

Administration of Emergency Medicine



EMERGENCY DEPARTMENT CROWDING IN RELATION TO IN-HOSPITAL ADVERSE MEDICAL EVENTS: A LARGE PROSPECTIVE OBSERVATIONAL COHORT STUDY

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Abstract—Background: Emergency department (ED) crowding has been linked with adverse medical events. However, this association was inadequately controlled for potential confounding variables. **Objectives:** To investigate whether ED crowding is independently associated with risk of in-hospital death and morbidity, and longer total hospital stay. **Methods:** Prospective observational cohort study of all patients (≥ 18 years) presenting to the ED of an academic teaching hospital in Leuven, Belgium from June 21, 2010 to July 20, 2012. Multivariate logistic regression and proportional hazard analysis was used to control for risk factors. ED occupancy was determined for 108,229 included patients and labeled “ED crowding” when occupancy was within the highest quartile of occupancy. **Outcomes within 10 days of ED admission** included in-hospital death, hospital-acquired morbidities, and total hospital stay. **Results:** During ED crowding, a median of 58 (interquartile range 55–63) patients were present for 40 licensed treatment bays. After controlling for all baseline risk factors and as compared with the lowest quartile of ED occupancy (30 [26–32] patients), ED crowding was not independently associated with mortality (odds ratio [OR] 0.94, 95% confidence interval [CI] 0.74–1.19; $p = 0.6$), but tended to be associated with higher incidence of hospital-acquired pneumonia (OR 1.24, 95% CI 0.96–1.62; $p = 0.09$). **Conclusions:** Failing to control for baseline risk factors may have led to false-positive associations between ED crowding and mortality in previous studies. After controlling for risk factors, we showed that ED crowding was associated with longer hospital stays but not with increased mortality. © 2015 Elsevier Inc.

Keywords—emergency department; crowding; adverse events; length of stay

INTRODUCTION

Since the 1999 report “To Err is Human” produced by the Institute of Medicine, the general public has been made aware that adverse events in medicine are one of the leading causes of morbidity and mortality in the United States (1). An adverse event is defined as an unintended injury caused by medical management rather than by a disease process and is an event that results in death, life-threatening illness, disability at time of discharge, admission to hospital, or prolongation of hospital stay (2). Examination of medical records is generally considered to be the gold standard for accurately monitoring adverse events (3).

Despite a growing patient-safety movement worldwide, health care has not become measurably safer (4,5). Health care is one of the few risk-prone social domains in which pressures of public demand irrationally limit the use of common sense and safety-enhancing solutions; for example, limiting the flow of and prioritizing incoming patients (6). The latter is especially true for emergency departments (EDs), because they deliver an important public service by providing emergency

care 24 h a day, 365 days a year, without discriminating against any particular social or economic status.

ED crowding is recognized as being a major, international problem that affects patients and providers (7). A recent report from the Institute of Medicine noted that the increasing strain caused by crowding is creating a deficit in quality emergency care (8). Indeed, crowding is reported to be linked with impaired or denied access to emergency medical services, higher patient mortality, and higher patient-care costs (9–17). Nevertheless, several unresolved, or unaddressed, issues remain with regard to the association between ED crowding and adverse events. First, existing evidence on adverse events is largely anecdotal and inconclusive (18). Second, many studies have failed to adequately disentangle the observed ED crowding-adverse events association from potential confounding variables that could be masking the true picture. One such confounding variable that has not been controlled for is severity of illness upon ED admission (14,15,19,20). Finally, explanations for the observed associations between ED crowding and adverse outcomes remain merely speculative (16,21,22).

We performed a large prospective observational study adequately powered to investigate whether ED crowding is independently associated with a higher incidence of adverse events, such as death and several morbidity outcomes, and whether it is associated with a longer duration of hospital stay. The specific hypothesis is whether the highest quartile of ED occupancy is associated with the studied adverse outcomes, once baseline risk factors are controlled for statistically.

MATERIALS AND METHODS

Design Overview

We performed a large prospective observational cohort study in a tertiary referral academic teaching hospital in Leuven, Belgium. The primary study objective was to determine whether ED crowding was independently associated with in-hospital death occurring within 10 days of ED admission. The secondary objective was to analyze whether ED crowding was independently associated with five morbidity events occurring in hospitalized adult patients during the first 10 days after ED admission or with the total duration of hospital stay.

Setting and Participants

We determined the number of participants we needed to achieve a statistical power of 90% and a certainty of 95%. Assuming an overall mortality rate of 1%, a cohort of 104,000 patients was required to identify an indepen-

dent, 20% increase in relative risk of death (hazard ratio [HR] of 1.2) during ED crowding. For adult patients admitted to hospital wards after ED admission, a mortality rate of 3% was assumed. Therefore, a cohort of 30,000 hospitalized patients was required to identify (same power) an independent 20% increase in relative risk of death during ED crowding in this subgroup.

Study population. The academic teaching hospital in Leuven has 1949 beds, with a mixed adult and pediatric population. The ED has an annual census of approximately 55,000 patients, with an average hospital admission rate of 36%. Thirteen percent of hospital admissions are patients younger than 18 years of age. The ED consists of 40 licensed treatment bays, consisting of an admission and treatment area with 15 cubicles, and a 25-bed observation ward. Of these, seven beds are equipped for intensive care and serve as a buffer zone for the intensive care unit in times of intensive care unit bed shortage. The ED is staffed by physicians and rotating residents from the departments of emergency medicine, internal medicine, pediatrics, trauma care, and psychiatry. Other specialties provide consultancy to the ED whenever required.

Treatment urgency and priority for patients presenting to the ED is determined according to the Emergency Severity Index, a five-level triage acuity tool; higher numbers indicate lower acuity (23).

All adult patients (≥ 18 years) presenting to the ED during the 2-year period from June 21, 2010 to July 20, 2012 were eligible for inclusion in the study.

Data collection. The ED occupancy rate was defined as the ratio of the total number of ED patients to the total number of licensed treatment bays per hour (24). Because the number of licensed treatment bays remained constant throughout the study, we used the raw number of ED patients to define crowding. The hospital administration computer system updated the total number of patients present at the ED every 10 min. For each of the included patients in the total cohort, the occupancy rate at the time of ED admission for that patient was calculated as the mean number of patients present at the ED in the epoch starting from 4 h prior to ED admission of that patient up to a maximum of 4 h after ED admission. The distribution of all individual mean ED occupancy rates was determined (Figure 1) and divided into four quartiles. The quartile with the highest occupancy (Q4) during the cohort period was considered as “ED crowding.” The least crowded quartile (Q1) was considered to be a reference value for the other quartiles (i.e., Q2 to Q4).

For all patients admitted to the ED during the 2-year study period, the following demographic characteristics and risk factors were prospectively collected from the

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