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National Hospital Care Survey Demonstration Projects: Stroke Inpatient Hospitalizations

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Abstract

Objective—This report shows the analytical potential of the National Hospital Care Survey (NHCS) through a demonstration of the use of its data to examine inpatient (IP) discharges and ambulatory visits for stroke. Unweighted data of IP and ambulatory encounters from the 2014 NHCS are linked to records from the 2014 and 2015 National Death Index (NDI).

Methods—For the 2014 NHCS, 94 hospitals provided IP administrative claims data and 88 provided ambulatory (emergency and outpatient department) claims data. Although these data are not nationally representative, the survey provides unique opportunities to study health conditions such as stroke, because all IP discharges and ambulatory encounters from participating hospitals are collected for a 12-month period. The collection of patient identifiers (e.g., patient name, Social Security number, and date of birth) allows for linkage to outside data sources such as NDI, providing information on patient mortality after hospital discharge. Analyses examined stroke encounters across various hospital settings.

Results—Approximately two-thirds of stroke IP discharges originated from hospital emergency departments. IP visits for stroke tended to originate from the IP department among younger patients, and from the emergency department for older patients. The likelihood of postdischarge mortality was higher for stroke patients aged 85 and over. Thirteen percent of stroke patients aged 85 and over died within 30 days of an IP discharge compared with almost 6% of stroke patients aged 75–84. This study highlights the unique analytical capabilities of NHCS.

Keywords: cerebrovascular accident • health care • mortality • National Death Index

Introduction

Cerebrovascular disease, or stroke, is a disease affecting the arteries leading to and within the brain, occurring when a blood vessel leading to the brain either ruptures or is blocked (1). Stroke is a leading cause of death and kills approximately 140,000 Americans annually (2,3). Those suffering from stroke need rapid medical attention to reduce morbidity and mortality, and in 2014, hospitalizations for stroke totaled 94,695 (4). The disease also has an economic burden, with an estimated $33 billion spent each year on stroke-related health care services, medicines, and missed days of work in the 50 states and District of Columbia (D.C.) (5).

The National Hospital Care Survey (NHCS) presents unique opportunities to detail how strokes are treated within the inpatient (IP) and emergency department settings and mortality after the hospital visit. Specifically, this report demonstrates how NHCS may be used to analyze hospital care outcomes, such as time spent in an intensive care unit (ICU) and mortality at the hospital and postdischarge. Through the collection of personally identifiable information, patients can be tracked through settings within the same hospital in the sample and linked to outside sources like the National Death Index (NDI). Linking hospital patient data to NDI allows for the reporting of mortality after hospital discharge. Although the NHCS data used in this report are unweighted and not nationally representative, the results offer examples of how researchers can use the unweighted detailed data to provide insight into research questions and how analyses may eventually be conducted with weighted nationally representative data.

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NCHS reports can be downloaded from: https://www.cdc.gov/nchs/products/index.htm.

Methods

Data source

To streamline data collection across health care settings and move toward collecting data on health care utilization electronically, the National Center for Health Statistics (NCHS) launched NHCS, which integrates the National Hospital Discharge Survey (NHDS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS). The goal of NHCS is to provide timely and reliable health care data for use in hospital-based settings. More details about the NHCS methodology are available elsewhere (6).

Sample design and analytic population

The target universe of NHCS is inpatient (IP) discharges, also called IP hospitalizations, and in-person visits made to emergency departments (EDs) and outpatient departments (OPDs), including ambulatory surgery, in noninstitutional, nonfederal hospitals in the 50 states and D.C. that have six or more staffed IP beds. Average length of stay (ALOS) is not used as an exclusion criterion, as was done in NHDS and NHAMCS, thus expanding the frame beyond short-stay hospitals with an ALOS of less than 30 days. No geographic primary sampling units are used in this design, and no certainty hospitals (those with a 100% selection probability) are defined a priori. The frame is from the 2010 release of "Healthcare Market Index" and "Hospital Market Profiling Solution, Second Quarter, 2010," both by Verispan. The 2014 sample consists of 581 hospitals: 506 acute care hospitals and 75 other specialty hospitals, including children's, psychiatric, long-term acute care, and rehabilitation hospitals.

