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Contribution of Sickle Cell Disease to the Pediatric Stroke Burden Among Hospital Discharges of African-Americans—United States, 1997–2012

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Abstract

Background—Approximately 10–20% of children with sickle cell disease (SCD) develop stroke, but few consistent national estimates of the stroke burden for children with SCD exist. The purpose of this study is to determine the proportion of diagnosed stroke among African-American pediatric discharges with and without SCD.

Procedure—Records for African-Americans aged 1–18 years in the Kids' Inpatient Database (KID) 1997–2012 with ≥1 ICD-9-CM diagnosis code for stroke were included. Data were weighted to provide national estimates. A total of 2,994 stroke cases among African-American children were identified. Diagnoses co-existing with ischemic or hemorrhagic stroke were frequency ranked separately.

Results—From 1997 through 2012, SCD was present in 24% of stroke discharges, with 89% being ischemic stroke. For hospital discharges of African-American children, SCD is the highest co-existing risk factor for ischemic stroke (29%). Stroke in children with SCD occurred predominantly in children aged 5–9 years, older than previously reported. The trend of stroke discharges significantly decreased for children with SCD from 1997 to 2012 for children aged 10–14 years.

Conclusions—SCD is a leading risk factor to pediatric stroke in African-American children. Reducing the number of strokes among children with SCD would have a significant impact on the rate of strokes among African-American children. Preventative intervention may be modifying initial age of presentation of stroke in children with SCD.

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Conflict of interest: Nothing to declare.

Keywords

hemorrhagic stroke; hospitalization; ischemic stroke; sickle cell disease

INTRODUCTION

Stroke affects an estimated 1.2–13 children per 100,000 population under the age of 18 each year in the United States of America.[1–4] It is the eighth leading cause of death for children 1–18 years of age and children who survived may be left with disabilities such as changes to or difficulties with cognitive ability, senses, speech, behavior, and partial or complete paralysis.[5–7] Despite signs, symptoms, and known risk factors, the diagnosis of stroke is often delayed or missed in children as they may be misdiagnosed with other conditions that mimic the symptoms of stroke.[1]

Approximately 72,000–100,000 people in the United States are affected by SCD.[8] Because of newborn screening, we know that SCD occurs in approximately one in 365 African-American births, making African-Americans the predominant group in the United States affected by the disease.[8]

Stroke is a leading cause of morbidity and mortality in children with SCD, especially in children with hemoglobin SS, the most common and severe form of SCD.[9] In a multi-center prospective natural history study (CSSCD), 11% of patients with hemoglobin SS under the age of 20 years develop stroke, with a peak incidence of 1.02 per 100 person-years in children between the ages of 2 and 5 years.[10] Most strokes among children with SCD are ischemic, caused by a vasculopathy that leads to progressive stenosis and eventual catastrophic occlusion of the large arterial branches off the circle of Willis. Patients with SCD also can develop other forms of brain injury including the following: hemorrhagic strokes (older patients), transient ischemic attacks, compensatory abnormal small blood vessel growths (Moya Moya disease), silent infarctions, and progressive neurocognitive impairment.[9] Patients with other forms of SCD (e.g., hemoglobin SC, S Beta thalassemia +, and S Beta thalassemia 0) also develop stroke and brain injuries, but these appear less frequent.[10]

There are few consistent national estimates of the proportion of children with SCD who have a stroke. Further confounding the issue is the fact that some estimates include only ischemic strokes or those with infarction, whereas others include both ischemic and hemorrhagic strokes.[11–13] Stroke is an important cause of cognitive decline in patients with SCD.[14] Understanding the burden of disease and disability due to stroke among those with SCD is important for both clinicians and policy makers.

The epidemiology of stroke and SCD is understudied in the African-American population, and most current studies in this area focus on adults with SCD. The purpose of this study was to determine the proportion of SCD among the African-American pediatric population with stroke.

