Pediatric Versus Adult Cardiomyopathy and Heart Failure−Related Hospitalizations: A Value-Based Analysis

CAROL A. WITTLIEB-WEBER, MD,[1] KIMBERLY Y. LIN, MD,[2] THEOKLIS E. ZAOUTIS, MD,[3] MATTHEW J. O'CONNOR, MD,[2] KEN GERALD, PhD,[4] STEPHEN M. PARIDON, MD,[2] ROBERT E. SHADDY, MD,[2] AND JOSEPH W. ROSSANO, MD[2]

Rochester, New York; Philadelphia, Pennsylvania; and Houston, Texas

ABSTRACT

Background: Value-based health care is a proposed driver for reimbursement under the Affordable Care Act, with value broadly defined as outcomes divided by cost. Data on value-based health care in pediatric heart failure are scarce.

Methods and Results: A retrospective analysis of the Healthcare Cost and Utilization Project Kids' Inpatient Database and Nationwide Inpatient Sample was performed for pediatric and adult cardiomyopathy and heart failure−related hospitalizations. The study included 5,689 pediatric and 473,416 adult hospitalizations. Pediatric cardiomyopathy and heart failure hospitalizations were significantly longer than adult hospitalizations (mean ± SE 16.2 ± 0.7 days vs 6.8 ± 0.1 days; $P < .001$). Overall mortality was greater for pediatric hospitalizations (7.7% vs 5.6%; $P < .001$), although it decreased over time for both pediatric and adult hospitalizations. Charges were greater for pediatric hospitalizations, both overall ($116,483 ± $5,735 vs $40,662 ± $1,419; $P < .001$) and for all years evaluated.

Conclusions: In a value-based model, pediatric cardiomyopathy and heart failure−related hospitalizations are associated with worse outcomes and greater charges than adult hospitalizations. More research is needed to understand the cost effectiveness of pediatric heart failure treatment and to reduce the burden on the health care system. (*J Cardiac Fail 2015;21:76−82*)

Key Words: Heart failure, cardiomyopathy, outcomes.

Pursuit of value-based health care is now a major aim of health policy in the United States, with value broadly defined as health outcomes achieved per dollar spent.[1] This concept has served as a proposed target for health care reimbursement with a movement away from "fee for service" and toward "pay for performance" reimbursement. Theoretically, aligning reimbursement with value rewards providers for efficiency in achieving good outcomes while creating accountability for substandard care. If value improves, patients, payers, providers, and suppliers can all benefit while the economic sustainability of the health care system increases.[1]

Heart failure is an important health care issue because of its high prevalence and cost of care which have been well documented in the adult population. The American Heart Association recently published a policy statement, "Forecasting the Impact of Heart Failure in the United States," which predicts that by 2030, >8 million adults in the United States will have heart failure. Between 2012 and 2030, real total direct medical costs of heart failure are projected to increase from $21 billion to $53 billion. Total costs, including indirect costs for heart failure are estimated to increase from $31 billion in 2012 to $70 billion in 2030. Impressively, if one assumes that all costs of cardiac care for heart failure patients are attributable to heart failure, the 2030 projected cost estimates of treating patients with heart failure will be 3-fold higher ($160 billion in direct costs).[2]

There are few studies in the United States that describe the outcomes and cost of cardiomyopathy and heart failure hospitalizations in children, and none that compare such hospitalizations with those for the same indication in adults. We hypothesized that pediatric cardiomyopathy and heart

From the [1]Department of Pediatrics, University of Rochester Medical Center, Rochester, New York; [2]Department of Pediatric Cardiology, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; [3]Department of Pediatric Infectious Disease, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania and [4]Weststat, Houston, Texas.

Manuscript received May 31, 2014; revised manuscript received October 14, 2014; revised manuscript accepted October 15, 2014.

Reprint requests: Joseph W. Rossano, MD, Children's Hospital of Philadelphia, Main Hospital, 8th Floor, 34th and Civic Center Boulevard, Philadelphia, PA 19104. Tel: 267-426-2882; Fax: 267-426-9800. E-mail: rossanoj@email.chop.edu

See page 81 for disclosure information.

1071-9164/$ - see front matter

http://dx.doi.org/10.1016/j.cardfail.2014.10.011

failure−related hospitalizations are associated with longer lengths of stay, higher mortality, and greater charges compared with adult cardiomyopathy and heart failure hospitalizations.

Methods

Data Source

A retrospective analysis of the Healthcare Cost and Utilization Project Kids' Inpatient Database (KID) and Nationwide Inpatient Sample (NIS) was performed. These databases are part of the Healthcare Cost and Utilization Project, managed by the Agency for Healthcare Research and Quality, which is part of the Department of Health and Human Services. They provide nationwide samplings of pediatric and adult hospital admissions, respectively. Data from 44 states within the United States were included in the most recent version of each of the databases. More than 100 clinical and nonclinical variables for each hospital admission, including primary and subsequent diagnoses and primary and subsequent procedures, are included in the databases. There are up to 15 diagnoses and procedures recorded for each hospitalization.

