ELSEVIER

The Journal of
Heart and Lung
Transplantation

http://www.jhltonline.org

Hospital charges for pediatric heart transplant hospitalizations in the United States from 1997 to 2006

Sabrina P. Law, MD,[a] Jeffrey J. Kim, MD,[b] Jamie A. Decker, MD,[b] Jack F. Price, MD,[b] Antonio G. Cabrera, MD,[b] Daniel E. Graves, PhD,[c] David L. S. Morales, MD,[d] Jeffrey S. Heinle, MD,[d] Susan W. Denfield, MD,[b] William J. Dreyer, MD,[b] and Joseph W. Rossano, MD[e]

From the [a]Division of Pediatric Cardiology, Seattle Children's Hospital, Seattle, Washington; the [b]Department of Pediatrics, Lillie Frank Abercrombie Section of Pediatric Cardiology, Baylor College of Medicine, Texas Children's Hospital, Houston, Texas, the [c]Department of Physical Medicine and Rehabilitation, Baylor College of Medicine, Houston, Texas, [d]Michael E. DeBakey Department of Surgery, Baylor College of Medicine, Texas Children's Hospital, Houston, Texas; and the [e]Cardiac Center, The Children's Hospital of Philadelphia, The Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania.

KEYWORDS:
pediatrics;
heart transplantation;
cost;
charges;
health care economics

BACKGROUND: Heart transplantation remains a resource-intensive therapy for children. However, data regarding change in costs over time are scarce. We tested the hypothesis that hospital charges for pediatric heart transplant hospitalizations would increase from 1997 to 2006 and assessed factors associated with hospital charges.

METHODS: A retrospective analysis of the Healthcare Cost and Utilization Project Kids' Inpatient Database was performed on admissions surrounding heart transplantation for the years 1997, 2000, 2003, and 2006. The database is a nationwide sampling of pediatric hospital discharges and is weighted to provide national estimates.

RESULTS: There were 353 (95% confidence interval, 201–505) pediatric heart transplants in 1997 and 355 (95% confidence interval, 226–485) in 2006. Mean hospital charges increased from $279,399 in 1997 to $451,738 in 2006 ($p < 0.001$). This increase was similar to that observed for other pediatric surgical diseases. Increases also occurred in morbidities, including pulmonary hypertension ($p = 0.04$) and sepsis ($p = 0.04$), and in the use of extracorporeal membrane oxygenation ($p = 0.03$). On multivariable analysis, greater hospital charges were associated with later calendar year ($p = 0.001$), stroke ($p = 0.03$), sepsis ($p = 0.001$), renal failure ($p = 0.008$), arrhythmia ($p = 0.03$), and use of extracorporeal membrane oxygenation ($p < 0.001$) and ventricular assist device ($p < 0.001$).

CONCLUSIONS: From 1997 to 2006, mean charges for pediatric heart transplant hospitalizations increased by > $170,000 (160%). Although greater morbidities in the later years of the study potentially contributed to increased charges, later calendar year was independently associated with increased charges. The changes in charges for heart transplant are similar to the increases seen in other surgical procedures. Ongoing study of management strategies is needed to determine cost-effective therapies for this complex group of patients.

J Heart Lung Transplant 2012;31:485–91

Heart transplantation remains the only therapy offering long-term survival for children with end-stage heart failure. The cost of heart failure in adults is estimated at more than $30 billion dollars annually,[1] with much of the expense occurring in patients with end-stage disease secondary to repeated hospitalization, procedures, and for some, heart transplantation. Recent studies have assessed the median cost of heart transplant hospitalization among adults is $130,000 to $150,000.[2] With potential significant changes in reimbursement with ongoing health care reform, the cost of these and other expensive therapies will likely become increasingly scrutinized.

Reprint requests: Sabrina P. Law, MD, M/S G-0035, PO Box 5371, Seattle, WA 98145. Telephone: 206-987-2015. Fax: 206-987-3839.
E-mail address: sabrina.law@seattlechildrens.org

1053-2498/$ -see front matter
doi:10.1016/j.healun.2011.12.008

However, only sparse data exist on the cost of pediatric heart transplantation and how these costs may have changed over time. A report from Texas Children's Hospital detailing pediatric heart transplants from 1988 to 1992 found the average cost of heart transplantation was nearly $50,000, although a number of charges were not included, such as laboratory, nursing, and ventilator charges.[3] A more recent report from Atlanta found the median cost for the first 90 days after pediatric heart transplantation exceeded $200,000.[4]

Although these studies provide some important insight into the cost of pediatric heart transplantation, they may or may not reflect the cost of transplantation throughout the United States. Therefore, we aimed to determine the hospital charges of pediatric admissions involving heart transplantation from hospitals throughout the United States and test the hypothesis that hospital charges would increase over time from 1997 to 2006. Also assessed were factors contributing to hospital charges, such as hospital characteristics and mechanical support, and comorbidities such as sepsis, stroke, arrhythmias, pulmonary hypertension, congenital heart disease, and renal failure.