METHODS

The present study utilized the Healthcare Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID). The KID is among a family of databases and software tools developed as part HCUP, sponsored by the Agency for Healthcare Research and Quality (AHRQ) in partnership with state-level data-collection organizations to provide national estimates of inpatient care.[15] KID is an administrative all-payer inpatient care database made of a stratified sample of pediatric discharges from community hospitals in the United States and includes weights to calculate national estimates. Since 1997, data for KID have been collected and released every three years and each release includes a single year of data. We utilized each available year of data—1997, 2000, 2003, 2006, 2009, and 2012—for a total of 6 years of data. KID includes information on discharges of patients 20 years of age and younger for years 2000–2012 and 18 years of age and younger for 1997.

We selected discharges where the race was recorded as black (which excludes those of Hispanic ethnicity) and where age at discharge was ≥1 year of age and ≤18 years of age. One year of age was chosen as the lower bound to minimize the inclusion of perinatal stroke in the study population and to be consistent across all years of data. Age was divided into four categories: 1–4 years, 5–9 years, 10–14 years, and 15–18 years to be consistent with existing literature. Discharges were included whether they were for patients alive or dead at time of discharge.

For each discharge, at least one ischemic (ICD-9-CM 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 436) and/or hemorrhagic stroke (430, 431) ICD-9-CM code had to be present in at least one of the 15 available diagnosis fields. For analyses considering SCD status, ICD-9-CM codes distinguishing the presence of SCD (282.60–282.64, 282.68–282.69, 282.41–282.42) had to be present in at least one of the 15 available standard diagnosis fields.

To identify the presence of co-existing medical conditions that are known risk factors for pediatric stroke, we modified a method originally from Fullerton et al.[16] and modified by Lo et al.[5] We searched all available diagnosis fields in a secondary data source for ICD-9-CM codes representing known pediatric stroke risk factors and then frequency ranked the results. In addition, we removed ischemic stroke diagnoses without infarction (433.x0, 434.x0), used the individual codes for each type of SCD (282.60–282.64, 282.68, and 282.69) instead of the overarching code (282.6), and added codes for sickle beta thalassemia (282.41 and 282.42). This modification was made to achieve better accuracy in identifying those with stroke and SCD (Table I).

All data analyses were conducted using the SAS (versions 9.2 and 9.3; SAS Institute Inc., Cary, NC) survey procedures. Using the HCUP provided weights, strata, and clusters, we calculated national estimates for frequencies of discharge demographics, SCD status, and stroke type. We utilized the F test to determine if there were differences in the proportions within each category (overall African-American children, African-American children with SCD, and African-American children without SCD) for age, for sex, and for age group. An F test was also used to determine if there were differences in the distribution of proportions

of age, sex, and age group for those with SCD compared to those without SCD (between group differences). The *P*-value associated with the F-value from the F test was used to determine whether statistically significant differences were present for these within group and between group analyses. A *P*-value of <0.05 was used as the cutoff point of statistical significance. We assessed for trends in the proportions of stroke among children with SCD from 1997 to 2012 using linear regression.

Weighted frequencies of 10 or lower were not presented in accordance with HCUP policies. All numbers reported in this manuscript are weighted and are rounded up to whole numbers to be consistent with HCUP reporting.

RESULTS

There were 1.8 million discharges aged 1–18 years with race identified as African-American in the HCUP KID 1997–2012 after weighting. Of the 1.8 million weighted discharges, 2,994 discharges had at least one stroke diagnosis code present. Of the 2,994 discharges with a stroke code, 703 (weighted) also had a diagnosis code for SCD. We found that for all African-American pediatric stroke discharges, regardless of SCD status, and for African-American pediatric stroke discharges without SCD, the highest proportion of discharges occurred among children 15–18 years of age, followed by children aged 10–14 ($P < 0.0001$). For African-American pediatric stroke discharges with SCD, however, the highest proportion of discharges occurred among children 5–9 years of age followed by children 10–14 years of age ($P < 0.0001$). In a comparison of the group with SCD and the group without SCD, we found the difference in the distributions of age to be significant ($P < 0.0001$). We found no significant difference in the distribution of stroke by sex for all African-American stroke discharges (*P* 0.2747) or in a comparison of the group with SCD and the group without SCD (*P* 0.3762) (Fig. 1).

