Incidence and treatment of chylothorax after cardiac surgery in children: Analysis of a large multi-institution database

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Objective: There is limited information regarding the true incidence of and risk factors for chylothorax after pediatric cardiac surgery. The objective of this study was to determine, from a large multi-institution database, incidence, associated factors, and treatment strategy in patients undergoing pediatric cardiac surgery.

Methods: All patients younger than 18 years in the Pediatric Health Information System (PHIS) database who underwent congenital heart surgery or heart transplant from 2004 to 2011 were included. Procedure complexity was assessed by Risk Adjustment for Congenital Heart Surgery-1.

Results: In all, 77,777 patients (55% male) of median age 6.7 months were included. Overall incidence of chylothorax was 2.8% (n = 2205), significantly associated with increased procedure complexity, younger age, genetic syndromes, vein thrombosis, and higher annual hospital volume. Patients with multiple congenital procedures had the highest incidence. Incidence increased with time, from 2% in 2004 to 3.7% in 2011 ($P < .0001$). Chylothorax was associated with longer stay ($P < .0001$), increased adjusted risk for in-hospital mortality (odds ratio, 2.13; 95% confidence interval, 1.75-2.61), and higher cost ($P < .0001$), regardless of procedure complexity. Of all patients with chylothorax, 196 (8.9%) underwent thoracic duct ligation or pleurodesis a median of 18 days after surgery. Total parenteral nutrition, medium-chain fatty acid supplementation, and octreotide were used in 56%, 1.7%, and 16% of patients, respectively.

Conclusions: Chylothorax is a significant problem in pediatric cardiac surgery and is associated with increased mortality, cost, and length of stay. Strategies should be developed to improve prevention and treatment. (J Thorac Cardiovasc Surg 2014;147:678–86)

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Supplemental material is available online.

The development of chylothorax after pediatric cardiac surgery is a known complication associated with significant respiratory, nutritional, immunologic, hematologic, and metabolic morbidity.[1] It has been associated with longer ventilation dependence,[2] longer postoperative stay,[3] and increased mortality.[2] According to contemporary single-institution studies, it is estimated that 4% to 9% of children undergoing cardiac surgery will acquire this complication.[3-5]

The mechanisms proposed for the development of chylothorax after cardiac surgery include surgical trauma to the thoracic duct or lymphatic tributaries, increased central venous pressure after procedures such as partial or complete cavopulmonary anastomoses, and the development of central venous thrombosis with consequent impairment of thoracic duct drainage.[1] Accordingly, some of the risk factors that have been found in single-institution studies to be associated with the development of chylothorax after cardiac surgery include type of procedure,[3,4] secondary chest closure,[4] low weight,[4] durations of cardiopulmonary bypass and crossclamping,[4] and presence of trisomy 21.[10] In particular, patients undergoing a Fontan procedure or heart transplant seem to be at the highest risk.[3,11]

Despite several small studies reporting the incidence of postoperative chylothorax in pediatric cardiac surgical patients, the actual risk factors for development of this complication, the trends in treatment strategy use, and the effect of this complication on outcomes have not been adequately studied. The goal of this study was to use a large multi-institution database to determine the incidence,

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Abbreviations and Acronyms

CI = confidence interval
ICD-9-CM = *International Classification of Diseases, Ninth Revision, Clinical Modification*
IQR = interquartile range
MCT = medium-chain triglycerides
OR = odds ratio
PHIS = Pediatric Health Information System
RACHS = Risk Adjustment for Congenital Heart Surgery-1
TPN = total parenteral nutrition

risk factors, current treatment strategies, and outcomes of children with chylothorax after cardiac surgery.

MATERIALS AND METHODS

Study Population

All patients younger than 18 years who underwent congenital heart surgery or heart transplant from 2004 to 2011 in the Pediatric Health Information System (PHIS) database were included in this retrospective study.

The PHIS database is an administrative database that contains inpatient, emergency department, ambulatory surgery, and observation data from 43 not-for-profit, tertiary care pediatric hospitals in the United States. These hospitals are affiliated with the Children's Hospital Association (Overland Park, Kan). The data warehouse function for the PHIS database is managed by Truven Health Analytics (Ann Arbor, Mich). For the purposes of external benchmarking, participating hospitals provide discharge and encounter data including demographic characteristics, diagnoses, and procedures. Forty-two of these hospitals also submit resource utilization data (eg, pharmaceutical, imaging, and laboratory resources) into PHIS. Data are electronically collected directly from existing elements located within each PHIS-participating hospital's electronic medical and financial record systems. The health information management office of each PHIS-participating hospital is responsible for data extraction and submission to PHIS. There is no manual data entry. Data are stripped of identifiers at the time of data submission. Data are subjected to a number of reliability and validity checks before being included in the database. Data quality and reliability are ensured through a joint effort between PHIS-participating hospitals and the Children's Hospital Association. Participating hospitals receive data quality reports on submission to the data warehouse and are required to meet predetermined quality thresholds before certification of data submission. The Children's Hospital Association used the PHIS Data Quality Program to audit data at the time of submission, after submission, and after production once in PHIS. For this study, data from 42 hospitals met study criteria.

