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Clinical Paper

The association between hospital type and mortality among critically ill children in US EDs☆

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ABSTRACT

Study aim: Little is known about the setting of care for critically ill children and whether differences in outcomes are related to the presenting hospital type. This study describes the characteristics of hospitals to which critically ill children present and explores the associations between hospital factors and mortality.
Methods: This is a retrospective cohort study using data from the 2007 Healthcare Cost and Utilization Project National Emergency Department Sample, representative of all US ED visits. Subjects include children aged 0–18 with ICD9 codes for cardiac arrest, respiratory arrest and/or respiratory failure. Predictor variables include: age, sex, presence of chronic illness, self-pay, public insurance, trauma diagnosis, major trauma center, urban hospital, ED volume and teaching hospital. Multivariate logistic regression estimates predictors of mortality. Analyses integrate clusters, strata, and weights from the probability sample.
Results: There were an estimated 29 million pediatric ED visits in 2007 including 42,036 (0.1%) visits for cardiac or respiratory failure. Teaching hospitals (OR 0.57, 95% CI 0.50–0.66), trauma centers (OR 0.76, 95% CI 0.67–0.86), and urban hospitals (OR 0.78, 95% CI 0.63–0.97) were associated with lower mortality odds. Presence of a chronic illness (OR 14.5, 95% CI 10.5–20.1), diagnosis of an injury (OR 1.2, 95% CI 1.1–1.4) and self-pay status (OR 3.6, 95% CI 2.9–4.4) were associated with increased mortality odds.
Conclusions: The majority of children with cardiac and respiratory arrest present to urban teaching hospitals and trauma centers. After accounting for important confounders, mortality is lower at teaching hospitals and/or major trauma centers.

1. Background

According to a report by the American Academy of Pediatrics (AAPs), fewer than 10% of EDs nationally have pediatric emergency departments or critical care services, however 76% admit children to their facilities and 25% of hospitals without trauma services admit critically injured children.[1] It has been reported that only 6% of EDs have the recommended necessary equipment to care for pediatric emergencies despite 59% of ED managers being aware of existence of guidelines for pediatric emergency equipment.[2]

There is some evidence to suggest that children with severe injuries have improved outcomes when treated at pediatric trauma centers.[3,4] Though there are data to suggest that many EDs are not well prepared for true pediatric emergencies, little is known regarding what type of emergency department (ED) critically ill children present to and whether hospital type impacts mortality for these patients. The objectives of this study were to describe hospital type (rural, urban, teaching, trauma center) among children presenting with cardiac and/or respiratory arrest, and to assess whether hospital characteristics are associated with mortality; we secondarily explored patient factors that affect morality.

2. Methods

2.1. Study setting and patient population

This is a retrospective cohort study using data from the 2007 Healthcare Cost and Utilization Project National Emergency Department Sample (NEDS), a 20% stratified sample of EDs representative of all United States (US) ED visits collected from 27 states.[5] These states include: AZ, CA, CT, FL, GA, HI, IA, IN, KS, MA, MD, ME, MN, MO, NC, NE, NH, NJ, NY, OH, RI, SC, SD, TN, UT, VT, and WI. NEDS is a publicly available database which tracks US ED visits. The database includes patient characteristics, hospital characteristics, procedure codes, diagnosis codes and disposition for both the ED visit and subsequent inpatient course for patients seen in US EDs. Our cohort included all children in the NEDS database aged 0–18

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with ICD9 codes for cardiac arrest, respiratory arrest and/or respiratory failure (427.5, 518.81, 799.1). These diagnoses had to be made in the ED in order for the patient to be included in the cohort. We chose these diagnoses to identify a subset of patients who present to the ED with critical illness and high mortality. Procedure codes such as endotracheal intubation could not be used since the NEDS does not distinguish location of procedures (ED vs. inpatient) for patients admitted form the ED though it does differentiate between ED and inpatient diagnoses. The study was approved by the Institutional Review Board of Oregon Health and Science University.

2.2. Variables

Patient-level predictor variables included: trauma diagnosis (defined by presence of an external cause of injury code [E-code]), age, sex, presence of chronic illness, self-pay, public insurance. Presence of a chronic illness was indicated by presence of a Chronic Condition Indicator which specifies 17 domains of chronic conditions from congenital anomalies to mental disorders. This Chronic Conditions Indicator code defines a chronic condition as present for more than 12 months with a need for ongoing medical care and impact on a patient's daily living. NEDS followed the methods described by Hwang et al. in constructing this indicator.[6]