Of the 2,994 total discharges among all African-American pediatric discharges with stroke in the study period, 1,170 (39.1%) had at least one diagnosis code for hemorrhagic stroke and 1,880 (62.8%) had at least one diagnosis code for ischemic stroke. There were 57 discharges (1.9%) that had diagnosis codes for both hemorrhagic stroke and ischemic stroke. Of the hemorrhagic stroke discharges, 486 (16.2%) had diagnosis codes for subarachnoid hemorrhage and 727 (24.3%) had diagnosis codes for intracerebral hemorrhage. There were 42 discharges (3.6%) that had diagnosis codes for both subarachnoid and intracerebral hemorrhage. Stroke discharges that also had diagnosis codes for SCD (703) represented 24% of total stroke discharges. The majority of SCD and stroke discharges had codes for ischemic stroke (89%) ($P < 0.0001$); the same was also true for stroke discharges without SCD (55%) ($P < 0.0001$) (Table II).

After 1997, there was a modest but statistically significant reduction in the proportion of all stroke discharges among African-American children associated with SCD (Fig. 2; Table III). The reduction in SCD-related stroke discharges was restricted to ischemic stroke. There was no reduction in SCD-related stroke at ages 1–4 years and almost no change at 15–19 years.

After frequency ranking co-existing pediatric stroke risk factors, we found that for ischemic stroke discharges among all African-American pediatric discharges with stroke, SCD was the most common co-existing risk factor (present in 33.8% of ischemic discharges), followed by congenital heart disease (19.2%), sepsis/bacteremia (16.4%), head trauma (15.2%), and meningitis/encephalitis (13.6%). For hemorrhagic stroke discharges among all African-American pediatric discharges with stroke, congenital heart disease was the most common co-existing risk factor (24.4%), followed by arrhythmias (18.4%), sepsis/bacteremia (16.2%), coagulation defects (13.2%), and arteriovenous malformation (12.7%). SCD frequency ranked ninth among co-existing diagnoses (8.0%) for hemorrhagic stroke discharges (Table IV).

DISCUSSION

Children with SCD, prior to a first stroke, develop increased blood flow in large cerebral vessels. This can be measured by noninvasive Transcranial Doppler (TCD) ultrasound, and identify an individual at risk for stroke. The Stroke Prevention in Sickle Cell Anemia or STOP trial found that chronic transfusion could prevent first stroke in children with SCD at high risk of stroke as determined by TCD screening. This strategy reduced the untreated risk of stroke, which was 10%, by 90%.[17] Since the first STOP trial, the National Heart Lung and Blood Institute has recommended TCD screening for children 2–16 years of age. The Optimizing Primary Stroke Prevention in Sickle Cell Anemia or STOP two Trial found that alternative long-term solutions are needed to maintain normal blood flow velocity after cessation of chronic transfusions.[18] Existing alternatives include stem cell transplantation, bone marrow transplantation, and oral hydroxyurea.[19–22]

Two recent studies of pediatric stroke hospitalizations among all children in the United States identified SCD as a risk factor for stroke. First, Fullerton et al. reported that compared to white children, African-American children are at an increased risk of stroke and the increased risk remained even when controlling for the presence of SCD.[16] Second, Lo et al. found SCD to be the fifth most frequent risk factor recorded for children with ischemic stroke and the 15th most frequent among children with hemorrhagic stroke but did not stratify by race/ethnicity.[5]

Three other studies examined recent trends in SCD as a comorbid diagnosis with pediatric stroke hospital diagnoses spanning the period before and after TCD screening, as well as hydroxyurea licensure in patients with SCD. George et al. found that from 1995–1996 to 2007–2008 the frequency of SCD diagnoses associated with ischemic stroke hospitalizations among children ages 5–14 years decreased by more than half but no change for hemorrhagic stroke was reported.[23] Ovbiagele and Adams also found a decrease in the frequency of SCD diagnoses among pediatric stroke discharges during the period from 1997 to 2006 that was concentrated among discharges with ischemic stroke.[24] McCavit et al. calculated estimated rates of stroke using two separate HCUP data sets: Nationwide Inpatient Sample (NIS) (an administrative all-payer sample of community hospitals in the United States) and the KID. [25] Rates of stroke significantly decreased between 1997 (0.54 and 0.51 per 100 admissions per year, respectively) and 2009 (0.24 and 0.28 per 100 person years).[25] All

three studies suggest effective implementation of stroke prevention strategies in patients with SCD.

