MAYO CLINIC

ORIGINAL ARTICLE

Adverse In-Hospital Events Are Associated With Increased In-Hospital Mortality and Length of Stay in Patients With or at Risk of Acute Respiratory Distress Syndrome

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Abstract

Objective: To explore the effect of various adverse hospital events on short- and long-term outcomes in a cohort of acutely ill hospitalized patients.

Patients and Methods: In a secondary analysis of a retrospective cohort of acutely ill hospitalized patients with sepsis, shock, or pneumonia or undergoing high-risk surgery who were at risk for or had developed acute respiratory distress syndrome between 2001 and 2010, the effects of potentially preventable hospital exposures and adverse events (AEs) on in-hospital and intensive care unit (ICU) mortality, length of stay, and long-term survival were analyzed. Adverse effects chosen for inclusion were inadequate empiric antimicrobial coverage, hospital-acquired aspiration, medical or surgical misadventure, inappropriate blood product transfusion, and injurious tidal volume while on mechanical ventilation.

Results: In 828 patients analyzed, the distribution of 0, 1, 2, and 3 or more cumulative AEs was 521 (63%), 126 (15%), 135 (16%), and 46 (6%) patients, respectively. The adjusted odds ratios (95% CI) for in-hospital mortality in patients who had 1, 2, and 3 or more AEs were 0.9 (0.5-1.7), 0.9 (0.5-1.6), and 1.4 (0.6-3.3), respectively. One AE increased the length of stay, difference between means (95% CI), in the hospital by 8.7 (3.8-13.7) days and in the ICU by 2.4 (0.6-4.2) days.

Conclusion: Potentially preventable hospital exposure to AEs is associated with prolonged ICU and hospital lengths of stay. Implementation of effective patient safety interventions is of utmost priority in acute care hospitals.

 ■ Mayo Clin Proc. 2015;90(3):321-328

Acute care hospitals, and intensive care units (ICUs) in particular, have a complex working environment that raises the probability of a high rate of adverse events (AEs). Medical errors and exposure to AEs, many of which may be preventable, can increase morbidity, mortality, and costs.[1-5]

Among the tenets emphasized in the landmark report from the Institute of Medicine "To Err Is Human"[1,6] is that "health care should be safe." It proposed that "all health professionals should be educated to deliver patient centered care as members of an interdisciplinary team, emphasizing evidence-based practice, quality improvement approaches and informatics."[7] Studies have found that adults in the United States receive slightly more than half of the recommended care,[8] and that beneficial interventions are given to low- and moderate-risk patients, often missing those at the highest risk of preventable events.[9]

Errors and AEs may precipitate patient admission to the ICU.[10,11] Adverse events known to be associated with increased patient morbidity include inadequate empiric antimicrobial coverage, inappropriate blood product transfusion, and medical or surgical misadventure.[12-15] As patient acuity and case complexity increase, the risk of AE exposure also increases.[5,16-19]

We have recently reported that specific, potentially preventable, hospital AEs pose a risk of the development of acute respiratory distress syndrome (ARDS), but the effect of these

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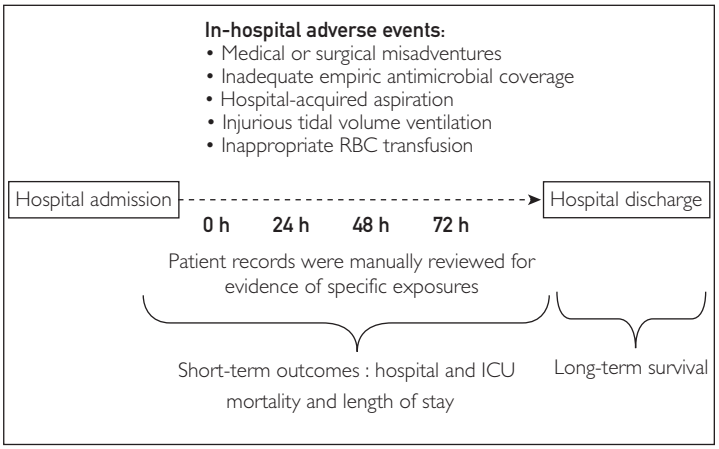

FIGURE 1. Study procedure. ICU = intensive care unit; RBC = red blood cell.

AEs on patients' outcomes is not known.[20] The aim of this study was to determine the effect of various potentially preventable hospital AEs on both short-term outcomes (in-hospital and ICU mortality and hospital and ICU lengths of stay) and long-term outcomes (survival) in hospitalized patients with or at high risk of ARDS. The choice of AEs was driven by a previous study that demonstrated their association with in-hospital development of ARDS.[20]

PATIENTS AND METHODS

This study was approved by the Mayo Clinic institutional review board, and all patients provided consent for the use of their medical records for research. In a secondary analysis of a population-based cohort spanning 10 years (2001-2010), we analyzed potentially preventable hospital AEs. The study methodology has been previously described.[20,21] In brief, eligible patients included adult residents of Olmsted County, Minnesota, admitted to Mayo Clinic hospitals in Rochester, Minnesota, between January 2001 and December 2010. From these patients, those who did not have ARDS on admission but subsequently developed ARDS were identified using a previously validated electronic surveillance tool and subsequent medical record review.[22] Patients with ARDS were matched with similar-risk patients without ARDS on the basis of age (±15 years), sex, surgery type (emergency vs elective), sepsis (yes/no), oxygen saturation/fraction of inspired oxygen ratio (±25 points), and Lung Injury Prediction Score (±1 point).[23] Trained study coordinators, masked to ARDS status and in-hospital mortality, determined the presence of hospital AEs through a detailed review of the electronic health record and paper charts. Hospital AEs occurring only in a specific time range were counted (Figure 1). The first admission of each patient in the study period was the admission of interest. Patients who were admitted for comfort care only, who died within 24 hours of admission, or who declined the use of their medical records for research were excluded. Screening to ascertain the cohort was conducted retrospectively from January 1, 2001, through October 31, 2008, and prospectively from November 1, 2008, through December 31, 2010.

For each patient in the cohort (both with and without ARDS), the occurrence of a prespecified group of hospital AEs was determined, along with the timing and intensity of any occurrences. Hospital AEs occurring only up to 6 hours before the development of ARDS (in cases) and during the corresponding at-risk period (in controls) were counted. This was performed by a detailed electronic medical record review of the patients' entire clinical course (including evaluation of monitoring data and review of nursing and physician documentation) by trained data abstractors (Figure 1). Standardized electronic data collection forms with embedded value range checks were used for all collected variables. The AEs studied were inadequate empiric antimicrobial coverage, hospital-acquired aspiration, medical or surgical misadventure, inappropriate blood product transfusion, and injurious tidal volume (TV) while on mechanical ventilation.

Inadequate empiric antimicrobial coverage was defined according to the work of Kumar et al[24] by both time of administration and antimicrobial use inconsistent "with broadly accepted norms for empiric management of the typical pathogens for the clinical syndrome (in the context of host immune/health status, environmental factors, and local flora)." Hospital-acquired aspiration was defined by medical personnel documentation of directly witnessed aspiration or the suctioning of gastric contents from the endotracheal tube.[25] Medical or surgical misadventures were defined according to standard definitions and were identified by using

Mayo Clin Proc. ■ March 2015;90(3):321-328 ■ http://dx.doi.org/10.1016/j.mayocp.2014.12.015
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