Incidence and mortality rates of acute ischemic stroke in hospitalized patients in the United States

Kamleshun Ramphul1, Yogeshwaree Ramphul1, Shaheen Sombans3, Petras Lohana4, Renuka Verma5, Nomesh Kumar4, Jyotsnav Joynauth6

1Shanghai Xin Hua Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China
2Sir Seewoosagur Ramgoolam National Hospital, Pamplemousses, Mauritius
3Bharati Vidyapeeth University Medical College and Hospital, Pune, India
4Liaquat University of Medical and Health Sciences Hospital, Jamshoro Sindh, Pakistan
5Guru Gobind Singh Medical College and Hospital, Punjab, India
6Zhejiang University, Hangzhou, China

Submitted: 5 January 2021
Accepted: 30 April 2021

The American Heart Association recently reported that stroke is currently the 5th most common cause of death among Americans as one in every 19 deaths is from stroke [1]. While some studies have shown a decline in the incidence and rate of acute ischemic stroke (AIS) hospitalizations among adults in the United States [2], its impact over the healthcare system in the United States is still a major burden. Several racial/ethnic and gender disparities have also been reported among AIS patients over the years. A rise in the incidence among younger individuals, which could be linked with the use of multiple drugs predisposing to stroke such as cocaine [3, 4], has also raised serious concerns about the condition [2]. Thus, we conducted a retrospective study on the incidence and mortality of AIS hospitalizations and understand its economic impact in the United States.

Each year, the “Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ) and their partners”, releases one of the largest public all-payer inpatient databases in the United States. The 2017 National (Nationwide) Inpatient Sample (NIS) database is the one of the most recent versions released by the HCUP [5]. It consists of more than 7 million unweighted records of admissions which, in its weighted form, is estimated to cover at > 97% of the US population from January 1st 2017 to December 31st 2017. Additional information about the database can be accessed from www.hcup-us.ahrq.gov.

We used the methodology described by Ramirez et al. in past studies of AIS to conduct a retrospective observational study [2]. First, we filtered the database to include only admissions of patients aged 25 and over. Cases of AIS were identified using the International Classification of Diseases, 10th Revision, Clinical Modification codes I63.x [6, 7], provided by the HCUP as primary discharge diagnostic codes. We compared the incidence of AIS in different groups based on sex, race, and primary payer forms. The mortality rates in each group were also compared. A p-value < 0.05 was considered statistically significant. We further used the 2017 census data (https://www.census.gov) to estimate the overall incidence
Incidence and mortality rates of acute ischemic stroke in hospitalized patients in the United States

of AIS as well as the incidence in males and females. As per HCUP guidelines, all data were converted to weighted forms (DISCWT) and the study was waived from institutional review board (IRB) approval and ethical clearance. IBM SPSS Statistics version 24.0 (IBM Corporation, Armonk, NY) was used for all statistical analyses.

The 2017 NIS data consisted of 522,740 cases of AIS with 261,980 (50.1%) females and 260,755 (49.9%) males ($p < 0.01$) (Table I). AIS had a higher prevalence per 100,000 admissions in males than females (2097 cases per 100,000 admissions in males and 1618 cases per 100,000 admissions in females). The overall rate per 100,000 Americans was 236 cases of AIS. 20,995 deaths were reported with an overall mortality rate of 3.1%. Females admitted with AIS had a higher mortality rate than males ($p < 0.01$). Medicare was the most common form of primary payer form, covering 65.8% of all AIS hospitalizations ($p < 0.01$).

The incidence of AIS was 243 per 100,000 Americans among males and 229 per 100,000 Americans among females. The mean length of stay was 4.91 days while the mean hospital charges were $60,002.50. The total hospital charges for AIS patients in 2017 were $31,252,598,673.