In the current study, approximately 24% of all African-American pediatric discharges with an ICD code for a stroke diagnosis also have a diagnosis code for SCD. Ischemic strokes were more common than hemorrhagic strokes among African-American pediatric stroke discharges. This difference was more pronounced for discharges with SCD compared to those without SCD (89% vs. 55%). As SCD is a known risk factor for ischemic stroke, this distribution was not unexpected.

The frequency of stroke discharges differed by age groups and SCD status. It was interesting to note that stroke discharges for children with SCD occurred predominantly in the 5–9 age group, Similarly, McCavit found that the median age at stroke was 8 years, with an inter quartile range between 5 and 13 years.[25] Stroke discharges for children without SCD occurred predominantly in the 15–18 age group.[26] The reason for these age differences was not assessed in this study, but most likely represents the differences in the mechanisms of disease. Stroke in patients with SCD appeared at an older age than previously reported in the CSSCD.[10]

The contribution of SCD to the pediatric stroke burden among discharges of African-American children is much higher than that reported previously for the general pediatric population by Lo et al. We found that among discharges reflected in HCUP KID, SCD was the most common co-existing risk factor for ischemic stroke discharges and the ninth most common co-existing risk factor for hemorrhagic stroke for children discharged during the study time period. This was consistent with the results from Fullerton et al. that also found the rate among African-American children to be higher and also that SCD was not the sole cause of strokes among African-American children.[16] It is important to continue to study this population separately to draw implications for treatment and prevention of pediatric stroke.

Mechanisms of stroke in children with SCD include disturbances in blood flow, perturbed red blood cell/endothelial wall interaction with subsequent damage, pro-inflammatory and pro-coagulant responses.[9] Known prior risk factors include high arterial blood velocity, transient ischemic attacks, silent infarction, acute chest syndrome, high blood pressure, or nocturnal hypoxia.[9] Although children with stroke in general are at increased risk for hereditary thrombophilias,[27] this has not been extensively reported in patients with SCD. Individuals with SCD and silent cerebral infarction[28] or stroke[29] were found to have decreased tissue plasminogen activator antigen,[28] ADAMTS-13,[28] and increased D-dimers [28,29] compared to controls. Chronic transfusion in children with SCD not only decreases percent of sickle cells, but also appears to correct SCD induced pro-coagulant marker profile.[30] Examination of such possible contributing factors requires detailed, accurate information, often not readily available in an administrative data set, and were not examined in the present study.

The recent study of children and adults with SCD and stroke by Ovbiagele et al. utilized different methodology than the present study.[24] That study utilized the HCUP NIS and

found a decrease in the frequency of SCD diagnoses among pediatric stroke discharges during the period from 1997 to 2006 that was concentrated among discharges with ischemic stroke.[24] Similar to the present study, Ovbiagele found that the proportion of ischemic stroke was higher than the proportion of hemorrhagic stroke for discharges with SCD.[24] The downside to using NIS to study children is that the hospital sample changes each year and may or may not include the same number of children and children's hospitals, unlike the KID database utilized in the present study. Consistent with the findings of George et al., [23] the reduction in SCD-related stroke hospitalizations was concentrated in the 5–14 years age group. The decrease was much larger in the 10–14 years age group than the 5–9 years age group and only the former decrease was significantly different from zero.

LIMITATIONS

The number of states varied by year of data collection and the analyses include information only from states that report race information. This limitation has been previously reported in studies that show up to 20% of race and ethnicity data is missing not at random inHCUP, a concern of great importancewhen considering the statistical validity of results involving race and ethnicity.[23,31,32] An average of 20.6% of discharges (range 8.2–28.1%) was excluded from the present study due to missing race and ethnicity information. Although the use of the provided weights helped adjust for this to a degree, there is also the possibility that our estimate of stroke cases and SCD cases is inaccurate.

