Journal of Clinical Anesthesia 39 (2017) 122–127

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

Original Contribution

Preoperative risk stratification of critically ill patients☆

Curtis C. Copeland, MD [a,b,c,*], Andrew Young, MD [c], Tristan Grogan, MS [c], Eilon Gabel, MD [c], Anahat Dhillon, MD [c], Vadim Gudzenko, MD [c]

[a] U.S. Air Force School of Aerospace Medicine, Center for the Sustainment of Trauma and Readiness Skills, Baltimore, United States
[b] University of Maryland School of Medicine, Department of Anesthesiology, R Adams Cowley Shock Trauma Center, US Air Force C-STARS Baltimore, 22 S. Greene Street, T4M14, Baltimore, MD 21201, United States
[c] David Geffen School of Medicine, Ronald Reagan Medical Center, UCLA, 757 Westwood Plz. Suite 3325, Los Angeles, CA 90095, United States

ARTICLE INFO

Article history:
Received 2 November 2016
Received in revised form 7 March 2017
Accepted 31 March 2017
Available online xxxx

Keywords:
Risk assessment
Organ dysfunction scores
Critical care outcomes
Postoperative complications

ABSTRACT

Study objective: Risk assessment historically emphasized cardiac morbidity and mortality in elective, outpatient, non-cardiac surgery. However, critically ill patients increasingly present for therapeutic interventions. Our study investigated the relationship of American Society of Anesthesiologists (ASA) class, revised cardiac risk index (RCRI), and sequential organ failure assessment (SOFA) score with survival to discharge in critically ill patients with respiratory failure.
Design: Retrospective cohort analysis over a 21-month period.
Setting: Five adult intensive care units (ICUs) at a single tertiary medical center.
Patients: Three hundred fifty ICU patients in respiratory failure, who underwent 501 procedures with general anesthesia.
Measurements: Demographic, clinical, and surgical variables were collected from the pre-anesthesia evaluation forms and preoperative ICU charts. The primary outcome was survival to discharge.
Main results: Ninety-six patients (27%) did not survive to discharge. There were significant differences between survivors and non-survivors for ASA (3.7 vs. 3.9, $p = 0.001$), RCRI (1.6 vs. 2.0, $p = 0.003$), and SOFA score (8.1 vs. 11.2, $p < 0.001$). Based on the area under the receiver operating characteristic curve for these relationships, there was only modest discrimination between the groups, ranging from the most useful SOFA (0.68) to less useful RCRI (0.60) and ASA (0.59).
Conclusions: This single center retrospective study quantified a high perioperative risk for critically ill patients with advanced airways: one in four did not survive to discharge. Preoperative ASA score, RCRI, and SOFA score only partially delineated survivors and non-survivors. Given the existing limitations, future research may identify assessment tools more relevant to discriminating survival outcomes for critically ill patients in the perioperative environment.

Published by Elsevier Inc.

1. Introduction

The practice and role of an anesthesiologist continue to evolve in the changing landscape of medicine. However, preoperative risk assessment for perioperative complications including but not limited to mortality remains a cornerstone of practice. The American Society of Anesthesiologists (ASA) classification [1] has become a gold standard and proven to correlate well with a variety of outcomes, including intraoperative blood loss [2], duration of postoperative ventilation [2,3], intensive care unit (ICU) length of stay [2,3], and mortality [2,4]. In addition to mortality, cardiovascular-related morbidity in patients undergoing non-cardiac surgery has been emphasized, leading to development of the Goldman cardiac risk index (1977) and subsequent revised cardiac risk index (1999). These predictive tools aid in decision making in regard to further testing or intervention prior to surgery [5].

As surgeries and procedures have become less invasive, our practice has changed to include an increasing number of critically ill patients undergoing a variety of procedures. Critically ill patients are at increased risk for major morbidity and mortality, even when compared to high-risk surgical patients [6–8]. Intensive care practitioners may use the sequential organ failure assessment (SOFA) to grade acuity and predict mortality; however, the SOFA score's association with postoperative mortality in ICU patients has not been well studied [9,10]. It may become more readily available for preoperative assessment given the recent inclusion of the SOFA score in sepsis definitions [11].

