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Pediatric Stroke in the United States and the Impact of Risk Factors

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Abstract

One approach to studying pediatric stroke is to analyze a national database that contains data on a significant number of children. We examined an administrative dataset of hospital discharges from the United States, Kids' Inpatient Database 2003 (KID2003), for *ICD-9* codes associated with hemorrhagic or ischemic stroke in children aged >30 days to 20 years. 3156 children were discharged with a diagnosis of ischemic stroke and 2022 with hemorrhagic stroke after statistical weighting. The odds for a male discharged with hemorrhagic stroke was 1.5 (CI: 1.35–1.68) and for ischemic stroke was 1.37 (CI: 1.24–1.51) compared with a female. The odds for males discharged with a stroke were greatest for ages 16 to 20 years and least for 4 years. This study confirms a male predominance for stroke. The odds for hospitalization with a stroke diagnosis are greatest in very young and older adolescent males. Hemorrhage is an important stroke subtype in children.

Keywords

stroke; risk factor; hemorrhagic; ischemic; gender; hospitalization

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Pediatric stroke affects survivors with lifelong disabilities in motor, cognitive, and behavioral function. Presently, there are no specific treatments for stroke, therefore prevention is exceedingly important. The role of risk factors and how they affect the risk of stroke in large groups of children is not well understood. Recent studies have demonstrated the wide range of risk factors that can predispose a child to arterial ischemic stroke[1–3]; however, many of these studies represent case series from a single institution.

There have been few population-based studies, most of relatively small cohorts of children, that examined the proportions of ischemic and hemorrhagic stroke, or the occurrence of stroke risk factors.[4–7] One large population-based study in California analyzed stroke subtypes and potential risk factors in 2278 children.[8] The study identified race and gender as important risk factors for ischemic and hemorrhagic stroke. In that study, a number of potential risk factors were ranked by their frequency of occurrence; congenital heart disease, arrhythmias, and infections were the 3 most common risk factors. This study demonstrated the value of large population-based studies in comparing the occurrence of ischemic versus hemorrhagic stroke, and in determining the frequency of risk factors in children.

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Five studies examined pediatric stroke at the national-level. Steinlin and colleagues determined the incidence, symptoms, and risk factors for 80 Swiss children with arterial ischemic stroke.[9] de Veber and colleagues analyzed the incidence, risk factors, and outcome in 160 children with cerebral sinovenous thrombosis in Canada.[10] Although these 2 studies examined national-level data, they examined comparatively small groups of children. Fullerton and colleagues analyzed US mortality data in 2 pediatric stroke studies,[11,12] and found that racial and geographic factors increased the risk of death from pediatric stroke. Death from stroke, however, represents only a small proportion of children affected by stroke. Recently, Chen and colleagues examined an administrative database of hospital discharges throughout Taiwan.[13] Although the data were not presented in detail, stroke incidence was said to be higher in males than females. The incidence of all pediatric strokes was highest in children aged < 4 years, followed by children aged 15 to 19 years.

Given the many gaps in our knowledge regarding pediatric stroke, larger population-based studies of pediatric stroke are needed. Such large population-based studies are difficult to perform because of the low incidence of pediatric stroke. One alternative is to use national administrative databases to examine gender, stroke subtype, and concurrent diagnoses for significant numbers of children who had stroke. For these reasons we analyzed a subset of the Nationwide Inpatient Survey, called KID2003, to determine the frequency of ischemic and hemorrhagic stroke discharge, and to determine associated risk factors in children in the United States.

Methods

Data Source

The most recent Kids' Inpatient Database (KID) 2003, a component of the Healthcare Cost and Utilization Project[14] was used in this study. The KID is the only dataset of its kind designed to study children's use of hospital inpatient services in the United States. It contains clinical information from inhospital discharges (up to 15 diagnoses per discharge) and discharge sampling weights of children aged 20 years or less from 3438 community, nonrehabilitation hospitals in 36 participating states. The reporting hospitals are nonfederal hospitals, short-term hospitals, general and other specialty hospitals, Federal hospitals, long-term hospitals, psychiatric hospitals, alcoholism/chemical dependency treatment facilities, and hospital units within institutions are excluded.[14]

The KID2003 data set included 2 984 129 hospital discharges that represent 7 409 162 discharges throughout the United States (after statistical weighting). The data in KID2003 are discharge-based and unique patients were not identified. We could not exclude the possibility that 1 participant might have been discharged multiple times; therefore we did not attempt to calculate incidences of stroke. Datasets for the KID were published for 1997 and 2000; however, there were changes in the number of participating states during this time. Therefore we restricted our analysis to 2003, the most recent year available.