For the 2014 data collection, 94 hospitals out of the 581 in the sample provided IP claims data, and 88 of the 94 hospitals also provided ambulatory claims data (a response rate of 16.2% and 14.3%, respectively). Of the 94 hospitals providing IP claims, 92% were general acute care hospitals, 4% were children's hospitals, 3% were psychiatric hospitals, and 0.4% were rehabilitation or long-term acute care hospitals. Of the 83 hospitals providing ED claims, 86% were general acute care hospitals, 8% were children's hospitals, 2% were psychiatric hospitals, and 4% were rehabilitation or long-term acute care hospitals. Participating hospitals were asked to provide all encounters in IP and ambulatory settings in the 2014 calendar year. The unweighted total number of encounters was approximately 1.7 million IP discharges or IP hospitalizations (1.5 million non-newborn IP discharges) and 4.5 million ED visits. This report looks only at first-listed diagnoses of stroke in IP and ED encounters. First-listed diagnosis of stroke (cerebrovascular disease) is defined as the first diagnosis listed in a record with an *International Classification of Diseases, Ninth Revision, Clinical Modification* value of 430–438. The first-listed diagnosis represents the diagnosis determined to be the chief reason for the encounter. The number of IP discharges with a first-listed diagnosis of stroke was 38,865 from 36,519 unique patients. Of the 36,519 patients with a first-listed stroke diagnosis in the 2014 NHCS data, 5,087 died either in the hospital or by the end of 2015. Although the data are unweighted and not nationally representative, this report demonstrates the potential that NHCS has for researchers using future data releases that will be generalizable to the United States.

UB–04 claims data

NHCS electronically collects Uniform Bill (UB)–04 administrative claims data from participating hospitals. The UB–04 claim is the administrative claim required by the Centers for Medicare & Medicaid Services (CMS) and most commercial insurance payers. Physician and patient identifiers, and data on patient demographics, diagnoses, procedures, and revenue codes, are included on the claims. Using claims data presents the challenge of deduplication of claims, because one discharge or ambulatory visit can have multiple claims. The initial deduplication is performed at the hospital level, using processes developed by NCHS to identify duplicate claims for the same discharge or visit within a hospital. After unique discharges and visits are identified, patient identifiers are created. See the Technical Notes for more information about data collection, deduplication, and patient identifiers.

Personally identifiable information

NHCS also uses personally identifiable information (PII) from the claims, such as name, date of birth, and Social Security number, to link patient data across hospital settings and with other data sources such as NDI (7). With the collection of PII, NHCS is also able to follow patients during an episode of care by linking records within the same hospital. For example, a person can be traced from an initial ED visit to admission to the hospital, then IP discharge, and, finally, to treatment in the hospital's OPD. Another benefit of PII is that patients who later return to any setting of the hospital can be identified. Linkage to NDI allows researchers to conduct a wide range of outcome studies (e.g., 30-, 60-, and 90-day mortality after discharge from a hospital) that are designed to investigate factors related to health care mortality.

Analysis

Due to the low response rate of sampled hospitals and unweighted data, the data presented in this report are not nationally representative. This report is a demonstration of the analytic capabilities of NHCS data and is not intended to serve as a standard NCHS report with nationally representative results. Due to privacy and data disclosure concerns, cell counts based on fewer than 60 cases are not reported. No statistical comparisons were conducted because this report is intended as an illustrative example of what can be done with these data, rather than to produce official, representative estimates of IP discharges related to stroke.

The results are divided into two sections, encounter level and patient level. The following characteristics of IP discharges for stroke are presented at the encounter level: admission from ED, length of stay, ICU stay, and discharge status. Patient-level data include the

number of IP encounters per patient and percentage of patients who died. Information from linked NDI files was used to report postdischarge mortality. A patient's last chronological discharge was the record used to determine the length of time between discharge and death. Several results were examined by age, because the incidence of stroke increases with age.