The PHIS database was queried to include all patients younger than 18 years who had either undergone a procedure with an assigned Risk Adjustment for Congenital Heart Surgery-1 (RACHS) score or a heart transplant (*International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] procedure code 37.51) during an inpatient admission within the study period.

Measurements

Patients who had an *ICD-9-CM* diagnosis code of 457.8 assigned to the same admission as the RACHS procedure or the heart transplant were considered to have acquired postoperative chylothorax. Even though the date of the procedure is captured in the PHIS database, the date of diagnosis of chylothorax is not.

Information on demographic data of sex, age, and race or ethnicity; procedure complexity as assessed by RACHS score; year of surgery; use of total parenteral nutrition (TPN), medium-chain triglycerides (MCT), and octreotide; and total cost for the admission were extracted from the database. Costs in the PHIS database are calculated from hospital charges by means of multiple individual cost-to-charge ratios for each hospital. All costs were adjusted to 2011 US dollars. Information on diagnosis of Down syndrome (*ICD-9-CM* diagnosis code 758.0), Noonan syndrome (*ICD-9-CM* diagnosis code 759.89), and Turner syndrome (*ICD-9-CM* diagnosis code 758.6) was extracted. Similarly, a diagnosis of neck or proximal upper extremity deep vein thrombosis (*ICD-9-CM* diagnosis codes 453.83-453.87) was noted. The occurrence of a thoracic duct ligation (*ICD-9-CM* procedure code 40.64) or a pleurodesis (*ICD-9-CM* procedure codes 34.6 and 34.92) during the same admission but after the cardiac surgical procedure date was included.

Age was classified in several groups according to age at admission: neonates ($\leq$30 days), infants ($\geq$31 days and <1 year), young children ($\geq$1 year and <6 years), older children ($\geq$6 years and <12 years) and teenagers ($\geq$12 years and <18 years). Race or ethnicity was classified as white, Hispanic, black, and others.

The data were stratified according to procedure complexity by means of RACHS score as provided by the PHIS database. The PHIS database assigns a single RACHS score to each operation on the basis of a predetermined algorithm. If a patient undergoes multiple procedures as part of the same operation, the operation is assigned the RACHS score for the highest-risk procedure. In our study, patients with RACHS scores of 5 and 6 were included in the same group. Patients with several separate operations during the same admission were assigned to a separate group (multiple procedures). Similarly, patients undergoing only a heart transplant during the admission were assigned to a separate group.

To analyze the data according to hospital volume, the median annual RACHS procedure volume was calculated for each hospital across the years that the particular hospital contributed to the database. All hospitals were then sorted from lowest to highest median volume. The median volumes were cumulatively added, and the hospitals were divided into quartiles according to these cumulative median volumes to ensure that each of the four groups had a relatively equivalent number of patients. The respective hospital volume quartile was then assigned to each entry depending on the hospital where the patient had the procedure performed. A similar analysis was performed to analyze the data according to median surgeon volume.

Data Analysis

The incidence of chylothorax was calculated for the entire group and for each subgroup. To determine the effect of risk factors on the incidence of chylothorax, univariate analyses were performed with χ^2 and Fisher exact tests as appropriate. A logistic multivariate regression model was created to determine the influence of each of the risk factors after adjustment for significant covariates. The results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The use of different treatment strategies (TPN, MCT, octreotide, and surgical procedures) and changes with time were analyzed with similar univariate methods.

The relationship between diagnosis of chylothorax and hospital stay and cost was determined with the Student *t* test and logarithmic linear regression models to adjust for covariates. The relationship between chylothorax and in-hospital mortality was analyzed with χ^2 testing and logistic regression for univariate and multivariate analyses, respectively.

All analyses were performed with the SAS 9.3 statistical software package (SAS Institute Inc, Cary, NC). Data are expressed as numbers and percentages or medians with interquartile ranges (IQRs) unless otherwise specified.