United States population estimates of children aged 20 years and younger were obtained from the National Center for Health Statistics website: www.cdc.gov/nchs.[15]

Measures

Stroke-related discharges—Discharges related to stroke were identified using the *International Classification of Disease codes, 9th revision* (*ICD-9*), for stroke in any of the available 15 diagnostic positions. We chose this approach because the identification of ischemic and hemorrhagic stroke cases is maximized if all positions are searched.[16] We excluded children aged <30 days to minimize the inclusion of children who had a perinatal stroke or neonatal intraventricular hemorrhage. Hemorrhagic strokes were defined as *ICD-9* codes: 430 (subarachnoid hemorrhage, SAH) or 431 (intracerebral hemorrhage, ICH). Ischemic strokes were defined as *ICD-9* codes: 433 (occlusion and stenosis of precerebral arteries); 434 (occlusion of cerebral arteries); 436 (acute, but ill-defined, cerebrovascular disease); and 437.6 (nonpyogenic thrombosis of intracranial venous sinus; cerebral sinovenous thrombosis).

To identify medical disorders that might predispose to childhood stroke, we modified a strategy used by Fullerton and colleagues[8] to search all the diagnostic fields for coexisting conditions that would be likely to predispose to stroke. That strategy was modified by including purpura and other hemorrhagic conditions (287.1–287.5), autoimmune disorders such as Kawasaki's disease and antiphospholipid antibody syndrome (136.1, 795.79, 446.1–7, 447.6, 714.xx), cardiomyopathy (425.x), and hypercoaguable states (289.xx). The categories of connective tissue disease and vasculitis were collapsed into one category of autoimmune disease. Polycythemia, iron deficiency anemia, hemolytic-uremic syndrome, atherosclerosis, smoking, and oral contraceptives were not searched in this study. (A complete list of codes is included in the Appendix.)

Statistical Analysis

Data analyses were conducted using SAS statistical software (version 9.1, SAS Institute Inc., Cary, NC) and Stata/SE (version 9.2 for Windows, StataCorp, College Station, Tex). Weighted frequencies of hospitalizations with the diagnoses of hemorrhagic or ischemic strokes were analyzed by age, gender, race, primary insurer, and median household income for patient's zip code. The associated diagnoses were listed in order of the frequency with which they appeared in hospital discharge records.

The incidence rates (standardized to the 2003 US population) of stroke-related hospitalizations in the United States by gender (age-adjusted) and age group were estimated using the weighted frequencies and the US population estimates. [17] Confidence intervals were calculated using the normal approximation with standard errors based on the Poisson distribution. Survey logistic regression was used to calculate odds ratios to compare gender, race/ethnicity, and age groups.

Frequencies of coexisting diagnoses were presented only when at least 10 actual cases were present. Estimates based upon smaller numbers of cases would not be accurate. This operational definition served to distinguish those potential risk factors that were more likely to be associated with stroke from those where the association was less certain.

This study was approved by the Institutional Review Board of the Research Institute at Nationwide Children's Hospital.

Results

Basic Demographics of Pediatric Stroke in the United States

There were 3015 reported stroke-related hospitalizations of ischemic, hemorrhagic stroke, or cerebral sinovenous thrombosis. After statistical weighting, this is equivalent to 5091 stroke-related hospitalizations of childhood stroke throughout the United States (3156 ischemic and 2022 hemorrhagic) in 2003 (Table 1). In the remainder of this report, hospitalizations will refer to the number of cases after weighting. (The sum of ischemic and hemorrhagic strokes do not total overall stroke because 51 children were coded as having both ischemic and hemorrhagic stroke.) We found that when the search was restricted to only the first 2 diagnostic positions, we only identified 53% of ischemic strokes and 72% of hemorrhagic strokes.