Results

Encounter-level data

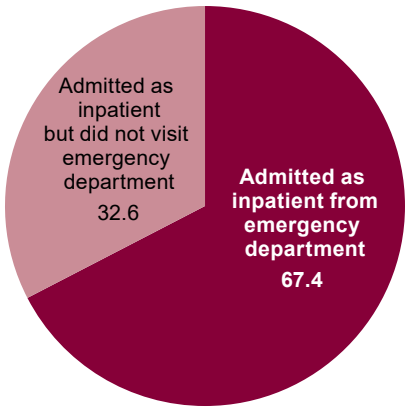
ED admissions to IP department for stroke diagnosis

Stroke patients who originally present to ED are often admitted to the IP setting to evaluate the potential worsening of the condition and any sequelae (8). Figure 1 describes the movement of patients with a first-listed diagnosis of stroke from ED to admission to the IP department.

- Of the 38,865 IP stroke encounters in 2014, 67.4% (26,193) were admitted from the hospital's ED (Figure 1).

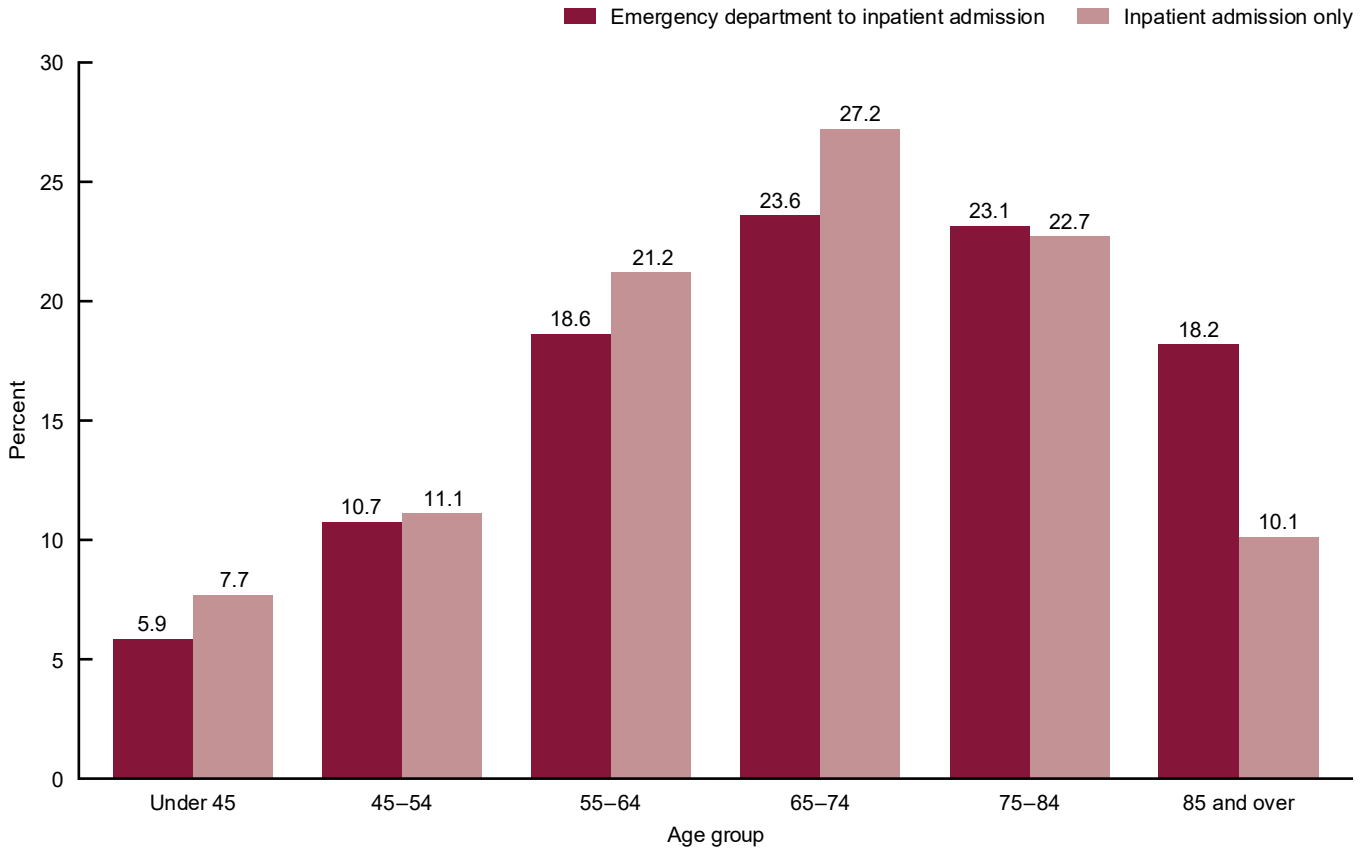
NHCS collects information on patient age at the time of the hospital visit. Figure 2 shows the distribution of age for patients admitted to the IP setting from ED compared with those who were admitted only as IP.

