The Impact of Insurance, Race, and Ethnicity on Age at Surgical Intervention among Children with Nonsyndromic Craniosynostosis

Yimo Lin, BA[1,2], I-Wen Pan, PhD[1,2], Dominic A. Harris, BA[1,2], Thomas G. Luerssen, MD[1,2], and Sandi Lam, MD, MBA[1,2]

Objective To examine the impact of demographic factors, including insurance type, family income, and race/ethnicity, on patient age at the time of surgical intervention for craniosynostosis surgery in the US.

Study design The Kids' Inpatient Database was queried for admissions of children younger than 3 years of age undergoing craniosynostosis surgery in 2009. Descriptive data regarding age at surgery for various substrata are reported. Multivariate regression was used to evaluate the effect of patient and hospital characteristics on the age at surgery.

Results Children with private insurance were, on average, 6.8 months of age (95% CI 6.2-7.5) at the time of surgery; children with Medicaid were 9.1 months old (95% CI 8.4-9.8). White children received surgery at mean age of 7.2 months (95% CI 6.5-8.0) and black and Hispanic children at a mean age of 9.1 months (95% CI 8.2-10.1). Multivariate regression analysis found Medicaid insurance (beta coefficient [B] = 1.93, $P < .001$), black or Hispanic race/ethnicity (B = 1.34, $P = .022$), and having 2 or more chronic conditions (B = 2.86, $P < .001$) to be significant independent predictors of older age at surgery.

Conclusion Public insurance and nonwhite race/Hispanic ethnicity were statistically significant predictors for older age at surgery, adjusted for sex, zip code median family income, year, and hospital factors such as size, type, region, and teaching status. Further research into these disparities is warranted. *(J Pediatr 2015;166:1289-96)*.

Craniosynostosis is a condition involving the premature fusion of one or more cranial sutures, affecting an estimated 1 in 2000-2500 live births worldwide.[1,2] This condition most often occurs independently but may occur in association with more than 130 different genetic syndromes. Sagittal suture fusion is the most common (40%-55%), followed by coronal (20%-25%), metopic (5%-15%), and lambdoidal (0%-5%). Associated findings may include calvarial or facial dysmorphism, midface hypoplasia, hydrocephalus, deafness, blindness, learning disabilities, speech impediment, and abnormalities of the extremities, heart, or lungs. Complications, such as hydrocephalus and blindness, are relatively uncommon in cases of nonsyndromic single suture synostosis.[1,2]

Multidisciplinary consensus guidelines recommend surgery for children with craniosynostosis before of 1 year of age.[2-4] Early evaluation by a multidisciplinary team is preferred, as the range of operative options decreases as the child grows older.[1,2,5,6] A recent multicenter prospective study with long-term neuropsychological follow-up suggests that younger age at surgery may be significantly associated with more favorable outcomes in sagittal synostosis[7]; however, not all patients and families experience the same access to evaluation or intervention by subspecialty care. Studies in the literature have shown that factors such as insurance status, income, and race influence both the access to, and the timing of, neurosurgical and craniofacial procedures for children.[8-11] Although insurance- and race-based disparities in care patterns among pediatric surgical patients have been reported in the neurosurgical and craniofacial literature,[8,9,11-13] this topic has not been studied previously in children with craniosynostosis.

In this study, we aimed to examine the impact of demographic factors, including insurance type, income, and race/ethnicity, in addition to hospital factors, such as size, type, and region, on patient age at the time of surgical intervention for craniosynostosis. This study uses nationally representative data from the Health Care Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID), which is the only all-payer dataset on hospital use, outcomes, and charges designed to study children's use of hospital services in the US.

Methods

Data are from the KID, one of a family of administrative databases developed by the HCUP and sponsored by the Agency for Healthcare Research and Quality.

HCUP	Health Care Cost and Utilization Project
ICD-9-CM	*International Classification of Diseases, 9th Revision, Clinical Manifestations*
KID	Kids' Inpatient Database

From the [1]Division of Pediatric Neurosurgery, Texas Children's Hospital; and [2]Department of Neurosurgery, Baylor College of Medicine, Houston, TX

The authors declare no conflicts of interest.

0022-3476/$ - see front matter.
http://dx.doi.org/10.1016/j.jpeds.2015.02.007

The KID is a sample of pediatric discharges from all community nonrehabilitation hospitals in states participating in HCUP. Pediatric discharges are defined as all inpatient discharges for which the patient was age 20 years or less at admission. The KID contains charge information on all patients, regardless of payer, including persons covered by private insurance, Medicaid, Medicare, and the uninsured.

Inpatient stay records in the KID include clinical and resource use information typically available from discharge abstracts. Patient discharge data include patient demographics, admission type and diagnostic and procedural codes defined by the *International Classification of Diseases, 9th Revision, Clinical Manifestations* (ICD-9-CM), length of stay, disposition, and payer data.