☆ The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Air Force, the Department of Defense, or the U.S. Government.

* Corresponding author at: USAF C-STARS Baltimore, R Adams Cowley Shock Trauma Center, 22 S. Greene Street, T4M14, Baltimore, MD 21201, United States.
E-mail address: curtiscopeland@gmail.com (C.C. Copeland).

http://dx.doi.org/10.1016/j.jclinane.2017.03.044
0952-8180/Published by Elsevier Inc.

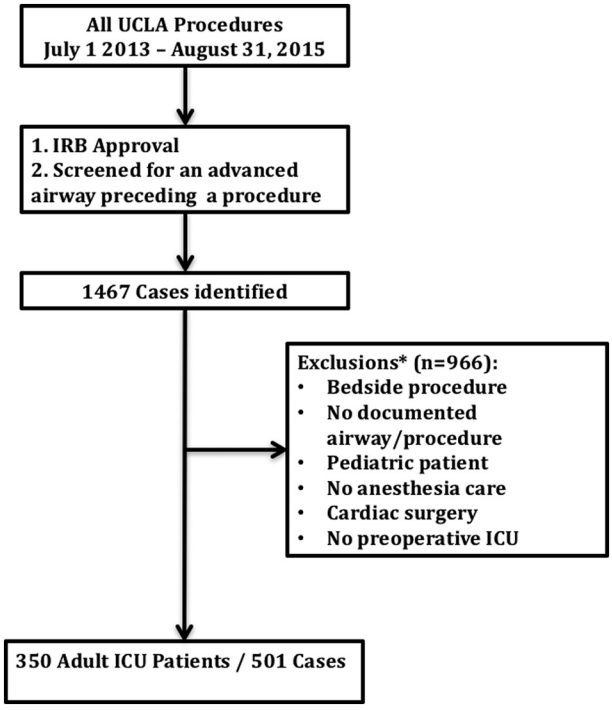

Fig. 1. Methodology. (*Not mutually exclusive).

The overlap between intensive care and anesthesia is increasing with movement of patients across these venues. Anesthesiologists recognize the importance of targeting preoperative evaluation to ICU patients and perceive that perioperative risk could be mitigated by reviewing information such as mechanical ventilation settings, intravascular access, and antimicrobial therapy [12]. Each area has its set of validated risk assessment tools; however, it is not clear what the value of these tools is in the perioperative assessment of critically ill patients. Therefore, we hypothesized there was a significant relationship between preoperative ASA class, revised cardiac risk index (RCRI), and SOFA score with postoperative survival to discharge in critically ill patients with respiratory failure.

2. Materials and methods

After institutional review board approval, all available medical records at a single tertiary medical center were retrospectively screened over a 21-month time period. Informed written consent of subjects has been waived by the institutional review board. Electronic medical record analysts conducted an automated initial screening for respiratory failure, a universal indicator for ICU admission, by identifying patients who underwent a surgical or interventional procedure with a preexisting advanced airway (endotracheal tube or tracheostomy).

A total of 1467 cases met the inclusion criteria. Of these, 966 were excluded for the following reasons: bedside procedures (e.g., bronchoscopy), no documented advanced airway or procedure, pediatric patients, no anesthesia care, cardiac surgery, and non-ICU preoperative disposition. For patients undergoing multiple procedures meeting the eligibility criteria, only the first case was included in the analysis, while the total number of eligible procedures was tallied and analyzed as an additional variable ("Number of Procedures"). Ultimately, the study population consisted of 350 adult ICU patients who underwent 501 procedures between July 1, 2013, and August 31, 2015 (Fig. 1). All study patients were mechanically ventilated in an intensive care unit preoperatively. The study time period started four months after institutional conversion to an electronic medical record and concluded when all of the authors agreed 350 patients would be sufficient for the exploratory nature of the investigation.