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United States' Burden of Pediatric Stroke, Stroke Type, Age, and Gender

We estimated hospitalization rates for stroke to assess the overall burden of pediatric stroke throughout the United States. The hospitalization rate of ischemic stroke (3.70 per 100 000 children) was more than 50% higher than the hospitalization rate with hemorrhagic stroke (2.37 per 100 000 children; Table 2). Rates were highest in children aged less than 4 years and between ages 15 and 20 years for ischemic (5.9 per 100 000 and 4.3 per 100 000, respectively) and hemorrhagic stroke (2.5 per 100 000 and 3.3 per 100 000, respectively; Table 2). Hospitalization rates by race/ethnicity could not be calculated because of different definitions of race/ethnicity in the population data available (Table 2). The rates of hospitalization were higher for males than for females for both hemorrhagic (2.49 per 100 000 versus 2.18 per 100 000) and ischemic stroke (3.77 per 100 000 vs 3.62 per 100 000). Inhospital deaths occurred in 10.1% cases of ischemic stroke and 18.0% cases of hemorrhagic stroke.

We calculated the odds ratios of males versus females for hospitalizations for ischemic or hemorrhagic stroke. The odds for males compared with females with ischemic stroke was 1.37 (95% CI: 1.24–1.51, $P < .001$; Table 3). The odds for males compared with females with hemorrhagic stroke was 1.50 (95% CI: 1.35–1.68, $P < .001$). When stratified by age group, the odds for males compared with females aged 15 to 20 was 2.62 (95% CI: 2.23–3.11, $P < .001$). Similarly, the odds of being hospitalized with the diagnosis of an ischemic stroke for males compared with females aged 15 to 20 years was 3.45 (95% CI: 2.85–4.18, $P < .001$; Table 3). There was a trend toward an increased odds for hospitalization in males aged $0 \leq 4$ years for hemorrhagic (odds ratio of 1.29) and ischemic stroke (odds ratio 1.17) when compared with females; however, these trends barely reached statistical significance.

Coexisting Diagnoses as Potential Risk Factors

When we searched all diagnostic positions for coexisting conditions that were likely to serve as risk factors for stroke, 70% of ischemic stroke and 71% of hemorrhagic stroke cases had no conditions present. For those cases of ischemic stroke in which a condition was present, the 5 most frequent diagnoses were congenital heart disease, head trauma, meningitis/encephalitis, sepsis, and sickle-cell disease, which were listed in 7.8% to 9.6% of the cases (Table 4). Cardiac arrhythmias and hypertension were modestly associated with pediatric ischemic stroke (6% and 5%, respectively). Associations between congenital heart disease, sepsis, meningitis, sickle-cell disease, and ischemic stroke have been reported in the past; however, a link between ischemic stroke and arrhythmias or hypertension was unexpected. Risk factors for adult stroke such as diabetes and obesity were reported less frequently.

The first 3 most common diagnoses associated with hemorrhagic stroke were congenital heart disease (13.6%), arteriovenous malformations (AVMs; 13.5%), and sepsis (9.4%; Table 4). These diagnoses have been previously reported as risk factors for hemorrhagic stroke, but as with ischemic stroke, there was an association with arrhythmias and hypertension, which were listed in 6% to 9% of cases. Although AVMs and sepsis might be expected to be associated with hemorrhagic stroke, congenital heart disease, hypertension, and arrhythmias have not been associated with pediatric hemorrhagic stroke.

Economic Status and Stroke

We found no association between economic status, the source of health care insurance, and the occurrence of stroke. The economic status of the patient's household, as measured by median household income for the residential zip code, was similar for those children with and without a stroke diagnosis (data not shown). The proportions of children with hemorrhagic or ischemic stroke were the same for all income levels (Table 5). In this cohort, roughly half of the patients were covered by private insurance and roughly half were covered by Medicaid. The source of health care insurance was the same for children who had a stroke and those children who did not (data not shown). The proportions of children with hemorrhagic or ischemic strokes were the same for all sources of health care insurance.

Discussion

The key findings of this study were (1) the risks of being hospitalized with the diagnoses of ischemic or hemorrhagic stroke are higher for males younger than age 4 years and older adolescent males when compared with females. (2) Intracranial hemorrhage is an important cause of pediatric stroke at a national level, and hemorrhagic stroke has many risk factors that overlap with those for ischemic stroke. (3) The analysis of large datasets can provide clues to risk factors for pediatric stroke that might not be detected in small studies. (4) Stroke-related hospitalization in children does not seem to be altered by household economic status or the level of health insurance.

