



Care of Acute and Critically Ill Adults

Association of severity of illness and intensive care unit readmission: A systematic review



Evan G. Wong, MD, MPH^{a,b,*}, Ann M. Parker, MD^c, Doris G. Leung, MD^{d,e},
Emily P. Brigham, MD^c, Alicia I. Arbaje, MD, MPH^f

^a Department of Surgery, McGill University, Montreal, Quebec, Canada

^b Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

^c Division of Pulmonary and Critical Care Medicine, Department of Medicine, School of Medicine, Johns Hopkins University, Baltimore, MD, USA

^d The Hugo W. Moser Research Institute, Kennedy Krieger Institute, Baltimore, MD, USA

^e Department of Neurology, School of Medicine, Johns Hopkins University, Baltimore, MD, USA

^f Division of Geriatric Medicine and Gerontology, Department of Medicine, School of Medicine, Johns Hopkins University, Baltimore, MD, USA

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ABSTRACT

Objectives: To determine whether ICU readmission is associated with higher severity of illness scores in adult patients.

Background: Readmissions to the intensive care unit (ICU) are associated with increased costs, morbidity, and mortality.

Methods: We performed searches of MEDLINE, EMBASE, and grey literature databases. We selected studies reporting data from adults who were hospitalized in an ICU, received severity of illness scores, and were discharged from the ICU. Characteristics of readmitted and non-readmitted patients were examined.

Results: We screened 4766 publications and included 31 studies in our analysis. In most studies, severity of illness scores were higher in patients readmitted to the ICU. Readmission was also associated with higher mortality and longer ICU and hospital stays. Excessive heterogeneity precluded the reporting of results in the form of a meta-analysis.

Conclusions: ICU readmission is associated with higher severity of illness scores during the same hospitalization in adult patients.

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Introduction

Readmission to the intensive care unit (ICU) is a frequent adverse outcome in the critically ill population.¹ Approximately 10% of patients discharged from the ICU require readmission during the same hospital stay.² Readmission exposes patients to increased risks, as transfers between health care professionals have been linked to an increased rate of adverse events, higher mortality, and longer hospital stays.^{2–5} Furthermore, the financial impact of ICU care is considerable, as up to 30% of total hospital costs and 1% of

the US gross national product are directly linked to ICU expenses.⁶ The management of critically ill patients therefore pose significant challenges to health care systems seeking to improve quality and reduce unplanned health care utilization.^{7,8}

Given the sizeable proportion of health care resources dedicated to critical care, reductions in ICU readmission rates could be an indicator of improved hospital performance.^{9,10} An important first step in reducing the number of ICU readmissions is identifying patients who are most likely to be readmitted. Therefore, there is substantial interest in examining risk factors associated with ICU readmission.

A 2009 systematic review and meta-analysis suggested that the Acute Physiology and Chronic Health (APACHE) score and the Simplified Acute Physiology Score (SAPS) may be useful in predicting ICU readmission. Both of these severity of illness scoring systems are routinely used in ICUs to predict mortality risk.^{11–13} Prediction models for ICU readmission that incorporate severity of illness scores have been proposed, but are not routinely used in

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* Corresponding author. Department of Surgery, McGill University Health Centre, 1650 Cedar Avenue, L9 411, Montreal, QC, Canada, H3G 1A4. Tel.: +1 514 934 1934; fax: +1 514 843 1503.

E-mail address: evan.wong@mail.mcgill.ca (E.G. Wong).

clinical practice.^{14–17} The prospect of predicting ICU readmission risk using only APACHE or SAPS scores is an attractive one, as implementation of these systems would not require additional ICU resources.

Since the publication of the prior review, the delivery of health care services in the US has been changing to adjust to Affordable Care Act (ACA) priorities. Adopted by the US Congress in 2010, the primary aim of the ACA is to increase affordability of health insurance to Americans. The ACA has also introduced programs through which payment for health care services are linked to quality of care. ACA programs provide incentives for hospitals to improve value by reducing complicated care transitions and unplanned health care utilization, including hospital and ICU readmissions. This has led to an increased number of studies focusing on quality of care and predictors of readmission. Furthermore, novel interventions, such as critical care transition programs, may lower discharge thresholds and modify readmission rates.¹⁸ The objective of this systematic review is to evaluate whether readmission to the ICU during the same hospitalization remains associated with the most commonly used severity of illness scores (APACHE and SAPS) in adult patients.