- Twenty-seven percent of IP stroke discharges that did not originate in ED were among patients aged 65–74, whereas almost 24% of IP stroke discharges were among patients admitted from ED in this age group (Figure 2).
- Among first-listed stroke diagnosis patients admitted to the IP department from ED, 18.2% were aged 85 and over, while 10.1% of those first seen in the IP department were aged 85 and over (Figure 2).



NOTE: The subsample *n* for inpatient discharges equals 38,865.
SOURCE: NCHS, National Hospital Care Survey, 2014.

Figure 1. Percentage of first-listed diagnosis of stroke in the inpatient setting that were admitted from emergency department: National Hospital Care Survey, 2014



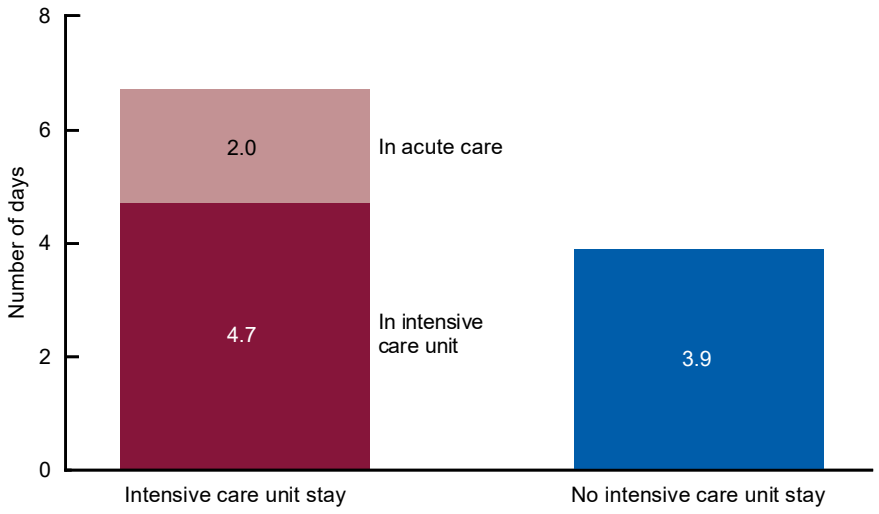
NOTE: The subsample *n* for emergency department to inpatient admissions equals 26,193, and the subsample *n* for inpatient admissions only equals 12,672.
SOURCE: NCHS, National Hospital Care Survey, 2014.

Figure 2. Age distribution of first-listed diagnosis of stroke, by setting of origination: National Hospital Care Survey, 2014