Effect of Age and Gender

The current study confirms earlier published reports[8,18–20] that male children are at greater risk for developing ischemic and hemorrhagic strokes than female children. The results of the current study are similar to those of an international cohort study, recently reported in abstract form.[21] That study found a male predominance for children with arterial ischemic stroke and cerebral sinovenous thrombosis, and also found increased risk for strokes due to cardiac disease, hematological malignancies, and head and neck trauma in males. We extend these earlier reports with the observation that there is an effect of age and gender together, so that males at specific age groups have significantly higher odds of having a stroke-related hospitalization when compared with females. This finding is similar to a recent analysis of pediatric stroke in Taiwan, which reported the highest incidences for all types of stroke in very young males followed by older adolescent males.[13] The reasons for these patterns are unknown, but are not readily explained by the lifestyle choices (smoking, alcohol, and atherosclerosis) prevalent in adults. Although older adolescents may adopt adult lifestyle choices, the duration of their exposure is not equivalent to middle-aged or elderly males. Further investigation into the role of male gender in the genesis of stroke is warranted.

Intracranial Hemorrhage is an Important Component of Pediatric Stroke

The present study demonstrated that hemorrhagic strokes accounted for 39% of all hospitalizations with a diagnosis of pediatric stroke. This frequency is consistent with earlier reports that noted the importance of hemorrhagic strokes in children in the United States.[4,5] These frequencies, however, may depend upon the population studied. The study from Taiwan, found that 60% to 70% of pediatric strokes was due to hemorrhage. Many studies of pediatric stroke have focused upon arterial ischemic stroke or sinovenous thrombosis,[22–24] and did not include hemorrhagic stroke. Given that we found hemorrhagic stroke accounts for one third of all stroke-related hospitalizations, future studies of pediatric stroke should address the management and outcome of hemorrhagic stroke.

Risk Factors for Pediatric Stroke

The analysis of coexisting diagnoses identified congenital heart disease and infections (sepsis and meningitis/encephalitis) as the most common diagnoses in children hospitalized with ischemic and hemorrhagic stroke. Arrhythmias, hypertension, and coagulation defects were associated with both types of stroke, similar to what was found in the California study.[8] Although associations between congenital heart disease, infection, and stroke are not surprising, the link between arrhythmias, hypertension, and stroke in children is unexpected. Few studies of pediatric stroke have identified a link between arrhythmias or hypertension. One cohort study of pediatric arterial ischemic stroke found that 50% of the participants had systolic hypertension, a level much higher than that found in the current study.[25] The finding of that cohort study and the current report suggest there is an association between hypertension and pediatric stroke. A recent cohort study of pediatric hypertension suggests that it may be more common than typically suspected;[26] therefore a link between hypertension and stroke in children is potentially significant. The nature of any association is unknown and requires further investigation. The association with arrhythmias is also unexplained. It is possible that arrhythmias are a surrogate marker for congenital heart disease; however, arrhythmias are not common complications of congenital heart disease.[27–29] This association also requires further investigation.

We did not find associations with certain risk factors that previously have been linked with stroke. Endocarditis, aneurysm, and varicella infection were listed in less than 11 actual cases. The lack of an association of varicella with hospitalization for ischemic stroke was unexpected. A number of studies have linked prior varicella infection to childhood arterial ischemic stroke.[30–32] Perhaps the extent of varicella immunization prior to 2003 reduced the number of varicella cases, and then reduced the frequency of ischemic stroke associated with varicella.

Hospitalization Rates

The current study reports hospitalization rates of 3.70 per 100 000 for ischemic stroke and 2.37 per 100 000 for hemorrhagic stroke. In the California study of pediatric stroke, which is the most similar to the current report, the incidence of all childhood strokes was 2.3 per 100 000 children, 1.2 per 100 000 for ischemic stroke, and 1.1 per 100 000 for hemorrhagic stroke. We recognize that the current study may have listed strokes that occurred prior to recorded discharge, and we cannot exclude the possibility that participants were hospitalized more than once. The hospitalization rate for childhood stroke in the United States has been reported previously in an abstract[33] to be 12 per 100 000 children for all strokes, 7.9 per 100 000 for ischemic stroke and 4.2 per 100 000 for hemorrhagic stroke. The range of these earlier reports suggests that our results provide an approximation for the occurrence of pediatric stroke in the United States.