Hospital-level predictors included ED volume, designation as a major trauma center, urban hospital, and teaching hospital. Hospital-level characteristics were coded within the dataset by the HCUP. Designation as a trauma center followed the Trauma Information Exchange Program (TIEP) database which is an inventory of US trauma centers collected by the American Trauma Society.[7,8] It identifies all US hospitals that are designated by a state authority or by the American College of Surgeons Committee on Trauma (ACS/COT). For the purposes of this study, the hospital characteristic of trauma center was applied to ACS/COT levels I and II centers which had comprehensive trauma services. The urban/rural distinction of the hospital was based on the county in which the hospital is located and was adapted for the NEDS from the Urban Influence Codes (UICs). For purposes of this study, both small and large metropolitan areas, with less than and greater than one million residents respectively were considered urban. (United States Department of Agriculture Economic Research Service, 2007) Teaching hospital EDs were those associated with a hospital which had an American Medical Association approved residency program, or were members of the Council of Teaching Hospitals, or had a ratio of full time trainees to beds of 0.25 or higher. The NEDS does not indicate whether or not a center is a Children's Hospital or has pediatric specific services available.

2.3. Outcomes

Our primary outcome measure was combined ED and in-hospital mortality among our cohort of critically ill children.

2.4. Data analysis

Variables were selected based on a priori hypotheses of factors which may be associated with mortality in this cohort in the setting of the data available in the NEDS. We used multivariate logistic regression modeling for analysis and the variables were directly included into the regression. Analyses integrated clusters, strata, and weights from the probability sample in order to make the data representative of all US hospital EDs. Analysis was performed to compare ED vs. combined ED/inpatient mortality. In addition, stratified analysis was done to assess the possible survival bias in favor of referral centers of patients who were transferred from non-teaching hospital EDs to teaching center EDs. Pre-arrival status including ambulance transport, private vehicle arrival, or transfer from another facility is not included in the NEDS and could not be directly controlled for. Approval for the study was granted by the Institutional Review Board of Oregon Health and Science University. SAS version 9.2 was used for database management and analysis.

Table 1
Summary statistics for the cohort comparing all visits to visits for cardiac or respiratory failure. The sample size listed is for the raw data and the percentages and confidence intervals are weighted estimates.

Characteristic	All visits (95% CI) (n = 6,271,710)	Visits for cardiac or respiratory failure (95% CI) (n = 8666)
Mean age in years	7.7 (7.5–7.8)	6.9 (6.6–7.3)
Female	48% (47.5–47.9)	42% (41–43)
Chronic illness	16% (15–17)	87% (85–88)
Self-pay	12% (11–13)	8% (7–10)
Public insurance	43% (42–45)	50% (46–53)
Mortality	0.02% (0.015–0.026)	27% (24–29)
Hospital characteristic		
Annual ED volume mean (standard error)	58,861 (3453)	65,091 (4701)
Urban	81% (79–82)	92% (90–94)
Teaching	37% (34–41)	66% (60–73)
Trauma center	22% (19–25)	49% (40–58)
Both teaching and Trauma center	17% (14–20)	40% (30–49)
Teaching, trauma and urban center	17% (14–20)	40% (30–49)

3. Results

There were 6,271,710 total pediatric visits in the raw data with 8666 visits for cardiac and/or respiratory failure. This yielded national estimates of 29 million pediatric ED visits in 2007 including 42,036 (0.1%) visits for cardiac and/or respiratory arrest/failure. Table 1 summarizes statistics for these visits. Of note, 87% of patients in the cardiac/respiratory failure group had chronic medical conditions compared to 16% overall. In addition, more than 49–66% of patients in the cardiac/respiratory failure cohort were seen at teaching centers or trauma centers compared to 22–37% of all visits. We noted that almost half of teaching hospitals were also trauma centers and all teaching and trauma centers were located in urban areas.

Combined ED/inpatient mortality in our cohort of patients was 27%. Table 2 describes unadjusted mortality rates by patient

Table 2
Unadjusted mortality among patients who presented with cardiac or respiratory failure by patient and hospital characteristic (n = 8666).

Patient characteristic	Mortality (95% CI)
Female	26% (23–28)
Male	29% (26–32)
Chronic illness	31% (28–35)
No chronic illness	4.3% (2.9–5.8)
Trauma patient	28% (25–32)
Non-trauma patient	27% (24–30)
Self-pay	56% (51–61)
Public insurance	24% (22–27)
Private insurance	25% (23–28)
Hospital characteristic	
Trauma center	22% (17–26)
Non-trauma center	32% (29–35)
Teaching hospital	23% (20–26)
Non-teaching hospital	37% (34–39)
Teaching and trauma center	22% (18–26)
Urban hospital	26% (24–29)
Urban non-trauma/teaching	38% (36–41)
Rural hospital	41% (37–45)