These results provide a fresh perspective of the impact and burden of AIS in the United States. Our study showed that the rate of AIS per 100,000 Americans increased in 2017. It rose from 204 in 2010 to 236 in 2017 [2]. The rise and presence of multiple risk factors over the years due to changes in lifestyle has been a major factor contributing to the [8] higher incidence of AIS over the years [1]. Hales et al. found that there has been increasing prevalence of obesity among adults over the last two decades [9], while Mitchell et al. adjusted their data for age, sex, and ethnicity to conclude that obesity led to a higher stroke risk with an odds ratio of 1.57 (95% confidence interval, 1.28–1.94) [10]. The presence of hypertension (42%) and diabetes mellitus (17%) have also been seen among young patients with AIS [11, 12]. While an improvement in awareness of hypertension is now present among young adults, no drastic improvement in prevalence and incidence has been reported [13]. In their study of prediabetes, Andres et al. noted higher prevalence of prediabetes in young adults than adolescents. They also found a higher incidence in males and obese patients.

The incidence of AIS per 100,000 Americans in men (243) was lower in 2017 as compared to 2000–2005 (298, 294, 281, 267, 254, 247), 2008 (246), and 2010 (245) and lower in females as compared to 2004–2010 (228, 219, 214, 208, 219, 207, 212) [2]. Higher mortality was also observed among females compared to males in our study. Persky et al. hypothesized that since women live longer, they are more likely to end up with a less favorable outcome for stroke at an older age [14]. In their analysis, George et al. also added that women have certain risk factors that can predispose them to AIS. The use of birth control as well as migraine and pregnancy greatly increase

| Characteristic | Acute Ischemic Stroke (%) | Number of acute ischemic stroke cases per 100,000 admissions | P-value | Death during hospitalization (%) | Deaths per 100,000 stroke patients | P-value |
|---------------|---------------------------|-------------------------------------------------------------|---------|---------------------------------|-----------------------------------|---------|
| Sex:          |                           |                                                             |         |                                 |                                   |         |
| Male          | 260755 (49.9)             | 2097                                                        | < 0.01  | 9700 (46.2)                     | 3722                              | < 0.01  |
| Female        | 261980 (50.1)             | 1618                                                        |         | 11295 (53.8)                    | 4313                              |         |
| Race:         |                           |                                                             |         |                                 |                                   |         |
| White         | 346785 (68.5)             | 1833                                                        |         | 14655 (73.2)                    | 4228                              |         |
| Black         | 87780 (17.3)              | 2143                                                        | < 0.01  | 2660 (13.3)                     | 3032                              | < 0.01  |
| Hispanic      | 41655 (8.2)               | 1440                                                        |         | 1430 (7.1)                      | 3432                              |         |
| Rest          | 30125 (6.0)               | 1744                                                        |         | 1270 (6.4)                      | 4217                              |         |
| Primary payer:|                           |                                                             |         |                                 |                                   |         |
| Medicare      | 343670 (65.8)             | 2375                                                        |         | 14730 (70.4)                    | 4288                              |         |
| Medicaid      | 47855 (9.2)               | 1017                                                        |         | 1375 (6.6)                      | 2875                              |         |
| Private       | 97610 (18.7)              | 1310                                                        | < 0.01  | 3225 (15.4)                     | 3306                              | < 0.01  |
| Self-pay      | 20155 (3.9)               | 1870                                                        |         | 645 (3.1)                       | 3202                              |         |
| No charge     | 1495 (0.3)                | 1600                                                        |         | 30 (0.1)                        | 2007                              |         |
| Other         | 11175 (1.4)               | 1432                                                        |         | 930 (4.4)                       | 8326                              |         |
their risk by up to 9-fold as well as worsening their prognosis [12]. The hypercoagulable state during pregnancy can also be a risk factor for AIS in young women of reproductive age. Miller et al. reported a 0.2% incidence of pregnancy-associated stroke in premenopausal women admitted for any reason in New York [15]. The higher incidence of AIS among Blacks corresponds to several studies that attributed it to a higher prevalence of risk factors such as hypertension and diabetes which can predispose to stroke [2, 16]. The LOS decreased from 5.27 days in 2010 to 4.91 days in 2017, and an improvement in the mortality rate was also observed, as it dropped from 6.98% in 2000 to 5.21% in 2010 to 3.1% in our study in 2017 [2]. Lackland et al. previously linked the recent drop in stroke mortality rates to novel interventions applied among stroke patients and also to multiple changes in treatment protocols made by hospitals based on several scientific findings that helped lower risk factors for stroke such as hypertension [17]. The burden on Medicare rose in 2017 (65.8%) compared to 2010 (64.3%) [2]. However, since previous studies did not report hospital charges, we are unable to compare the financial burden of the disease.