Systematic random sampling was used to select 10% of uncomplicated in-hospital births, 80% of complicated in-hospital births, and 80% of all other pediatric admissions. To obtain national estimates, patient records were provided with weights by use of the American Hospital Association universe of non-Federal community hospitals as the standard. Hospital data were stratified by the following 6 characteristics: ownership/control, bed size, teaching status, rural/urban location, US region, and status as a freestanding children's hospital. The number of participating states was 44 in 2009, with data from 4100 hospitals. The KID contains information from 2 to 3 million pediatric discharges, weighted to represent 6.5-7.5 million national discharges.[14] The KID is a sampled, weighted database, so results are reported as estimated national values with 95% CIs. The basic unit of analysis is a patient discharge, rather than an individual patient. According to the 2009 KID documentation, 6 states were excluded from the registry because age data in months were unavailable[15]: Connecticut, Florida, Maine, South Carolina, Texas, and Virginia. An estimated 280 potential cases were excluded.

Records from 2009 were selected from patients aged 36 months old or younger at the time of admission who had both a diagnosis of ICD-9-CM code 756.0 (anomalies of skull and face bones, including craniosynostosis) and 1 or more of the following ICD-9-CM procedure codes: 02.01 (opening of cranial suture: linear/strip craniectomy), 02.03 (formation of cranial bone flap: repair of skull with flap), 02.04 (bone graft to skull), or 02.06 (other cranial osteoplasty: repair of skull not otherwise specified). The use of these variables to capture craniosynostosis surgery has been reported previously in the literature.[16] To restrict the dataset to nonsyndromic cases of craniosynostosis, patients with ICD-9-CM diagnosis codes for concomitant congenital malformations were excluded; these included all codes between 740.0 and 759.9 (except 756.0), as well as 524.0 to 524.9 (dentofacial anomalies).[17] Variables selected for analysis included subject age (in months), sex, race/ethnicity, median income quartile by the patient's zip code, insurance type, number of chronic conditions, and hospital variables such as bed size, hospital type, and region. Patients were separated into those with one documented condition only (ie, craniosynostosis) and those with 2 or more chronic conditions (http://www.hcup-us.ahrq.gov/toolssoftware/chronic/chronic.jsp). Patients were divided into 3 age groups: 0-4 months, 5-12 months, and 13-36 months. This breakdown was chosen because of potential differences in surgical management: patients 4 months of age and younger may be candidates for endoscopic or open suture release procedures, and those >5 months of age usually undergo calvarial vault reconstruction.[2-4,18] Initial surgical management for craniosynostosis is recommended within the first 12 months of life, so patients aged 1-3 years may represent a more complex or heterogeneous group including revision and delayed procedures.[1,2] The "primary payer" variable included the following categories: Medicaid (fee for service and managed care), private insurance, and self-pay/other.[19] The variable "quartile of median income by ZIP" provides a quartile classification based on the estimated median household income of residents in the patient's zip code. These values were derived from zip code-demographic data obtained from Claritas.[20] Region was defined by state borders, and the specific states in each region can be found in the "Introduction to the HCUP KID."[15]

Statistical Analyses

Descriptive statistics with weighted national estimates were conducted to evaluate the distribution of patient and hospital characteristics for those in this cohort. Because KID is a sampled database, our results are reported as estimated values, such as means and frequencies with 95% CIs. These estimates represent national estimates for the associated year. Because of the sampling methodology, national medians cannot be obtained; hence, continuous data are expressed as estimated means. SEs were adjusted for the stratification and clustering of the KID sampling design as described in the 2009 KID documentation published by the Agency for Healthcare Research and Quality.[15] It is important to note that because data in the KID are a composite of deidentified state-level information, our unit of analysis is a patient admission and not a uniquely identified patient. To evaluate the effect of patient and hospital characteristics on the estimated mean age of surgery, we used multivariate ordinary least squares regression to calculate beta coefficients (B) and 95% CIs, using the SVY command in Stata to account for the sampling characteristics of KID. Multivariate logistic regressions were used to calculate OR of undergoing surgery at 0-4 months vs at 5+ months. All regressions were performed on 2009 data only. Two-sided tests were used, with P values <.05 considered statistically significant. All statistical analyses were performed with Stata 12 (StataCorp, College Station, Texas).

Sensitivity Analyses

A proportion of subjects missing race/ethnicity data were labeled as "unspecified" race. We performed a sensitivity analysis to determine the potential impact of these missing data. We evaluated multiple scenarios, including (1) randomly assigning 209 unspecified subjects to white, black/Hispanic, or other (2) assigning all 209 as black/Hispanic, and (3) assigning