The use of secondary data, including administrative data, is advantageous for studying rare conditions when considering both the amount of time needed to gather a significant number of observations in a primary data study, particularly one that is nationally representative. However, the variation in methodology also increases the chance for misclassification bias. The misdiagnosis or inaccurate coding of stroke could contribute to an under or overestimation of stroke events or discharges. Stroke diagnosis in adults, based on Joint Commission and the Centers for Medicare and Medicaid criteria,[33] have positive predictive value (PPV) above 90%.[34] PPV for ischemic stroke in children varies between 40 and 74% for outpatients and inpatients, respectively, when these were compared to imaging report text searches.[35] In that study, 57% of diagnosis of stroke was missed by ICD9/CP code registry search.[35] For a single sickle cell diagnosis, PPV varies between 83 and 96% for outpatients and inpatients, respectively, when compared to newborn screening.[36] With repeated diagnosis, PPV and specificity increase, but sensitivity decreases.[36]

We likely underestimated the number of stroke discharges and stroke discharges with SCD due to changes in the available variables used to calculate age. In 2012, variables that would allow for the selection of children under the age of 1 but greater than 28 days were unavailable for HCUP KID. Thus, the age of 1 year was used as the cutoff for inclusion in all years and relevant strokes for children under the age of 1 were not included.

One limitation of this study is the lack of a comparison population affected by SCD. Hispanic children would be an optimal group to use due to the rising population in the United States and the fact that one out of every 16,305 Hispanic births is affected by SCD.[8] It was not possible to do so in this study due to the small number of Hispanic children

with SCD and stroke (32 hospitalizations after weighting). Future studies would benefit from the utilization of data with a larger Hispanic population.

A final limitation is that the analysis did not include discharges with diagnoses of SCD for which stroke diagnoses were not recorded. As is true of previous analyses, this analysis was limited to SCD as a comorbid condition and did not assess the frequency of stroke among children hospitalized with SCD. However, such estimates were recently published. This study complements McCavit et al.'s study, by placing SCD in the context of stroke burden in the general African-American population.population.[25]

As with prior studies, we used an administrative data set of hospital discharges with no individual record linkages. McCavit included stroke diagnosis if it was listed first.[25] Because we included any stroke diagnosis listed, our data likely included first stroke, as well as repeat visits by individuals with a prior stroke, representing a measure of prevalence. Trends appeared more modest in the current study possibly because these trends reflect overall burden of stroke rather than acute stroke, as defined by a first diagnosis. The use of a large multi-year secondary data source allowed for the identification of rare outcomes such as stroke and SCD among a nationally representative group of African-American discharges in the United States. This study fills some gaps in knowledge of stroke and SCD in the African-American population such as how large of a contribution SCD makes to stroke among African-American children and adolescents compared to the general pediatric population. This study demonstrates the value of looking at the relationship between stroke and SCD using a population-based approach as well as the need for further studies especially on the age distribution of stroke considering SCD status and the trend of stroke among SCD patients before and after the introduction of TCD screening.

Stroke among African-American children is to a degree preventable particularly with the use of methods such as TCD screening and chronic transfusion. Because the contribution of SCD to the stroke burden in African-American children is significant, African-American children with SCD should be targeted for stroke prevention, intervention, and further study.

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Abbreviations

HCUP	healthcare cost utilization project
ICD	International Classification of Diseases
KID	kids' inpatient database
NIS	nationwide inpatient sample
SCD	sickle cell disease
STOP	stroke prevention in sickle cell anemia
TCD	transcranial dopplar

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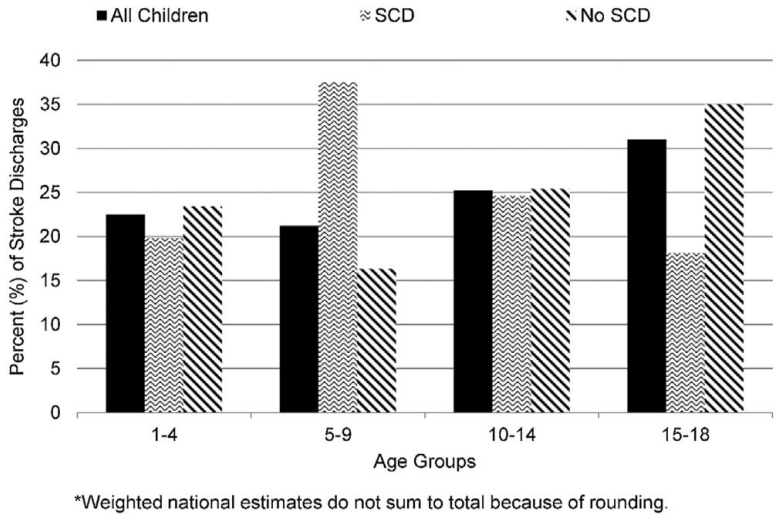

Fig. 1.

