer record.

Statistical analysis and modeling

Logistic regression using age, gender, and medications as the independent variables were used to develop a predictive model for in-hospital postoperative morbidity based on the database (Gender-Age-Medications Morbidity Assessment: GAMMA).

An additional model was created that attempted to predict in-hospital morbidity using ASA score as the independent variable (ASA Morbidity: ASA-M). As both age and number of medications are important known risk predictors,[17 20] model (GAMMA-Number modification: GAMMA-N) attempted to predict morbidity solely on gender, age and the number of medications the patient was taking. In-hospital morbidity included occurrence of any of the following complications: atrial fibrillation, pulmonary embolism, myocardial infarction, venous thromboembolism, or acute kidney injury. Medications were encoded as a binary variable that indicated whether it was or was not prescribed to the patient.

Binary logistic regression analyses were used for binary outcome models. These models were assessed for discrimination and explanatory power by area under the receiving operator characteristic curve (c- statistic). Calibration was assessed using Brier score[21] and χ^2 likelihood ratio was determined for model significance. The c-statistic is useful for discrimination of binary outcome variables (patient did/did not have chosen diagnosis) but does not include an internal measure of accuracy. A c-statistic value greater than 0.8 typically indicates a strong model. By comparison, the Brier score is calculated by comparing actual events with predicted probabilities and may be superior for evaluation of a risk model's predictive power, a Brier score close to 0 suggests an accurate prediction.[2 21–23]

The models were developed using the full dataset (as opposed to the relatively inefficient use of separate training and validation sets) to maximize efficient use of data, and were further validated using k-fold cross-validation with 10 folds to assess prediction error and overfitting. Subsequent validation was performed on a database including data from the entire yr of 2014. All statistical operations were performed using R Statistical Software (version 3.1.1, R Foundation for Statistical Computing, Vienna, Austria).

Results

From the complete adult database, 82708 elective encounters remained for morbidity modeling purposes after exclusion (Fig. 1).

ASA scores as determined by the anaesthetist responsible for each patient, surgical services, and frequency of adverse events for both the derivation and validation datasets are listed in Table 1. Table 2 shows frequency of adverse event separated by ASA score.