The NIS data provided by the HCUP allow us to calculate the most recent estimates and incidences of multiple healthcare associated problems. The higher incidence in AIS hospitalization should encourage proper education among the population in recognizing the signs and symptoms of stroke and calling 911 [18]. Comparisons between different stroke protocols among hospitalized patients should also be encouraged across multiple hospitals in the United States. There are some limitations associated with the database, as it does not allow users to verify diagnoses and confirm severity. However, the database provides a large sample size and further research is encouraged.

Acknowledgments

The authors are grateful to the HCUP Agency for Healthcare Research and Quality and its partners for granting us access to their database (https://www.hcup-us.ahrq.gov/db/hcupdatapartners.jsp).

Conflict of interest

The authors declare no conflict of interest.

References

1. 2019 Stroke Fact Sheet. 2019; https://www.stroke.org/-/media/stroke-files/about-us/asm/general asm-resources/2019-stroke-fact-sheet--approved.pdf?la=en&hash=4722D6AE8F431C7888546921CA18AD A6C79783FD. Accessed July 1st, 2020.
2. Ramirez L, Kim-Tenser MA, Sanossian N, et al. Trends in acute ischemic stroke hospitalizations in the United States. J Am Heart Assoc 2016; 5: e003233.
3. Ramphul K, Gonzalez Mejias S, Joynauth J. Cocaine use increases the risk of stroke among teenagers in the United States. Int J Stroke 2020; 15: NP8.
4. 2020. Alcohol and Drug Abuse Among for Young Adults; https://americanaddictioncenters.org/rehab-guide/addiction-statistics/young-adults. Accessed July 1st, 2020.
5. HCUP National Inpatient Sample (NIS). Healthcare Cost and Utilization Project (HCUP). 2017. Agency for Healthcare Research and Quality, Rockville, MD. https://www.hcup-us.ahrq.gov/nisoverview.jsp. Accessed July 1st, 2020.
6. Kokotalo RA, Hill MD. Coding of stroke and stroke risk factors using international classification of diseases, revisions 9 and 10. Stroke 2005; 36: 1776-81.
7. Balsam E, Rucker G. How to perform a meta-analysis with R: a practical tutorial. Evid Based Ment Health 2019; 22: 153-60.
8. Andes LJ, Cheng YJ, Rolka DB, Gregg EW, Imperatore G. Prevalence of prediabetes among adolescents and young adults in the United States, 2005-2016. JAMA Pediatr 2020; 174: e194998.
9. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity among adults and youth: United States, 2015-2016. NCHS Data Brief 2017; 288: 1-8.
10. Mitchell AB, Cole JW, McArdle PF, et al. Obesity increases risk of ischemic stroke in young adults. Stroke 2015; 46: 1690-2.
11. Kernan WN, Dearborn JL. Obesity increases stroke risk in young adults: opportunity for prevention. Stroke 2015; 46: 1435-6.
12. George MG. Risk factors for ischemic stroke in younger adults: a focused update. Stroke 2020; 51: 729-35.
13. Zhang Y, Moran AE. Trends in the prevalence, awareness, treatment, and control of hypertension among young adults in the United States, 1999 to 2014. Hypertension 2017; 70: 736-42.
14. Persky RW, Turtzo LC, McCullough LD. Stroke in women: disparities and outcomes. Curr Cardiol Rep 2010; 12: 6-13.
15. Miller EC, Gatollari HJ, Too G, et al. Risk factors for pregnancy-associated stroke in women with preeclampsia. Stroke 2017; 48: 1752-9.
16. Howard VI. Reasons underlying racial differences in stroke incidence and mortality. Stroke 2013; 44 (6 Suppl 1): S126-8.
17. Lackland DT, Roccella EJ, Deutsch AF, et al. Factors influencing the decline in stroke mortality: a statement from the American Heart Association/American Stroke Association. Stroke 2014; 45: 315-53.
18. Yang Q, Tong X, Schieb L, et al. Vital signs: recent trends in stroke death rates – United States, 2000-2015. MMWR Morb Mortal Wkly Rep 2017; 66: 933-9.