African-American pediatric stroke discharges by age group and SCD status from 6 years of HCUP KID 1997–2012. The highest proportion of discharges for all children (N = 2,994) and for those without SCD (N = 2,291) occurred among children 15–18 years of age. For children with SCD (N = 703), the highest proportion of discharges occurred among children aged 5–9. SCD, sickle cell disease; HCUP, Healthcare Cost and Utilization Project; KID, Kids' Inpatient Database.

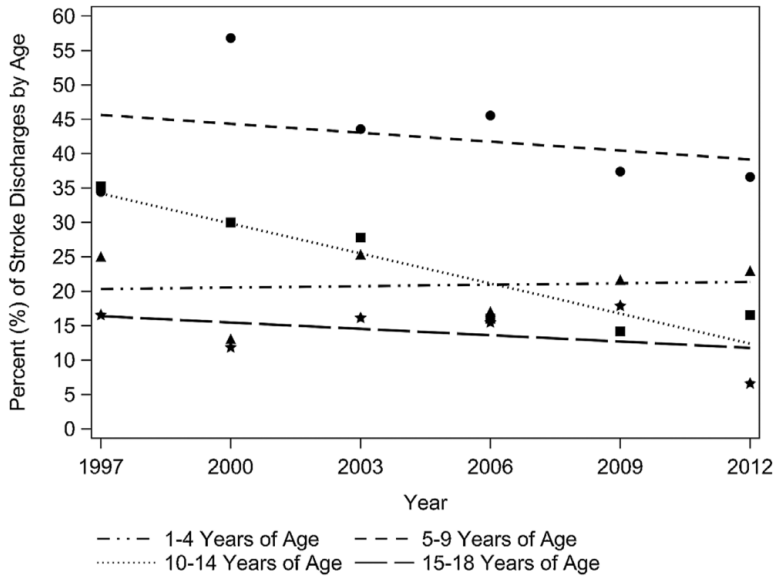

Fig. 2.

Trend of pediatric stroke discharges among African-American children with SCD by age from six years of HCUP KID 1997–2012. The percentage of discharges for stroke among African-American children with SCD declined significantly for those aged 10–14 years of age from 1997 through 2012. SCD, sickle cell disease; HCUP, healthcare cost and utilization project; KID, kids' inpatient database.

TABLE I

ICD-9-CM Codes Used to Identify Co-Existing Pediatric Stroke Risk Factors

Congenital heart disease	648.5, 745.xx, 746.xx, 747.xx
Cardiomyopathy	425.x
Valvular heart disease	424.0–424.3
Arrhythmias	427.xx
Cardiac arrest	427.5
Aneurysm	437.3
Arteriovenous malformations	747.81, 228.02
Moyamoya disease	437.5
Brain tumors (benign and malignant)	191.x, 225.x, 239.6, 198.3, 237.5, 237.6
Dehydration	276.5x, 775.5
Coagulation defects	286.x, 790.92
Other diseases of blood and blood forming organs hypercoaguable states	289.8, 289.81, 289.82
Purpura and other hemorrhagic conditions	287.x
Leukemia, lymphotic	204.x
Leukemia	205.x, 206.x, 207.x, 208.x
Lymphoma	200.xx–203.xx
SCD	282.60–282.64, 282.68, 282.69, 282.41, 282.42
HIV/AIDS	42
Chicken pox/varicella	52
Meningitis/encephalitis	003.21, 013.x, 036.x, 047.x, 048.x, 049.x, 053.0–054.1x, 054.3, 054.72, 056.01, 062.x, 064, 066.2, 063.x, 072.1–072.2, 090.42, 091.81, 094.2, 094.81, 098.82, 100.81, 112.83, 114.2, 115.01, 115.11, 115.91, 130.0, 136.2, 139.0, 320.xx–322.xx, 323.xx
Endocarditis	036.42, 074.22, 098.84, 093.20–24, 112.81, 115.04, 115.14, 115.94, 391.1, 421.x, 424.91
Sepsis/Bacteremia	038.xx, 790.7, 771.8x
Autoimmune disease	136.1, 437.4, 446.x, 447.6, 710.x, 714.xx, 795.79
Migraine	346.xx
Head trauma	850–854.1, 800–804.9
Birth trauma	767.x
Cocaine/amphetamine	304.2, 305.6, 760.75, 304.4, 305.7
Hypertension	401.x, 404.x, 405.x
Diabetes	250
Lipid abnormalities	272.x
Obesity	278.00–01

