Multivariable Predictors of Postoperative Respiratory Failure after General and Vascular Surgery: Results from the Patient Safety in Surgery Study

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BACKGROUND: Postoperative respiratory failure (RF) is associated with an increase in hospital morbidity, mortality, cost, and late mortality. We developed and tested a model to predict the risk of postoperative RF in patients undergoing major vascular and general surgical operations. This model is an extension of an earlier model that was derived and tested exclusively from a population of male patients from the Veterans Affairs National Surgical Quality Improvement Program.

METHODS: Patients undergoing vascular and general surgical procedures at 14 academic and 128 Veterans Affairs Medical Centers from October 2001 through September 2004 were used to develop and test a predictive model of postoperative RF using logistic regression analyses. RF was defined as postoperative mechanical ventilation for longer than 48 hours or unanticipated reintubation.

RESULTS: Of 180,359 patients, 5,389 (3.0%) experienced postoperative RF. Twenty-eight variables were found to be independently associated with RF. Current procedural terminology group, patients with a higher American Society of Anesthesiologists classification, emergency operations, more complex operation (work relative value units), preoperative sepsis, and elevated creatinine were more likely to experience RF. Older patients, male patients, smokers, and those with a history of congestive heart failure or COPD, or both, were also predisposed. The model's discrimination (c-statistic) was excellent, with no decrement from development (0.856) to validation (0.863) samples.

CONCLUSIONS: This model updates a previously validated one and is more broadly applicable. Its use to predict postoperative RF risk enables the study of preventative measures or preoperative risk adjustment and intervention to improve outcomes. (J Am Coll Surg 2007;204:1188–1198. © 2007 by the American College of Surgeons)

Respiratory failure (RF) after major operations occurs frequently and with serious consequences for hospital morbidity, mortality, and cost.[1-5] Beyond its early impact on perioperative outcomes, postoperative RF has also been associated with decreased longterm survival.[5] In 2000, Arozullah and colleagues[3] published the experience of the Department of Veterans Affairs (VA) National Surgical Quality Improvement Program (NSQIP) with respiratory failure after major noncardiac operations. Postoperative respiratory failure was defined as

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Abbreviations and Acronyms

ASA = American Society of Anesthesiologists
CHF = congestive heart failure
CPT = current procedural terminology
NSQIP = National Surgical Quality Improvement Program
PSS = Patient Safety in Surgery
RF = respiratory failure
RRI = respiratory risk index
RVU = relative value unit
VA = Veterans Affairs

mechanical ventilation for longer than 48 hours or unplanned reintubation.[3] The generalizability of that predictive model can be limited, because it was derived from a VA-based population exclusive of female patients. The experience presented here updates the earlier study by combining a contemporary experience of both the VA sector and 14 private-sector academic centers that participated in the Patient Safety in Surgery (PSS) Study. The PSS Study was a collaborative effort between the VA-NSQIP and the American College of Surgeons. Funded by the Agency for Healthcare Research and Quality, it explored the applicability of the VA-NSQIP to the private sector. From this updated risk model, a respiratory failure risk index (RRI) is developed and validated for broad application to patients undergoing general and vascular surgery procedures.

METHODS

This study, which was based on data collected during a 3-year period from 128 VA hospitals and 14 private-sector academic institutions, used the methods of the NSQIP and the PSS Study, which have been described in detail in other publications.[6-10] A brief description of the pertinent methodology is provided here.

Patient population

Patients from 128 VA medical centers and 14 private-sector hospitals who underwent major general or vascular procedures from fiscal years 2002 through 2004 were assessed as part of this study. Major operations as defined by the NSQIP included operations using general, spinal, or epidural anesthesia. Patients having carotid endarterectomy are included regardless of anesthetic type. A list of types of operations included in the study and their current procedural terminology (CPT) codes is shown in Table 1. Exclusions include those patients undergoing operations in the previous 30-day period, vascular patients having catheter-based operations outside the operating room, and selected CPT codes with known low postoperative mortality and morbidity. Transplantation procedures have also been excluded because they are performed rarely in the VA system. Certain very common operations, such as inguinal hernia repairs, breast lumpectomies, and transurethral resection of the prostate or bladder tumors, are limited to the first 5 consecutive cases in each 8-day cycle. For hospitals that perform more than 140 eligible operations per month, the operations included in the NSQIP are sampled as follows. The first 40 operations in each 8-day cycle are included, with each cycle beginning on a different day of the week. The VA-NSQIP includes nine surgical subspecialties: general, vascular, cardiac, noncardiac thoracic, orthopaedics, urological, otolaryngology, neurosurgery, and plastic surgery. The PSS study has been limited to general and vascular surgery, and the VA sample for this study was accordingly limited.

Variable selection

The preoperative, operative, and postoperative variables available for analysis were described previously.[3] Because the intention of the NSQIP was to cover all major operations performed in a VA surgical service, the variables chosen were generic and not disease-specific or operation-specific. They were selected on the basis of clinical relevance, reliability of data collection, and availability and ease of data collection. Preoperative variables include demographics; some lifestyle variables; functional status; American Society of Anesthesiologists (ASA) classification; selected laboratory tests; and selected pulmonary, cardiac, hepatobiliary, renal, vascular, central nervous system, nutritional, and immunologic comorbidities. Operative data included CPT codes for the principal operation and any secondary operations, emergency status, wound classification, anesthesia method, operative times, blood loss, and blood transfused. Outcomes variables included 30-day mortality from any cause inside or outside the hospital; length of stay; return to the operating room; and 19 different postoperative complications, including respiratory failure, occurring in the 30-day postoperative period.

Data-collection protocol

A surgical clinical nurse reviewer is assigned at each medical center to collect the NSQIP data. The nurses receive in-depth training on study protocol, patient selection,