



## Race and outcomes in gastroschisis repair: a nationwide analysis☆☆☆☆☆☆☆☆



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### ARTICLE INFO

#### Article history:

Received 12 November 2016

Received in revised form 5 March 2017

Accepted 7 March 2017

#### Key words:

Gastroschisis

Pediatric surgery

Outcomes

Race

Health disparities

### ABSTRACT

**Background:** The incidence of gastroschisis has increased 30% between the periods 1995–2005 and 2006–2012, with the largest increase in Black neonates born to Black mothers younger than 20 years old.

**Objective:** Racial disparities in peri- and post-operative outcomes have been previously identified in several types of adult and pediatric surgical patients. Is there an association between race and clinical outcomes and healthcare resource utilization in neonates with gastroschisis?

**Methods:** Retrospective study using national administrative data from the Kid's Inpatient Database (KID) from 2006, 2009, and 2012 for neonates (age < 28 days) with gastroschisis. Multivariable logistic regression was constructed to determine the association of race and socioeconomic characteristics with complications and mortality; linear regression was used for length of stay and hospital charges.

**Results:** We identified 3846 neonates with gastroschisis that underwent surgical repair, including 676 patients with complex gastroschisis. When controlling for birth weight, payer status, socioeconomic status, and hospital characteristics, Black neonates had increased odds of having complex gastroschisis and associated atresias. Mortality was higher in patients with complex gastroschisis, patients from the lowest income quartiles, and patients with Medicaid as primary payer (compared to those with private insurance). Length of stay (LOS) was increased in patients with complex gastroschisis, birth weight < 2500 g, and Medicaid patients. Hospital charges were higher in complex gastroschisis, Black and Hispanic neonates (as compared to Whites), males, birth weight < 2500 g, and Medicaid patients.

**Conclusions:** There is an association between race and complex gastroschisis, associated intestinal atresias, and total charges in neonates with gastroschisis. In addition, income status is associated with mortality and hospital charges while payer status is associated with complications, mortality, LOS, and hospital charges. Public health and prenatal interventions should target at-risk populations to improve clinical outcomes.

**Prognosis Study:** Level of Evidence: II

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Gastroschisis is a congenital abdominal wall defect through which intraabdominal viscera protrude [1]. The medical and post-surgical management of neonates with gastroschisis varies considerably [2],

however, surgical repair of the abdominal wall defect is common [3]. Complex gastroschisis (10.9% of gastroschisis cases) [4] defined as the presence of atresia, volvulus, necrotic bowel, or bowel perforation, is associated with delayed implementation of enteral feedings and achievement of full feeds, higher complication rates, an increased length of stay, and increased mortality [4–6]. Survival rates are as high as 90–97%, however; the repair of complex gastroschisis is associated with a high risk of short- and long-term morbidity [5]. Other factors that increase the risk for mortality in gastroschisis include large bowel resection, congenital circulatory and pulmonary disease, and sepsis. Contributing risk factors for sepsis include intestinal ostomy, congenital circulatory anomalies, and necrotizing enterocolitis [6].

Several studies have attempted to identify prenatal and perinatal factors that can predict poor outcomes in gastroschisis. Polyhydramnios [5], low birth weight, and prematurity [7] are associated with worse outcomes (i.e., prolonged time to full enteral feeds, increased length of

**Abbreviations:** KID, Kid's Inpatient Database; ICD-9, International Classification of Diseases, Ninth Revision; IQR, interquartile ranges; LOS, length of stay; OR, odds ratio; SE, standard error; NEC, necrotizing enterocolitis.

☆ Funding Source: National Institutes of Health T32 DK007639 (FJB).

☆☆ Financial Disclosure: All authors have no financial relationships relevant to this article to disclose.

★ Ethical Approval: Informed consent and study protocol approval not required for this study.

★★ Conflict of Interest: All authors have indicated they have no potential conflicts of interest to disclose.

☆☆☆ Clinical Trial Registration: N/A

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hospital stay (LOS), higher rates of sepsis). Clear association has not been demonstrated for other factors, such as mode of delivery, surgical technique used for repair, bowel dilation and bowel wall thickness [2,8].

The Institute of Medicine report in 2003 identified the study of health disparities in the United States as one of the most important public health issues; these health disparities still persist today – racial and ethnic minorities receive suboptimal healthcare, regardless of access-related factors [9]. A growing body of evidence suggests that patient demographic factors, such as race, socioeconomic status, and payer status are associated with health disparities in peri- and post-operative outcomes in pediatric surgery, including general, cardiac, neurological, and oncologic procedures [8,10–13]. In addition, risk-adjusted analysis of race and gender by Stone et al. revealed significant differences in postoperative morbidity, mortality, and hospital resource utilization for pediatric surgeries [14].

Gastroschisis disproportionately affects young mothers. Furthermore, the incidence of gastroschisis has increased 30% between the two periods 1995–2005 and 2006–2012, with the largest increase in Black mothers younger than 20 years old [15].