We were surprised to find no association between the patient's economic status and a stroke-related hospitalization. The ratio of children with a stroke-related hospitalization relative to hospitalizations for children without a stroke-related diagnosis was the same regardless whether the children were covered by private insurance, Medicaid, self-pay, or no charge. Similarly, the ratio of children hospitalized with a diagnosis of hemorrhagic or ischemic stroke to unaffected children was the same regardless of the household income level. There is substantial evidence in adults that socioeconomic status is inversely linked to the incidence of stroke,[34–39] and may reflect the lack of access to preventive medical care. Such a link is not apparent with children.

There are limitations to the current study. The use of *ICD-9* codes to identify patients with stroke is known to miss cases of adult ischemic stroke.[40,41] Golomb and colleagues reported that pediatric cases coded as arterial ischemic stroke,[42] or cerebral sinovenous thrombosis[43] may be miscoded, so that the cases might actually represent some other diagnosis. Because we did not have access to the primary medical records, we cannot exclude the possibility that some of the cases in KID2003 might not have involved strokes. Because the data are anonymized and discharge-level, we could not examine records in detail to verify the sensitivity and specificity of the codes. Furthermore, a child who was discharged multiple times would appear as multiple cases. Therefore, it is possible that certain diagnoses such as sickle-cell disease or malignancies may be over-represented. Hospital discharge records do not include children who are managed only as outpatients, so children who suffered silent infarcts from sickle-cell disease or who had the delayed diagnosis of presumed perinatal stroke are underrepresented in this dataset. We believe, however, that the large number of cases will tend to average out individual errors of counting. We believe that excluding infants aged less than 1 month minimized the inclusion of neonatal intraventricular hemorrhages. It is possible that some cases listed as nontraumatic intracerebral hemorrhage may actually reflect traumatic hemorrhage.

The KID2003 database was not designed to study stroke, so the extent of the diagnostic evaluations reflect the practice of the average physician in 2003. It is possible that if all cases were prospectively evaluated by pediatric stroke specialists, the evaluations might have identified a greater number of coexisting diagnoses. This limitation is particularly applicable in the category of the prothrombotic disorders where there has been rapid growth in the number of identifiable disorders.[1]

The population of the United States is heterogeneous and composed of multiple ethnic groups. The results of this study cannot be readily applied to nations with more homogeneous populations. The results can serve as the basis for comparisons with other countries where the populations have been heavily influenced by the immigration of multiple ethnic groups.

Despite these limitations the current study provides a population-based overview of pediatric stroke sub-types and the frequency with which potential risk factors occur in affected children. This study identified that hemorrhagic stroke is frequently listed in pediatric stroke-related hospitalizations. This study also confirmed that arrhythmias and hypertension are associated with pediatric stroke-related hospitalizations. The reason for this association is uncertain and is an area for future research. However, this type of question likely will be answerable only by examining large datasets of children with hypertension or arrhythmias, or by prospectively acquired data.

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Appendix. ICD-9 Codes used to identify cases of stroke

Hemorrhagic Stroke

430 Subarachnoid hemorrhage

431 Intracerebral hemorrhage

Ischemic Stroke

433.xx Occlusion and stenosis of precerebral arteries

434.xx Occlusion of cerebral arteries

436 Acute, but ill-defined, cerebrovascular disease

437.6 nonpyogenic thrombosis of intracranial venous sinus

ICD-9 Codes used to identify 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 (malignant and benign)	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, and 289.82
Purpura and other hemorrhagic conditions	287.x
Leukemia, Lymphocytic	204.x
Leukemia	205.x, 206.x, 208.x, 207.x
Lymphoma	200.xx–203.xx
Sickle Cell disease	282.6x
HIV/AIDS	042
Chicken pox/varicella	052
Meningitis/encephalitis	003.21, 013.x, 036.xx, 047.x–049.x, 053.0–053.1x, 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 1

Demographic Characteristics of Stroke-Associated Hospitalizations for Actual Sample and National Estimates, 2003[a]