Methods

Data sources

Our analysis was performed in accordance with methodology described in the Cochrane Handbook for Systematic Reviews of Interventions.¹⁹ We searched the MEDLINE and EMBASE databases for literature published from inception to February 3 2014. Our search strategy included a combination of controlled vocabulary (MeSH and Emtree) and free-text keywords. Searches were developed in consultation with information specialists from the Johns Hopkins Welch Medical Library. We selected search terms related to three concepts: intensive care; severity of illness; and ICU readmission. We did not restrict the searches with regards to language, study type, or publication year. The full search strategy is presented in [Supplementary Data Table 1](#). We searched the reference lists from our included articles to identify any additional relevant citations and completed forward citation searching through Web of Science. Using an abbreviated search strategy, we identified potentially relevant unpublished studies from the following databases: the NIH clinical trials registry (www.clinicaltrials.gov), WHO International Clinical Trials Registry Platform, Cochrane Register of Controlled Trials (CENTRAL), OpenSIGLE (System for Information on Grey Literature in Europe) and the New York Academy of Medicine Grey Literature Report and Database. We also searched conference proceedings of the American Thoracic Society and the European Respiratory Society.

Study selection

All titles and abstracts were randomly assigned to be independently screened by two of five investigators (EGW, AMP, DGL, EPB and AIA). Observational studies (prospective or retrospective cohort studies, and case–control studies) that collected severity of illness measures and ICU readmission data were included in our systematic review. Abstracts as well as full-length publications were included in order to minimize potential publication bias. Reviews, case reports, randomized-controlled trials (RCTs), editorials, and case series were excluded. Studies were subsequently excluded during the selection process if they: 1) did not study adult ICU patients (≥ 18 years of age, predefined as “adults” by the manuscript authors, or admitted to an adult ICU); 2) did not categorize patients based on readmission status; 3) did not report a

severity of illness score (SAPS, APACHE); 4) were not in English, Spanish, or French (languages spoken by the investigators); or 5) were not observational studies. The full texts of all studies selected based on titles and abstracts were also reviewed by two independent investigators, and the same exclusion criteria were applied. Any disagreements regarding inclusion of a specific article were adjudicated by discussion among investigators.

Data extraction and risk of bias assessment

Studies selected for analysis were randomly distributed across the five-investigator group. Data was independently extracted from each study by two investigators and subsequently verified between the dyad. Any discrepancies were resolved through discussion. Study design, participant, exposure, and outcome information was collected and entered into an electronic database. Risk of bias assessments were performed using the Newcastle-Ottawa Scale (NOS) for Assessing the Quality of Nonrandomized Studies in Meta-Analysis.²⁰ Two investigators independently assessed each study for the following characteristics that would increase the risk of bias: selection of study subjects; comparability of exposure groups; and measurement of the exposure or outcome. Potential reporting and publication biases were examined graphically with a funnel plot.

Data synthesis and analysis

Our primary measure of association was the standardized mean difference (SMD) in severity of illness scores between readmitted and non-readmitted patients. This measure was selected so that different severity of illness indices could be compared. If studies reported both APACHE and SAPS scores, we used the APACHE scores in our combined analysis because this measure was the most frequently reported. When both ICU admission and discharge scores were available, admission scores were used to maximize comparability with the other included studies. For studies reporting severity of illness scores as medians and interquartile ranges (IQR), a normal distribution was assumed: medians were substituted for the mean, and IQRs were converted to standard deviations as recommended by the Cochrane Handbook.¹⁹ Secondary outcomes included ICU length of stay (LOS), hospital LOS, and in-hospital mortality.

We assessed the degree of clinical heterogeneity between studies by comparing multiple types of study characteristics: study participants; type of ICU; type of severity of illness score; and timing of severity of illness measurement. In addition, we evaluated methodological heterogeneity by comparing study designs and risk of bias assessments. Forest plots were generated using Stata 12/IC software (StataCorp LP, College Station, TX) to assess for heterogeneity between studies. Poor overlap of the confidence intervals of SMD's would suggest significant heterogeneity. Quantitative assessment for heterogeneity was performed by calculating I^2 statistics. We considered an I^2 value above 50% as evidence of significant heterogeneity. We also calculated chi-squared statistics (Cochran's Q test) to assess for heterogeneity, with a p -value < 0.05 suggesting significant heterogeneity.

Subgroup analyses were performed for the following pre-specified groups: type of severity score used (APACHE vs. SAPS); version of score used (APACHE I-IV, SAPS I-III); time of severity score assessment (ICU admission vs. ICU discharge); type of ICU (medical vs. surgical vs. mixed); risk of bias (low, moderate, high); type of study design (case–control vs. cohort); and continent in which the study was performed. We conducted sensitivity analyses to determine the impact of excluding studies with higher risk of bias, or studies reported in the grey literature. We also performed a sensitivity analysis to determine the impact of excluding studies

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