Methods

Data

This study was a retrospective review of the Kids Inpatient Database (KID) for the years 1997, 2000, 2003, and 2006. The KID is part of the Health Care Cost and Utilization Project, managed by the Agency for Healthcare Research and Quality, which is part of the United States Department of Health and Human Services. The database was created to allow analyses of hospital utilization by children across the United States.[5]

The KID consists of nationwide sampling of pediatric hospital admissions. A systematic random sampling is used to select 80% of pediatric hospital admissions and complicated in-hospital births and 10% of uncomplicated in-hospital births. To further ensure accurate representation of pediatric admissions, the discharges are sorted by state, hospital, diagnostic-related group (DRG), and a random number within each DRG.[5] Hospitals included in the database are specialty hospitals, public hospitals, and academic medical centers. The KID contains data from 2 to 3 million hospital discharges per year for children. There were 22 states that contributed data in the 1997 database, 27 states in the 2000 database, 36 states in the 2003 database, and 38 states in the 2006 database. The large sample size of the KID enables analyses of even rare diagnoses and procedures.[6–9] In addition, the KID can be weighted to produce national estimates.

The KID is composed of more than 100 clinical and nonclinical variables for each hospital stay, including primary and subsequent diagnoses and primary and subsequent procedures. There are up to 15 diagnoses and procedures for each discharge. Heart transplantation and other diagnoses and procedures were identified by *International Classification of Diseases, Clinical Modification*[10] (ICD-9) codes (Table 1, available in the online version at www.jhltonline.org). Additional data include admission and discharge status, and patient demographics (eg, sex, age, race,), hospital length of stay (LOS), and hospital characteristics (eg, location, size, teaching status).[5] The hospital's location, teaching status, and size were determined by the American Hospital Association Annual Survey of Hospitals. Designation of a children's hospital was assigned based on information provided by the National Association of Children's Hospitals and Related Institutions (NACHRI). A hospital was not considered a children's hospital if it was not identified as such by NACHRI. The primary payer was also identified. KID does not make a distinction between private insurance and health maintenance organizations (HMOs), and both are listed under private insurance.

Statistical analysis

Descriptive statistics were used to describe the clinical characteristics of transplant admissions. Logistic regression analysis was used to determine changes in morbidities over time. A general linear model was created to compare charge trends in continuous and categoric variables across the 4 years. To assess if any changes over time in hospital charges evident among pediatric heart transplant patients was on par with changes among other categories of diseases, additional analyses were performed on hospitalizations for kidney transplantation, tetralogy of Fallot repair, and pyloromyotomy. A logistic regression model was used to compare differences in years among categoric variables. For multivariable analysis, the following variables were included in the model: calendar year 2006 compared with other years, hospital characteristics, sex, age, congenital heart disease, arrhythmias, sepsis, pulmonary hypertension, acute cerebrovascular disease, acute renal failure, ventricular assist device (VAD), extracorporeal membrane oxygenation (ECMO), region, and payer. All analyses were performed on weighted values with SPSS 18.0 software (SPSS Inc, Chicago, IL). Statistical significance was defined as $p < 0.05$.

Results

The database showed 353 (95% confidence interval [CI], 201–505) pediatric hospital admissions surrounding heart transplants in 1997 and 355 (95% CI, 226–485) in 2006 (Table 2). The number of heart transplants performed did not increase significantly from 1997 to 2006. Across all years, the mean age at admission was 6.95 years (95% CI, 6.24–7.65 years), with 29% (95% CI, 23.6%–34.9%) infants (age < 1 year). The duration of hospitalization did not change significantly during the study. The mean LOS was 48.8 days (95% CI, 43.5–54.2 days) in 1997 and 51.8 days in 2006 ($p = 0.197$). The number of heart transplants performed at a teaching hospital increased significantly over time, from 273 (77.3%) in 1997 to 341 (99.7%) in 2006 ($p < 0.001$; Table 3).

Hospital charges increased significantly from 1997 to 2006, from a mean of $279,399 (95% CI, $206,208–$352,589) to $451,738 (95% CI, $403,488–$499,987; $p < 0.001$), representing a 62% increase over the study period (Table 2). There were also significant increases over time in charges for kidney transplants (64%), tetralogy of Fallot repair (88%), and pyloromyotomy (62%) (Table 7).

Increases were also seen in some morbidities, such as sepsis, and in the use of ECMO (Table 4). Hospital mortality rates, however, did not significantly vary from 1997 to