Impact of Hospital Teaching Status on Mortality, Length of Stay and Cost Among Patients With Cardiac Arrest in the United States

Elena V. Dolmatova, MD[a], Kasra Moazzami, MD, MPH[a], Marc Klapholz, MD[a,b], Neil Kothari, MD[a], Mirela Feurdean, MD[a], and Alfonso H. Waller, MD[a,b,*]

Limited data exist regarding the in-hospital outcomes in patients with cardiac arrest (CA) in teaching versus nonteaching hospital settings. Using the Nationwide (National) Inpatient Sample (2008 to 2012), 731,107 cases of CA were identified using *International Classification of Diseases, Ninth Edition* codes. Among these patients, 348,368 (47.6%) were managed in teaching hospitals and 376,035 (51.4%) in nonteaching hospitals. Patients in teaching hospitals with CA were younger (62.42 vs 68.08 years old), had less co-morbidities ($p < 0.001$), were less likely to be white (54.6% vs 65.5%) and more likely to be uninsured (9.1% vs 7.6%). Mortality in patients with CA was significantly lower in teaching hospitals than in nonteaching hospitals (55.3% vs 58.8%; all $p < 0.001$). The mortality remained significantly lower after adjusting for baseline patient and hospital characteristics (odds ratio 0.917, CI 0.899 to 0.937, $p < 0.001$). However, the survival benefit was no longer present after adjusting for in-hospital procedures (OR 0.997, CI 0.974 to 1.02, $p = 0.779$). In conclusion, teaching status of the hospital was associated with decreased in-hospital mortality in patients with CA. The differences in mortality disappeared after adjusting for in-hospital procedures, indicating that routine application of novel therapeutic methods in patients with CA in teaching hospitals could translate into improved survival outcomes. **(Am J Cardiol 2016;118:668−672)**

Cardiac arrest (CA) has been defined as a sudden and unexpected pulseless condition attributable to cessation of cardiac mechanical activity.[1] It is estimated that more than 200,000 patients experience CA in US hospitals each year with survival to discharge of 25.5%.[2,3] Inherent differences between teaching and nonteaching hospitals have been previously considered as a potential systems-level variable affecting patient outcomes.[4,5] Integrating medical education as part of patient care is among the differences observed between teaching and nonteaching hospitals. Although multiple reports have compared the outcomes of teaching and nonteaching hospitals in different clinical settings,[6−11] data regarding the outcomes of CA are lacking. In addition, morbidity and mortality has remained the main focus of previous studies, and the impact of hospital teaching status on other outcome measures including length of hospital stay and hospital costs have not been fully investigated. Therefore, in the present study, we used the National (Nationwide) Inpatient Database (NIS) to assess the effect of hospital teaching status on outcomes, length of stay, and hospital costs in patients with CA.

Methods

The NIS is the largest all-payer inpatient database consisting of approximately 20% of inpatient admissions to nonfederal, nonrehabilitation hospitals in the United States.[12] We collected data from NIS database from 2008 to 2012. National estimates could also be predicted using sampling weights provided in the database.

The *International Classification of Diseases, Ninth Edition, Clinical Modification* was used to identify all patients with CA from 2008 to 2012. Primary diagnostic code 427.5 was used to identify this population. In addition, primary procedure codes were used to identify patients who underwent post-CA procedures (Supplementary Table 1). Teaching status of a hospital was used as provided in the NIS database.

Agency for Healthcare Research and Quality co-morbidity measures using *International Classification of Diseases, Ninth Edition, Clinical Modification* diagnoses were used to identify the co-morbidities in patients with CA. The Charlson Comorbidity Index (CCI) was used to evaluate the severity of co-morbidities.[13] In this index, 17 co-morbid conditions are included; they are assigned differential weights with a total score ranging from 0 to 33. Higher CCI scores correspond to greater burden of co-morbid diseases.

Inpatient cost of hospitalization was calculated by merging data from the NIS database with cost-to-charge ratios available from the Healthcare Cost and Utilization

[a]Department of Medicine and [b]Division of Cardiology, Department of Medicine, Rutgers New Jersey Medical School, Rutgers, The State University of New Jersey, Newark, New Jersey. Manuscript received February 25, 2016; revised manuscript received and accepted May 24, 2016.

Drs. Dolmatova and Moazzami contributed equally to this work.

