Morbidity and mortality in patients with esophageal atresia

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Background. *This study reports national estimates of population characteristics and outcomes for patients with esophageal atresia with or without tracheoesophageal fistula (EA/TEF) and evaluates the relationships between hospital volume and outcomes.*

Methods. *Patients admitted within 30 days of life who had International Classification of Diseases, 9th Edition, Clinical Modification diagnosis and procedure codes relevant to EA/TEF during 1999–2012 were identified with the Pediatric Health Information System database. Baseline demographics, comorbidities, and postoperative outcomes, including predictors of in-hospital mortality, were examined up to 2 years after EA/TEF repair.*

Results. *We identified 3,479 patients with EA/TEF treated at 43 children's hospitals; 37% were premature and 83.5% had ≥1 additional congenital anomaly, with cardiac anomalies (69.6%) being the most prevalent. Within 2 years of discharge, 54.7% were readmitted, 5.2% had a repeat TEF ligation, 11.4% had a repeat operation for their esophageal reconstruction, and 11.7% underwent fundoplication. In-hospital mortality was 5.4%. Independent predictors of mortality included lower birth weight, congenital heart disease, other congenital anomalies, and preoperative mechanical ventilation. There was no relationship between hospital volume and mortality or repeat TEF ligation.*

Conclusion. *This study describes population characteristics and outcomes, including predictors of in-hospital mortality, in EA/TEF patients treated at children's hospitals across the United States. Across these hospitals, rates of mortality or repeat TEF ligation were not dependent on hospital volume. (Surgery 2014;156:483-91.)*

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ESOPHAGEAL ATRESIA WITH OR WITHOUT TRACHEOESOPHAGEAL FISTULA (EA/TEF) is a rare congenital anomaly that mandates operative intervention and frequently is associated with other anomalies. Patients with EA/TEF often have complicated medical courses as a result of both the esophageal anomaly and related comorbidities.[1,2] Complications associated with EA/TEF repair include anastomotic leaks, strictures, and recurrence of TEF.[2-5] In addition, many patients experience gastroesophageal reflux disease and recurrent pulmonary aspiration, both of which can result in hospitalizations or additional operative intervention.[6,7] Furthermore, despite substantial improvements in neonatal care and surgical techniques, some infants with EA/TEF will not survive.[8-10]

With an incidence of two to four cases per 10,000 births, many children's hospitals will treat only a few patients with EA/TEF each year.[11] This low incidence has limited the types of published reports on EA/TEF to mainly single-institution experiences. In addition, because of its rarity and complexity, the number of EA/TEF cases treated per year at an individual center may affect outcomes. Many operative specialties, including pediatric surgery, have investigated the effect of hospital volume of a specific procedure on outcomes with mixed results.[12-16] In particular to EA/TEF, a system of regionalized subspecialization for treating patients with EA/TEF in the United Kingdom has been described and has demonstrated modest improvements in outcomes.[17] No study to date has investigated the relationship between hospital volume and outcomes for EA/TEF in the United States.

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Administrative databases represent data sources that can be used to compile large multi-institutional cohorts of patients with rare diseases to perform descriptive studies and to examine interhospital differences in patient populations, treatments, and outcomes.[12,18] Using a multi-institutional administrative database of free-standing pediatric hospitals, we sought to describe national estimates of baseline characteristics and clinical outcomes for patients with EA/TEF and to determine whether greater hospital volume was associated with improved outcomes, specifically lesser rates of in-hospital mortality and repeat TEF ligations.

METHODS

Cohort identification and validation. We conducted a retrospective, multi-institutional cohort study of neonates with a diagnosis of EA/TEF who underwent at least one related operative procedure between 1999 and 2012. This study used the Pediatric Health Information System (PHIS), a multi-institutional administrative database that contains inpatient, observation, emergency department, and ambulatory surgery discharge/encounter data from freestanding children's hospitals that are part of the Children's Hospital Association. Data elements were collected from 43 PHIS hospitals, including demographics, and diagnosis and procedure codes (*International Classification of Diseases,* 9th Edition, Clinical Modification [ICD-9-CM]). Since 1999, resource use data have been collected in the PHIS as date-stamped billing codes for radiology, laboratory, pharmacy, and other hospital level charges; therefore, we initiated our cohort to coincide with the availability of this data to allow for a more detailed characterization of the procedures and treatments administered. Encrypted medical record numbers allow for longitudinal tracking of patients across multiple hospital encounters.

The methodology to identify the cohort of neonates with EA/TEF has been published previously.[18] In brief, all patients with an ICD-9-CM diagnosis code for either congenital EA/TEF (750.3) or acquired TEF (530.84) who were admitted by 30 days of life and also had at least one EA or TEF related procedure during the index encounter were included in the cohort. This methodology has a sensitivity of 96% and positive predictive value of 96% for correctly identifying patients with EA/TEF. Patients with the diagnosis code for EA or TEF but who underwent only a gastrostomy with no subsequent reparative EA/TEF procedure code identified within the PHIS were excluded. No other exclusion criteria were applied.

Data abstracted from the PHIS were validated by reviewing medical records of all patients with EA/TEF treated at two PHIS institutions (Nationwide Children's Hospital, Columbus, OH; and Children's Hospital of Philadelphia, Philadelphia, PA). The Institutional Review Boards of both institutions approved this study.

Data elements and statistical analysis. Preoperative variables examined included demographic and clinical characteristics at the initial admission during which the first EA/TEF-related procedure was performed. Postoperative outcomes that occurred during the index admission and within 2 years of the first EA/TEF related procedure also were examined. Sequelae of EA/TEF often persist for many years, so we chose to assess outcomes for a duration of 2 years to balance the competing goals of achieving a large sample size and having a substantially long follow-up period to capture delayed EA/TEF-related outcomes such as recurrent TEF, or undergoing a fundoplication or a repeat esophageal reconstruction. Comorbidities were based on ICD-9-CM procedure codes or hospital billing codes whenever possible and ICD-9-CM diagnosis codes in other cases. For example, a diagnosis of recurrent TEF was determined by the surrogate of an additional TEF ligation procedure, whereas for comorbid congenital anomalies such as congenital heart disease (CHD) diagnoses were grouped into broad categories that included all relevant diagnosis codes. All characteristics were reported as frequencies and percentages for categorical variables and as medians and interquartile ranges for continuous variables. The associations between hospital volume and in-hospital mortality or repeat TEF ligation were evaluated with hierarchical logistic regression models, with volume first examined as a continuous variable then as a categorical variable.

To determine associations between individual preoperative characteristics and mortality, χ^2 and Fisher exact tests were performed for categorical preoperative variables, and Wilcoxon rank sum tests were performed for continuous variables. A multivariable logistic regression model for in-hospital mortality was fit after performing multiple imputation, starting with preoperative characteristics associated with mortality at $P < .15$ in bivariate analyses then individually removing variables in order of decreasing statistical significance until only variables significant at $P < .10$ remained. Clinically relevant first-order interactions