Demographic, surgical, and clinical variables were collected for each patient from the electronic pre-anesthetic evaluation form and ICU chart. Age, gender, and body mass index (BMI) served as baseline variables. Surgical information included procedure location (operating room, interventional cardiology, interventional radiology, or gastroenterology suite), preoperative critical care unit, surgical service, procedure, and surgical risk per the RCRI. The preoperative critical care units included medical, surgical, cardiothoracic surgical, and coronary care services, as well as liver failure (pre- and post-transplant) and neuroscience (stroke, traumatic brain injury, neurosurgery, seizures, etc.) units. The ASA class was taken directly from the associated preoperative anesthetic assessment.

In the same manner, comorbidities for the revised cardiac risk index were obtained exclusively from the preoperative anesthetic record, which included both relevant history entered by the anesthesia provider as well as an automated problem list. In addition to surgical risk (low or high), RCRI includes a history of stroke, coronary artery disease, congestive heart failure, renal dysfunction and insulin dependent diabetes. Since creatinine is a more reliable indicator of renal function in a steady state, any reference to renal insufficiency, renal failure, or dialysis in the ICU was considered a positive RCRI score. Similarly, a reference to diabetes or insulin drip was counted in the RCRI under the assumption that the patient would be receiving insulin preoperatively in the ICU for glycemic control.

While both the ASA class and RCRI were derived from the preoperative assessment, the components of the SOFA score were gathered by reviewing the archived comprehensive ICU chart for 24 h preoperatively. The SOFA score is the sum of assessments of organ dysfunction in neurologic, cardiovascular, pulmonary, hepatic, renal, and hematologic systems, assigning a range of 0 for normal organ function to 4 for organ failure [9]. By using the lowest values identified by chart review, the total score and components were determined according to the table in the original article by Vincent and colleagues [9]. For missing arterial oxygen tension to inspired oxygen concentration values in patients without a preoperative arterial blood gas, the ratio of pulse oxygen saturation to inspired oxygen concentration was substituted

Table 1
Sample characteristics.

Variable	Average (SD) or frequency (%) for			*p*-Value
	Overall cohort ($n = 350$)	Survived to discharge ($n = 254$)	Did not survive to discharge ($n = 96$)	
Age	55 (18)	54 (19)	58 (16)	0.091
Male	228 (65.1%)	175 (68.9%)	53 (55.2%)	0.016
BMI	27.4 (6.8)	27.1 (6.0)	28.3 (8.4)	0.170
Emergent	130 (37.1%)	83 (32.7%)	47 (49.0%)	0.005
Number of procedures	1.43 (0.99)	1.39 (0.98)	1.54 (1.00)	0.081
Procedure location				<0.001
Catheterization lab	20 (5.7%)	9 (3.5%)	11 (11.5%)	
Interventional radiology	30 (8.6%)	15 (5.9%)	15 (15.6%)	
Gastroenterology suite	9 (2.6%)	4 (1.6%)	5 (5.2%)	
Operating room	291 (83.1%)	226 (89.0%)	65 (67.7%)	
Surgical/interventional service				<0.001
Cardiology	21 (6.0%)	10 (3.9%)	11 (11.5%)	
Otolaryngology	42 (12.0%)	36 (14.2%)	6 (6.3%)	
Gastroenterology	8 (2.3%)	3 (1.2%)	5 (5.2%)	
General Surgery	100 (28.6%)	64 (25.2%)	36 (37.5%)	
Liver transplant-related surgery	45 (12.9%	38 (15.0%)	7 (7.3%)	
Interventional Radiology	30 (8.6%)	15 (5.9%)	15 (15.6%)	
Neurosurgery	56 (16.0%)	48 (18.9%)	8 (8.3%)	
Gynecology	2 (0.6%)	2 (0.8%)	0	
Orthopedics	19 (5.4%)	18 (7.1%)	1 (1.0%)	
Other[a]	11 (3.1%)	9 (3.5%)	2 (2.1%)	
Thoracic	9 (2.6%)	6 (2.4%)	3 (3.1%)	
Urology	7 (2.0%)	5 (2.0%)	2 (2.1%)	

BMI = body mass index; SD = standard deviation.
[a] Radiation oncology, plastics, oral maxillofacial, unknown.