The KID is the only all-payer inpatient care database for children in the United States, containing data from 2−3 million hospital admissions per year. A systematic random sampling is used to select 80% of pediatric hospital admissions. The NIS is the largest all-payer inpatient care database for adults in the United States, containing data from ∼8 million adult hospital admissions each year. The NIS contains all discharge data from >1,000 short-term and non-Federal hospitals each year, which approximates a 20% stratified sample of community hospitals in the United States.

Study Population

Pediatric and adult hospital admissions with the diagnosis of both cardiomyopathy and heart failure were identified from the respective databases with the use of ICD-9 codes (Supplemental Table 1, available online). The inclusion criteria were such to diminish the effect that heart failure from other etiologies, such as congenital heart disease, would have on outcomes. Hospitalizations for subjects ≤20 years of age were included from the KID and hospitalizations for subjects >20 years of age were included from the NIS. Data were obtained from years 2000, 2003, 2006, and 2009. The demographic information collected included age in years, sex, geographic region of the United States, size of hospital, and type of hospital (eg, teaching hospital).

Study Variables

The primary outcomes of interest were hospital length of stay, mortality during hospitalization, and hospital charges. Secondary outcomes included the presence of comorbidities (arrhythmia, respiratory failure, acute renal failure, sepsis, stroke, and pulmonary hypertension) and the use of mechanical circulatory support (ventricular assist devices [VADs] and extracorporeal membrane oxygenation [ECMO]). Comorbidities, mechanical circulatory support, and heart transplant were identified with the use of ICD-9 codes (Supplemental Table 1).

Statistical Analysis

Descriptive statistics were used to describe and compare the clinical characteristics and morbidities between pediatric and adult cardiomyopathy and heart failure hospitalizations. The chi-square test was used for frequency counts, and the 2-sample *t* test was used for continuous data. Trends in the data within each of the cohorts and between the 2 cohorts were compared by means of either the Cochran-Armitage Test for frequency counts or linear contrast from analysis of variance for continuous data. For multivariable analysis, the following variables were included in the model: hospital characteristics (including size and type of hospital and geographic region of the United States), subject sex, subject ethnicity, comorbidities (including arrhythmia, respiratory failure, acute renal failure, sepsis, stroke, and pulmonary hypertension), and use of mechanical circulatory support (VAD and ECMO). All analyses were performed with the use of SAS statistical software (SAS Institute, Cary, North Carolina) designed for finite population statistics. Statistical significance was defined as $P < .05$.

Results

The study included 5,689 pediatric and 473,416 adult cardiomyopathy and heart failure hospital admissions. Patient and hospital characteristics are summarized in Table 1. Pediatric patients were significantly younger, more likely to be of a nonwhite race, and were more likely to be cared for in urban teaching hospitals compared with adult patients. There was a male predominance in both pediatric and adult cohorts.

Length of Stay

Overall, pediatric heart failure hospitalizations were significantly longer than adult hospitalizations at a mean ± SE of 16.2 ± 0.7 days compared with 6.8 ± 0.08 days for adults ($P < .001$). Furthermore, pediatric hospitalizations were significantly longer than adult hospitalizations at each time point analyzed in this study. There was a significant difference in trends between the 2 groups in that length of stay has been decreasing over time for adult heart failure hospitalizations but has remained largely unchanged for pediatric hospitalizations ($P < .001$; Fig. 1A). When stratifying length of stay by age, infants had a significantly longer length of stay for heart failure hospitalizations than any other age group. Additionally, length of stay for all pediatric age groups was significantly longer than length of stay for any of the adult age groups (Fig. 1B).

Mortality

Although there were overall more deaths in the adult cohort (26,511 vs. 431), a significantly larger percentage

Table 1. Patient and Hospital Characteristics for Pediatric and Adult Cardiomyopathy and Heart Failure

	Pediatric	Adult	*P* Value
No. of hospitalizations	5,689	473,416	
Age (y), median (IQR)	14.1 (1.6−18.1)	69.8 (56.8−79.5)	<.001
Male, n (%)	3,060 (53.8%)	268,427 (56.7%)	.002
Nonwhite, n (%)	3,317 (58.3%)	169,956 (35.9%)	<.001
Urban location, n (%)	5,496 (96.6%)	420,393 (88.8%)	<.001
Teaching hospital, n (%)	4,479 (82.3%)	206,473 (43.9%)	<.001

IQR, interquartile range.