ICU use during IP hospitalizations for stroke

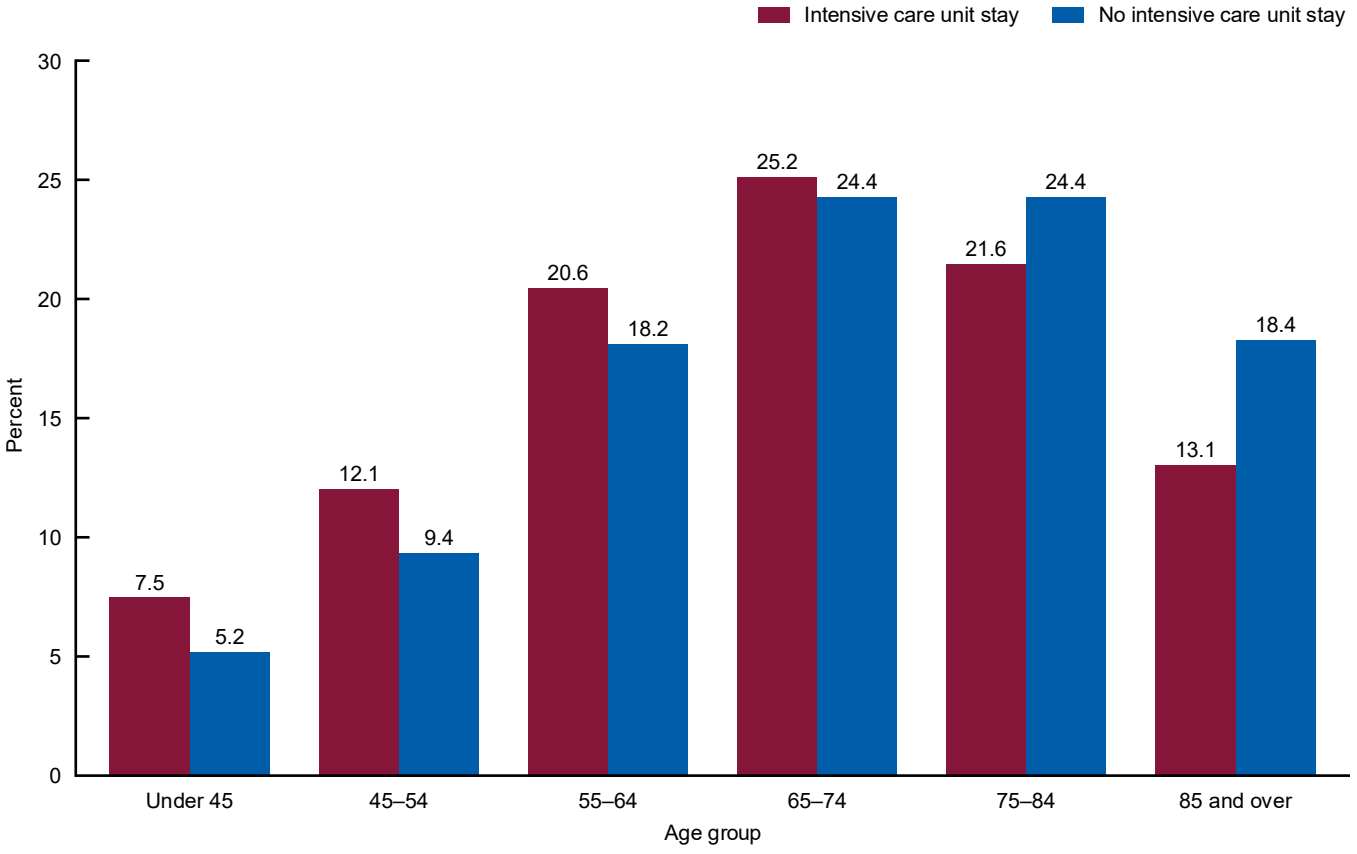
Once a patient is admitted to the hospital, an ICU stay may be necessary for the most severe strokes. Analyses for ICU stays related to stroke are shown in Figures 3 and 4 and Tables 1 and 2. Information on ICU use was not previously available in NHDS but can be useful for understanding a patient's length of stay in the IP department.

- About one-half of hospitalizations for stroke (53.7%) resulted in an ICU stay (Table 1).
- ALOS for IP stroke encounters with an ICU stay was 6.7 days, of which an average of 4.7 days was spent in ICU (Figure 3, Table 2).
- ALOS for IP stays for stroke without an ICU stay was 3.9 days (Figure 3, Table 2).



NOTE: The subsample *n* for intensive care unit stays equals 20,888, and the subsample *n* for no intensive care unit stays equals 17,977.
SOURCE: NCHS, National Hospital Care Survey, 2014.

Figure 3. Average length of stay for first-listed diagnosis of stroke inpatient discharges, by intensive care unit status: National Hospital Care Survey, 2014



NOTE: The subsample *n* for intensive care unit stays equals 20,888, and the subsample *n* for no intensive care unit stays equals 17,977.
SOURCE: NCHS, National Hospital Care Survey, 2014.

Figure 4. Age distribution for first-listed diagnosis of stroke for inpatient discharges, by intensive care unit status: National Hospital Care Survey, 2014

Age for ICU stay

Figure 4 presents age distribution for stroke-related hospital admissions that required an ICU stay and those that did not.