TABLE II

African-American Pediatric Stroke Discharges by SCD Status and Stroke Type in Six Years of HCUP KID 1997–2012*

	National estimate	%	*P*
Total stroke	2,994		<.0001
Subarachnoid hemorrhage	486	16.2	
Intracerebral hemorrhage	727	24.3	
Ischemic stroke	1,880	62.8	
SCD	703	23.5	<.0001
Subarachnoid hemorrhage	45	10	
Intracerebral hemorrhage	50	8.5	
Ischemic stroke	623	88.7	
No SCD	2292	76.5	<.0001
Subarachnoid hemorrhage	441	19.2	
Intracerebral hemorrhage	678	29.6	
Ischemic stroke	1257	54.8	

SCD, sickle cell disease; HCUP, healthcare cost and utilization project; KID, kids' inpatient database;

*Weighted national estimates do not sum to total because of rounding and because of overlapping stroke diagnoses in 57 discharges (13 with sickle cell disease overlap, 44 without sickle cell disease overlap). There are overlapping hemorrhagic stroke diagnoses in 42 discharges (2 with sickle cell disease overlap, 40 without sickle cell disease overlap).

TABLE III

Results of Trend Analysis for Stroke Among Discharges With SCD by Age in HCUP KID 1997–2012

	Parameter estimate	95% CI
All stroke with SCD	−0.54562	−0.91286, −0.17839
All stroke with SCD—1–4 years of age	0.06851	−1.12819, 1.26520
All stroke with SCD—5–9 years of age	−0.43234	−2.38594, 1.52126
All stroke with SCD—10–14 years of age	−1.45378	−2.28326, −0.62431
All stroke with SCD—15–18 years of age	−0.30807	−1.5226, 0.63612
Ischemic stroke with SCD	−0.52736	−0.81455, −0.24017
Ischemic stroke with SCD—1–4 years of age	0.43815	−1.41568, 2.29197
Ischemic stroke with SCD—5–9 years of age	−0.71007	−4.36199, 2.94185
Ischemic stroke with SCD—10–14 years of age	−2.15424	−4.33152, 0.02304
Ischemic stroke with SCD—15–18 years of age	−0.24319	−1.47389, 0.98751

SCD, Sickle cell disease; HCUP, healthcare cost and utilization project; KID, kids' inpatient database.

TABLE IV

Proportion Distribution of Pediatric Stroke by Co-Existing Risk Factors Among African–American Discharges in Six Years of HCUP KID 1997–2012

	N	%
Ischemic stroke		
SCD	635	33.8
Congenital heart disease	361	19.2
Sepsis/Bacteremia	309	16.4
Head trauma	285	15.2
Meningitis/Encephalitis	256	13.6
Arrhythmias	256	13.6
Hypertension	177	9.4
Coagulation defects	155	8.2
Autoimmune disorders	131	7
Dehydration	125	6.6
Hemorrhagic stroke		
Congenital heart disease	286	24.4
Arrhythmias	215	18.4
Sepsis/Bacteremia	190	16.2
Coagulation defects	155	13.2
Arteriovenous malformation	149	12.7
Hypertension	143	12.2
Meningitis encephalitis	113	9.7
Brain tumors	105	9
SCD	94	8
Purpura and other hemorrhagic conditions	90	7.7

SCD, sickle cell disease; HCUP, healthcare cost and utilization project; KID, kids' inpatient database.