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Effects of hospital volume on patient outcomes and costs in infants with pyloric stenosis



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ABSTRACT

Background: There is a well-established relationship between surgical volume and outcomes after complex pediatric operations. However, this relationship remains unclear for common pediatric procedures. The aim of our study was to investigate the effect of hospital volume on outcomes after hypertrophic pyloric stenosis (HPS).

Methods: The Kid's Inpatient Database (2003-2012) was queried for patients with congenital HPS, who underwent pyloromyotomy. Hospitals were stratified based on case volume. Low-volume hospitals performed the lowest quartile of pyloromyotomies per year and high-volume hospitals managed the highest quartile. Outcomes included complications, mortality, length of stay (LOS), and cost.

Results: Overall, 2137 hospitals performed 51,792 pyloromyotomies. The majority were low-volume hospitals ($n = 1806$). High-volume hospitals comprised mostly children's hospitals (68%) and teaching hospitals (96.1%). The overall mortality rate was 0.1% and median LOS was 2 d. High-volume hospitals had lower overall complications (1.8% versus 2.5%, $P < 0.01$) and fewer patients with prolonged LOS (17.0% versus 23.5%, $P < 0.01$) but had similar rates of individual complications, similar mortality, and equivalent median LOS as low-volume hospitals. High-volume hospitals also had higher costs by \$1132 per patient (\$5494 versus \$4362, $P < 0.01$). Regional variations in outcomes and costs exist with higher complication rates in the West and lower costs in the South. There was no association between mortality or LOS with hospital volume or region.

Conclusions: Patients with pyloric stenosis treated at high-volume hospitals had no clinically significant difference in outcomes despite having higher costs. Although high-volume

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hospitals offer improved outcomes after complex pediatric surgeries, they may not provide a significant advantage over low-volume hospitals in managing common pediatric procedures, such as pyloromyotomy for congenital HPS.

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Introduction

The effects of hospital volume on surgical outcomes have been extensively studied^{1–3} to further elucidate the influence of hospital-level, surgeon-level, and patient-level factors on disparities in health care. The majority of studies show improved outcomes in patients treated at high-volume hospitals.^{2,3} In the pediatric surgery literature, a strong association between hospital volume and surgical outcomes has been well established for complex surgeries.^{3,4} However, this relationship is not well defined for common pediatric surgical procedures. Recently, our group showed that infants with gastroschisis, a fairly common congenital condition, did not have improved outcomes when treated at high-volume hospitals.⁵

For congenital hypertrophic pyloric stenosis (HPS), the association between hospital volume and surgical outcomes after pyloromyotomy, a common pediatric surgical procedure, remains unclear. Only a few studies have specifically examined this relationship^{3,6,7} and their results are inconclusive with one study showing lower complications at high-volume hospitals⁶ and another study concluding no difference in complication rates.⁷ Furthermore, regional variations in surgical outcomes have been described for various other procedures,^{8–11} but its impact on outcomes after common pediatric surgical procedures have not been well studied.

Thus, the aim of our study was to use national data to evaluate the impact of hospital volume on the surgical outcomes and costs of pyloromyotomies performed on infants with HPS and to evaluate for any regional differences in outcomes. We hypothesized that hospitals that treat a higher volume of infants with pyloric stenosis would show improved outcomes compared to low-volume hospitals and that regional differences in outcomes exist.

Materials and methods

Data source

The Kids' Inpatient Database (KID) from the Healthcare Cost and Utilization Project (HCUP) comprises data from pediatric inpatient discharges from participating non-Federal general hospitals and specialty hospitals, including public hospitals and academic medical centers, in the United States for patients aged below 21 y.¹² The database is released every 3 y and the most recent year, 2012, includes data from 4179 hospitals in 44 states. The KID contains information regarding basic hospital characteristics, children's hospital designation, teaching hospital status, patient demographics, insurance status, diagnoses, procedures performed, hospital length of stay (LOS), and total charges. The 2012 database stratifies hospital type into freestanding children's hospitals or other

hospitals based on data from the Children's Hospital Association.¹³ For our study, children's hospitals were defined as freestanding children's hospitals, which admit children only and do not include children's units in general hospitals. This study was exempted from IRB approval by the Human Subjects Committee at Harbor-UCLA Medical Center.

Study population

We queried the KID from the years 2003, 2006, 2009, and 2012 for pediatric patients who underwent pyloromyotomy for congenital HPS. To identify patients, we used International Classification of Diseases, Ninth Revision (ICD-9) procedure codes 43.3 (pyloromyotomy) and 44.2 (pyloroplasty) with diagnosis code 750.5 (congenital HPS). Patients were stratified into one of three cohorts based on the hospital where the operation was performed: low-volume hospitals, medium-volume hospitals, or high-volume hospitals. To determine the hospital volume of pyloromyotomy cases performed per year, the sample was divided into quartiles. Low-volume hospitals represented the lowest quartile (1–12 pyloromyotomy cases per y), medium-volume hospitals represented the two middle quartiles (13–66 pyloromyotomy cases per y), and high-volume hospitals represented the highest quartile (67–190 pyloromyotomy cases per y).

Outcomes

The outcomes analyzed in this study included rates of different types of complications (during procedure, gastrointestinal, respiratory, and cardiovascular), mortality rate, hospital LOS, and cost. We investigated the common complications associated with pyloromyotomy using ICD-9 codes (Table 1). Because of limitations for reporting sample sizes ≤ 10 per the data use agreement with HCUP, certain types of complications were reported as a group. Prolonged LOS was defined as 4 d or longer.^{14,15} Cost was derived from charges using the charge-to-cost ratio files provided by HCUP¹⁶ and published medical consumer price index. The cost was adjusted to represent 2010 dollars to account for inflation.¹⁷

Statistical analysis

Bivariate and multivariable analyses were used to examine the association between hospital volume and patient outcomes and costs for each cohort of pyloromyotomy patients. Complication and mortality rates were assessed with hierarchical logistic regression. Hierarchical negative binomial regression was used to assess LOS, whereas hierarchical multivariable linear regression was performed on cost. The cost was log transformed to account for the right skew in the data. The primary predictor in each analysis was hospital volume (low-, medium-, or high-volume hospitals). Covariates

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