- Younger patients tended to have a higher percentage of IP stroke encounters that required an ICU stay compared with no ICU stay, and older patients tended to have a lower percentage of stroke encounters resulting in an ICU stay compared with no ICU stay (Figure 4, Table 3).
- Thirty-five percent of IP stroke encounters that involved an ICU stay were among patients aged 75 and over. Almost 43% of IP stroke encounters for patients aged 75 and over did not require an ICU stay (Figure 4, Table 3).

Discharge status

Discharge status for the IP setting is described in Figure 5.

- Forty-five percent of the IP stroke encounters resulted in discharge to home or self-care.
- Fifteen percent of IP stroke encounters resulted in discharge to an IP rehabilitation facility.
- Six percent of first-listed IP stroke encounters resulted in patients who died in the hospital.

Patient-level data

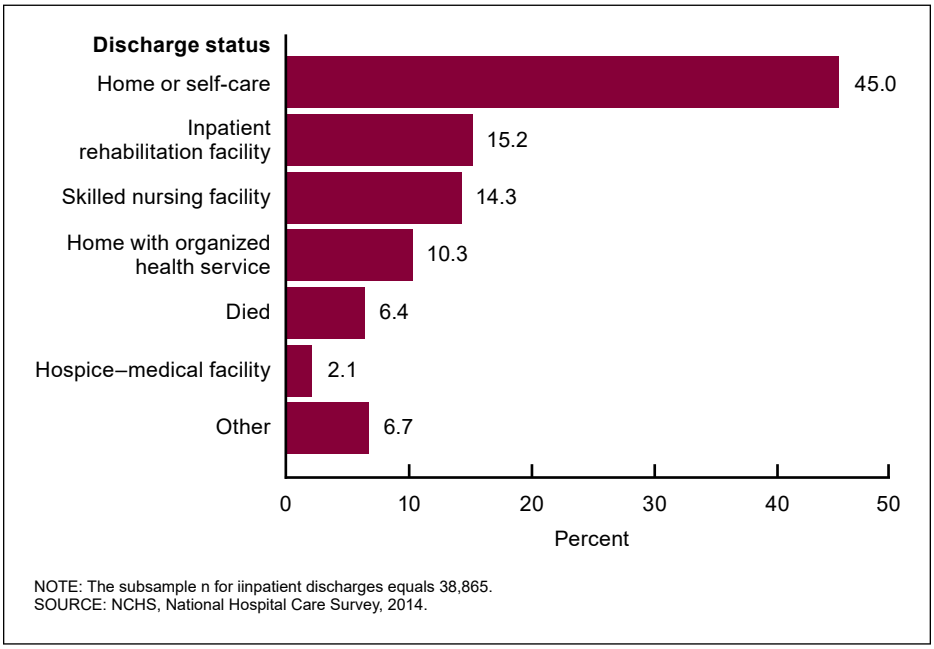
The 38,865 stroke IP encounters consisted of 36,519 unique patients. Through the collection of PII data, patients with multiple hospital stays can be identified. Figure 6 shows the number of stroke IP encounters for the 36,519 patients.

- Ninety-four percent of the patients admitted to the hospital for a stroke were admitted for only one stroke in 2014 (Figure 6).
- Five percent of stroke patients had two stroke IP encounters, and less than 1% had between three and five stroke IP admissions (0.5%) during 2014 (Figure 6).

Mortality among IP hospitalizations for stroke

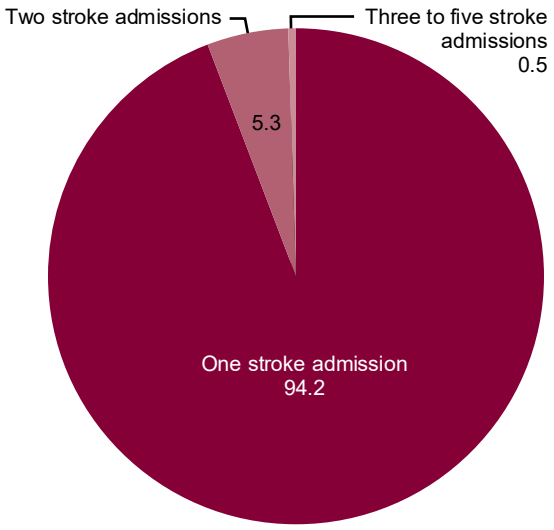
A total of 5,087 stroke patients died either in the hospital or postdischarge in 2014 or 2015. The percentage of persons who have died from strokes by age group, and the number of days between a person's death and the date of the patient's last hospital discharge in 2014, are shown in Figure 7 and Table 2.