Support for this publication was provided by the New Jersey Medical School Department of Medicine and New Jersey Medical School Hispanic Center of Excellence, Health Resources and Services Administration through Grant D34HP26020, Newark, New Jersey.

See page 671 for disclosure information.

*Corresponding author: Tel: (+1) 973-972-4731; fax: (+1) 973-972-2116.

E-mail address: ahw22@njms.rutgers.edu (A.H. Waller).

0002-9149/16/$ - see front matter
http://dx.doi.org/10.1016/j.amjcard.2016.05.062

Table 1
Demographics, hospital characteristics, and outcomes of cardiac arrest among teaching and nonteaching hospitals in the United States from 2008 to 2012

Variable	All (731,107)	Teaching (348,368)	Non-Teaching (376,035)	*P*-Value
Patient Age (year)				
Mean, (SD)	65.32, (18.5)	62.42 (20.32)	68.08 (16.38)	<0.001
< 65	42.8%	48.4%	37.5%	
65-74	21.6%	20.8%	22.4%	
>75	35.6%	30.9%	40.1%	
Gender				<0.001
Male	55.1%	56.3%	54.1%	
Female	44.9%	43.7%	45.9%	
Race				<0.001
White	60.2%	54.6%	65.5%	
Black	14.5%	18.2%	11.0%	
Hispanic	7.4%	7.6%	7.2%	
Asian or Pacific Islander	2.3%	2.5%	2.2%	
Native American	0.6%	0.5%	0.6%	
Other	3.0%	3.3%	2.7%	
Missing	11.9%	13.2%	10.8%	
Charlson Comorbidity Index				<0.001
0	16.4%	18.5%	14.5%	
1	22.2%	22.1%	22.4%	
2	21.4%	20.7%	21.9%	
>2	40.0%	38.6%	41.2%	
Primary Payment type				<0.001
Government	70.9%	68.3%	73.3%	
Private	20.5%	22.4%	18.9%	
Other/None	8.4%	9.1%	7.6%	
Region of Hospital				<0.001
Northeast	16.7%	22.5%	11.6%	
Midwest	22.2%	25.3%	18.8%	
South	41.0%	36.8%	45.1%	
West	20.0%	15.4%	24.5%	
Hospital Bed Size				<0.001
Small	10.3%	10.9%	10.0%	
Medium	22.9%	24.3%	22.0%	
Large	65.8%	64.8%	67.9%	
Length of Stay median (IGR)	4 (1-11)	5 (2-13)	4 (1-9)	<0.001
Cost, mean (SD),	$31,221, (46,220)	$38,851 (58,058)	$24,232 (30,192)	<0.001
Mortality	57.1%	55.3%	58.8%	<0.001

Project of the Agency for Healthcare Research and Quality. Given total charges for each inpatient stay available in the database, costs were then calculated by multiplying the total hospital charge with cost-to-charge ratios which were used to account for the inherent variability among hospitals and regions for any given procedure. All costs were adjusted for inflation according to the latest consumer price index data released by the US government on January 16, 2016.

Hospital-level discharge weights provided by NIS were used to generate national estimates. Categorical variables were compared using the chi-square, whereas Wilcoxon signed-rank test was used for continuous variables. Two-level hierarchical models (with patient level factors nested within hospital-level factors) were created using the unique hospital identification number incorporated as random effects within the model. A p value of <0.05 was considered significant. All analyses were performed using Stata IC 13 (Stata Corp, College Station, Texas).

Results

A total of 731,107 cases of CA were estimated between the years of 2008 and 2012 (348,368 in teaching hospitals and 376,035 in nonteaching hospitals). Demographics and clinical characteristics are presented in Table 1. The mean (SD) age of patients with CA was 65.3 (18.5) with male predominance. Among all patients, more than a half were of white race, 8.4% had no governmental or private insurance, and 40% had CCI of more than 2. The median length of stay was 4 days (interquartile range 1 to 11), whereas cost of stay varied with a mean cost of $31,221.

The most common associated condition was aspiration pneumonia followed by coma and hyperglycemia. Among all patients, the most commonly associated intervention was percutaneous coronary intervention (PCI) followed by tracheostomy and intraaortic balloon pump.

Similar percentage of patients was managed in nonteaching hospitals and teaching hospitals (51.4% vs