The treatment and management of patients with gastroschisis utilizes a significant amount of healthcare resources [6]. For patients with uncomplicated gastroschisis, the median length of stay is 28 days and median hospital charges are \$90,788. Moreover, complex gastroschisis increases the median LOS (67 days), median inflation adjusted hospital charges (\$197,871), and the risk of complications (gastrointestinal, respiratory, or infectious) (2.9% vs. 8.7%) [4]. The aim of this study was to identify whether a patient's race was associated with adverse clinical outcomes and increased healthcare resource utilization in neonates with gastroschisis.

## 1. Patients and methods

### 1.1. Study design and data source

A retrospective cross-sectional study was conducted using national administrative data from 2006, 2009, and 2012 Kid Inpatient Database (KID) files, the most recently available data sets, produced by the Agency for Healthcare Research and Quality as a component of the Healthcare Cost and Utilization Project (HCUP). This database, released every three years, contains demographic, clinical, and charge data for all pediatric inpatient encounters from community, non-rehabilitation hospitals in the United States. A total of 38 to 44 states participated from 2006 to 2012, and approximately 4000 hospitals reported in 2012. Information in the KID includes but is not limited to: age at admission, sex, race, payer status, median zip code income, diagnosis and procedure codes, total hospital charges, length of stay, and hospital characteristics such as size, location, and teaching status.

### 1.2. Study cohort

Neonates (<28 days of age) with gastroschisis were identified by *International Classification of Diseases, Ninth Revision* (ICD-9) procedure code of 54.71 [16].

### 1.3. Predictor variables

Predictor variables were race, socioeconomic status, payer status, and birth weight. Gender, hospital region, bed size, ownership, and teaching status were included in the regression model to control for possible confounding characteristics. Race was defined as White, Black, Hispanic, or Other, as reported by the KID. The median household income of the patient's home zip code served as a proxy for socioeconomic status and was defined by quartiles (For 2012: quartile 1: \$1 to \$38,999, quartile 2: \$39,000 to \$47,999, quartile 3: \$48,000 to \$62,999, quartile 4: >\$63,000), derived from ZIP Code-demographic data obtained

from Claritas. Payer status was defined as Medicaid, Private, or Other (self-pay, charity, uninsured). Birth weight was defined as <1500 g, 1500 to 2499 g, and ≥2500 g, as a proxy for gestational age at birth (a variable found to be unreliably reported in the KID data as ICD-9 diagnostic codes for prematurity) [17,18]. Birth weight of <1500 g was used as a proxy for prematurity. Hospital regions were defined as northwest, midwest, south and west. Hospital bed sizes were defined as small or large, as defined by the HCUP-KID. Hospital ownership was defined as either government (public) or private.

### 1.4. Outcomes

In-hospital complications, mortality, LOS, and total hospital charges were the primary outcome measures in neonates with gastroschisis. In-hospital complications related to complex GS, such as atresia, volvulus, necrotic bowel, or bowel perforation (indicated by additional abdominal surgery) were identified in the patient dataset by searching for pertinent ICD-9 diagnostic and procedure codes, which may have been entered into the patient's chart at any point in the hospitalization. In-hospital mortality, LOS and total hospital charges were already present in the administrative data. Total hospital charges were calculated with the HCUP-KID cost to charge ratio file and then inflation adjusted to 2012 dollars. All charges were converted to 2012 dollar amounts using the consumer price index.

### 1.5. Statistical analysis

All statistical analyses were adjusted for the KID survey design and discharge weights were used in the analysis to generalize results at the national level. Descriptive statistics were used to characterize the study cohort. In-hospital complications and mortality were summarized using proportions; LOS and total charges were described using medians and interquartile ranges (IQRs). Unadjusted categorical and continuous variables were compared by patient characteristics using chi-square and t-tests, respectively. Multivariable logistic regression was constructed to determine the association of race with in-hospital complications and mortality. Multivariable linear regression was used to determine association of predictor variables with LOS and total hospital charges. All statistical analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, North Carolina). This study was considered non-human subjects research and was deemed exempt by the Institutional Review Board at the University of Texas Medical Branch, Galveston.

## 2. Results

Out of 12,485,585 weighted neonatal discharges, we identified 3846 (0.03%) neonates with gastroschisis who underwent repair with birth weights available. Demographic characteristics are described in Table 1. Overall, in-hospital mortality was 3.7%, median LOS was 35.3 days (IQR: 24.8 to 58.5) and median total hospital charges were \$218,933 (IQR: \$139,717 to \$384,184). For patients with simple gastroschisis, in-hospital mortality was 1.97%, median LOS was 32.6 days (IQR: 24.0 to 47.2) and median total hospital charges were \$196,148 (IQR: \$133,913 to \$322,671).

We identified 676 (17.6%) neonates with complex gastroschisis, which was defined as presence of atresia, volvulus, necrotic bowel, or bowel perforation (indicated by additional abdominal surgery during that hospitalization). For patients with complex gastroschisis, in-hospital mortality was 11.7%, median LOS was 76.6 (IQR: 42.1 to 119.2) and median total hospital charges were \$406,434 (IQR: \$233,102 to \$687,282). There was a significant difference in race, infant birth weight, and hospital ownership for the outcome of complex gastroschisis. Only infant birth weight was significant for the outcome of in-hospital mortality.

Table 2 reports the number of patients with complex gastroschisis, as identified by atresia, volvulus, necrotic bowel, or bowel perforation

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