	Overall Strokes				Ischemic Stroke				Hemorrhagic Stroke			
	Actual Sample	National Estimates	95% Confidence Interval	Percentage of Nonmissing Totals	Actual Sample	National Estimates	95% Confidence Interval	Percentage of Nonmissing Totals	Actual Sample	National Estimates	95% Confidence Interval	Percentage of Nonmissing Totals
Total	3015	5091	(4556, 5627)		1851	3156	(2790, 3522)		1215	2022	(1793, 2251)	
Gender												
Males	1594	2697	(2404, 2991)	53.0	965	1646	(1447, 1846)	52.2	650	1089	(955, 1223)	53.9
Females	1399	2362	(2090, 2634)	46.4	883	1506	(1311, 1700)	47.7	546	905	(788, 1024)	44.8
Missing	22				≤10				19			
Race												
White	1055	1804	(1523, 2085)	47.4	661	1142	(947, 1338)	48.3	415	698	(577, 819)	46.2
Black	460	804	(659, 948)	21.1	315	556	(449, 662)	23.5	150	257	(203, 312)	17.0
Hispanic	487	827	(656, 998)	21.7	264	456	(348, 565)	19.3	234	390	(303, 477)	25.8
Asian/Pacific Islander	62	100	(64, 136)	2.6	38	61	(36, 87)	2.6	25	41	(24, 58)	2.7
Native American	17	29	(15, 44)	0.8	≤10				≤10			
Other	141	242	(173, 312)	6.4	78	134	(92, 177)	5.7	64	110	(72, 149)	7.3
Missing	793				485				319			
Age group												
≤ 4 years	946	1647	(1398, 1895)	32.4	668	1168	(981, 1355)	37.0	289	500	(409, 591)	24.7
5 years ≤ age ≤ 9 years	437	749	(634, 863)	14.7	273	472	(391, 552)	15.0	174	295	(232, 357)	14.6
10 years ≤ age ≤ 14 years	500	854	(729, 978)	16.8	271	467	(386, 552)	14.8	243	411	(335, 487)	20.3
15 years ≤ age ≤ 20 years	1132	1843	(1669, 2015)	36.2	639	1051	(930, 1173)	33.3	509	819	(726, 911)	40.5

[a] Weighted estimates do not sum to total because of rounding. Sum of Ischemic and Hemorrhagic Stroke do not total overall stroke because of overlapping diagnoses in 51 children. Source: KID 2003.

Table 2

National Estimates and Rates of Stroke-Associated Hospitalization for Children Aged Over 30 Days and 20 Years or Less[a]

A. National Estimates and Rates per 100 000 of Stroke-Associated Hospitalization by Stroke Subtype

Stroke subtype	National Estimates (n)	Rate	95% Confidence Interval
Ischemic	3156	3.70	3.57–3.83
Hemorrhagic	2022	2.37	2.27–2.47

B. National Estimates and Rates per 100 000 of Stroke-Associated Hospitalization by Stroke Subtype and Age Group

	Hemorrhagic			Ischemic		
Age group	National Estimates (n)	Rate	95% Confidence Interval	National Estimates (n)	Rate	95% Confidence Interval
≤4 years	500	2.5	2.31–2.75	1168	5.9	5.57–6.24
5–9	294	1.5	1.32–1.66	471	2.4	2.17–2.60
10–14	411	1.9	1.75–2.13	466	2.2	2.00–2.40
15–20	818	3.3	3.10–3.55	1051	4.3	4.01–4.53

C. National Estimates of Stroke-Associated Hospitalization by Race/Ethnicity

	Hemorrhagic	Ischemic
Ethnic group	National Estimates (n)	National Estimates (n)
White	698	1142
Black	257	556
Hispanic	290	456
Asian/Pacific Islander	41	61
Native American	14	17
Other	110	134
Percent missing[b]	25.4%	25.0%

D. National Estimates and Rates per 100 000 of Stroke-Associated Hospitalization by Gender and Stroke Subtype

	Hemorrhagic				Ischemic	
Gender	National Estimates (n)	Rate	95% Confidence Interval	National Estimates (n)	Rate	95% Confidence Interval
Male	1089	2.49	2.34–2.64	1646	3.77	3.58–3.95
Female	906	2.18	2.03–2.32	1506	3.62	3.44–3.81

[a]Note there was a small amount of missing gender data based on the weighted frequency: 1.3% for Hemorrhagic Stroke and <1% for Ischemic Stroke.

[b] The percent missing is based on the weighted frequency.

