Increased ICU workload is not associated with increased inpatient mortality

Theodore J. Iwashyna, MD, PhD, (1) Andrew A. Kramer, PhD, (2) Jeremy M. Kahn, MD, MSc (1)

(1) Division of Pulmonary, Allergy and Critical Care Medicine, and Leonard Davis Institute of Health Economics, Hospital of the University of Pennsylvania, Philadelphia, PA. (2) Cerner Corporation, Kansas City, KS

Abstract

Rationale: Although ICUs with higher overall patient volume may achieve better outcomes, there are few data on the effects of increasing patient loads on patients within the ICU.

Methods: We examined 198,877 patients in 108 ICUs in 2002 - 2005 using conditional logistic regression with an ICU-specific fixed effect

Main Results: Patients admitted on high census days had the same odds of inpatient mortality or transfer to another hospital as patients admitted on average or on low census days.

Conclusions: The ICUs in this data set are able to function as high-reliability organizations.

Background

- There is increasing demand for the concentration of critical care services in a smaller number of hospitals due to (1) hospital closures; (2) payer-initiative to achieve economies of scale; and (3) policy decisions to implement regionalized care.
- Higher volume hospitals may be associated with improved patient outcomes for many critical care services.
- The impact of increasing patient volumes on ICU performance is unknown.
- In many other acute services, particularly emergency care, higher than typical workload is associated with worse patient outcomes.

Objective

Examine the effects of day-of-admission ICU occupancy on the mortality rate of patients admitted to that ICU, compared to other patients admitted to the same ICU.

Methods

Data sources and patients
- Hospitals participating in APACHE clinical information system from 1/1/2002 - 6/30/2005
- Exclusions:
  - CABG patients
  - ICUs with fewer than 100 patients
  - Initial 100 patients for each ICU in the dataset

Variables
- Exposure: Census of the ICU on day of admission, divided into deciles relative to the mean census of the ICU.
- Primary Outcome: Inpatient Mortality
- Secondary Outcome: ICU and hospital length of stay, rates of transfer to other hospitals

Statistical Analyses
- Patient-level analysis of the effect of census on outcome using conditional logistic regression with an ICU-specific fixed effect
- Risk adjustment using APACHE IV
  - Clinical variables, age, diagnostic category, and physiologic variables from the first 24 hours of the ICU admission

Results

- 196,877 patients were admitted to 108 ICUs in 46 hospitals
- Patients were admitted across a wide-range of ICU relative census, from <65% of mean census to >147% for that specific ICU.
- There was no significant relationship between day-of-admission census and inpatient mortality or discharge destination. (See Figure.)

Conclusions

- ICUs appear to function as high-reliability organizations, in the sense that they are able to maintain patient outcomes across a wide-range of operational conditions.
- Research is needed into the organizational characteristics of ICUs that allow them to function robustly -- the lack of high reliability organizations in health care is often noted and lamented.

Policy Implications

- Effective organizational structures appear able to buffer individuals from the effects of high workload, even in the medical setting
- Increasing workload in large ICUs as a result of regionalization or concentration of care may be safe for patients.

Sensitivity Tests. Our results were robust in a range of analyses, including:
- Alternative parameterizations of daily census, including 14-prior-day moving average
- In surgical and non-surgical patients
- In patients with >50% predicted inpatient mortality
- In ICUs of non-teaching, small teaching, and major teaching hospitals
- In patients admitted on weekends and weekdays