Table 3

Odds Ratios for Stroke-Related Hospitalizations in Males Compared With Females by Stroke Subtype and Age Group

	Odds Ratio	95% Confidence Interval	*P*-value
Stroke Subtype			
Ischemic	1.37	1.24–1.51	<.001
Hemorrhagic	1.50	1.35–1.68	<.001
Age group for Ischemic			
Age range			
≤4 years	1.17	1.00–1.37	.048
5–9 years	0.72	0.55–0.93	.011
10–14 years	1.16	0.90–1.50	.242
15–20 years	2.62	2.23–3.11	<.001
Age group for Hemorrhagic			
Age range			
≤4 years	1.29	1.00–1.65	.049
5–9 years	0.98	0.71–1.33	.882
10–14 years	0.92	0.69–1.22	.555
15–20 years	3.45	2.85–4.18	<.001

Table 4

Coexisting Diagnoses With the Diagnosis of Ischemic Stroke (n = 3156) and Hemorrhagic Stroke (n = 2022)

	N	Percent
Ischemic Stroke		
Congenital heart disease	304	9.6
Head trauma	299	9.5
Meningitis encephalitis	276	8.7
Sepsis	268	8.5
Sickle-cell disease	246	7.8
Coagulation defects	195	6.2
Arrhythmia	193	6.1
Hypertension	172	5.4
Autoimmune disorders	145	4.6
Purpuric disorders	131	4.2
Moyamoya	81	2.6
Brain tumor	77	2.4
Leukemias	76	2.4
Migraine	76	2.4
Cardiac arrest	76	2.4
Cardiomyopathy	66	2.1
ALL	64	2.0
Diabetes	51	1.6
Birth trauma	46	1.5
Valvular heart disease	46	1.5
Obesity	44	1.4
Hypercoaguable states	43	1.4
Arteriovenous malformation	36	1.1
Endocarditis	36	1.1
Cocaine	31	1.0
Aneurysm	23	0.7
Hemorrhagic Stroke		
Congenital heart disease	276	13.6
Arteriovenous malformation	272	13.5
Sepsis	191	9.4
Arrhythmia	181	9.0
Coagulation defect	155	7.7
Hypertension	124	6.1
Purpuric disorders	122	6.0
Brain tumor	114	5.6
Meningitis encephalitis	77	3.8
Leukemia (includes ALL)	59	2.9
Cardiac arrest	59	2.9

	N	Percent
Head trauma	58	2.9
Autoimmune	52	2.6
ALL	42	2.1
Sickle-cell disease	31	1.5
Cocaine	26	1.3
Aneurysm	22	1.1
Diabetes	20	1.0
Cardiomyopathy	19	0.9

Note: ALL, acute lymphocytic leukemia.

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Table 5

Stroke-Associated Hospitalizations by Income Level and by Payor Status, 2003[a]

	Overall Strokes				Ischemic Stroke				Hemorrhagic Stroke			
	Actual Sample	National Estimates	95% Confidence Interval	Percentage of Nonmissing Totals	Actual Sample	National Estimates	95% Confidence Interval	Percentage of Nonmissing Totals	Actual Sample	National Estimates	95% Confidence Interval	Percentage of Nonmissing Totals
Median Income[b]												
$24 999 or less	818	1408	(1214, 1603)	28.3	503	879	(737, 1021)	28.4	327	350	(466, 634)	19.8
$25 000–$34 999	799	1331	(1152, 1510)	26.8	520	873	(740, 1005)	28.3	292	482	(405, 559)	27.3
$35 000–$44 999	723	1209	(1057, 1361)	24.3	425	717	(615, 819)	23.2	311	515	(433, 598)	29.1
$45 000 or more	603	1020	(865, 1176)	20.5	363	621	(514, 728)	20.1	252	421	(344, 498)	23.8
Missing	72				40				33			
Payor												
Medicare	12	20	(8, 33)	0.4	≤10				≤10			
Medicaid	1261	2140	(1859, 2420)	42.1	826	1,411	(1203, 1619)	44.8	455	764	(654, 874)	37.8
Private insurance	1439	2418	(2148, 2688)	47.6	842	1,431	(1254, 1607)	45.4	621	1029	(692, 1165)	51.0
Self pay	136	227	(180, 274)	4.5	70	119	(90, 149)	3.8	69	112	(80, 145)	5.5
No charge	≤10				≤10				≤10			
Other	153	263	(179, 346)	5.2	95	165	(101, 231)	5.2	62	105	(73, 138)	5.2
Missing	≤10				≤10				≤10			

[a]Weighted estimates do not sum to total because of rounding. Sum of ischemic and hemorrhagic stroke do not total overall stroke because of overlapping of diagnoses in 51 children.

[b]Median income for patient's zip code of residence.