- Among IPs with a first-listed diagnosis of stroke in 2014, 77.5% were alive at the end of 2015 (Figure 7).
- Nearly 7.0% of stroke IPs died at the hospital, 4.7% of stroke IPs died within 30 days of discharge, and 1.4% died between 31 and 60 days of being discharged (Figure 7).



NOTE: The subsample n for iinpatient discharges equals 38,865.
SOURCE: NCHS, National Hospital Care Survey, 2014.

Figure 5. Inpatient discharge status for first-listed diagnosis of stroke: National Hospital Care Survey, 2014



NOTE: The subsample *n* for patients equals 36,519.
SOURCE: NCHS, National Hospital Care Survey, 2014.

Figure 6. Percentage of inpatient stroke admissions, by number per patient: National Hospital Care Survey, 2014

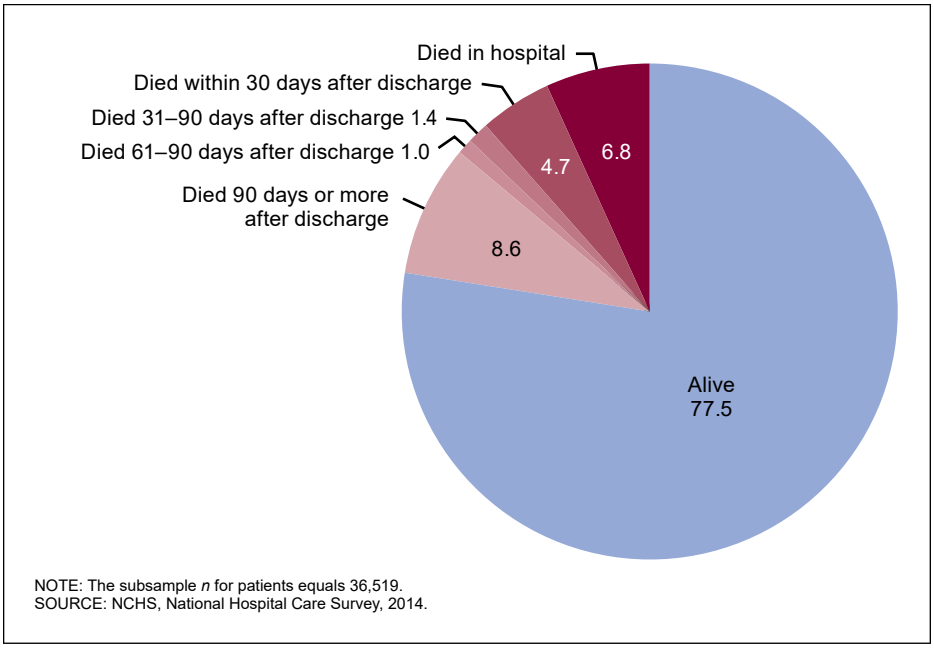


Figure 7. Percentage of deaths for inpatient admissions with a first-listed diagnosis of stroke, by number of days after last discharge: National Hospital Care Survey, 2014, linked to National Death Index, 2014 and 2015

- Nearly 9.0% of stroke IPs died more than 90 days after being discharged (Figure 7).

Mortality among IPs by age

- General mortality among patients who suffered a stroke increased with age. Mortality in the hospital tended to show less variation by age, while mortality after hospital discharge tended to increase with age (Table 4).
- Slightly more than 6% of IP stroke patients under age 45 died at the hospital, while approximately 7% of stroke patients aged 65–74 died in the hospital, and 3% died within 30 days after discharge. In the oldest age group (aged 85 and over), 9% of stroke patients died at the hospital, and 13% died within 30 days after discharge (Table 4).

Conclusion

This report examines stroke encounters in various hospital settings, focusing on stroke patients who were admitted to a hospital's IP department. Although the NHCS data used were not nationally representative, this report shows the type of analyses that are now possible with NHCS data. Approximately two-thirds of the IP stroke encounters in 2014 were admitted from ED. Stroke encounters that were admitted to the IP department from ED tended to be among patients older than those who were not admitted from ED.

NHCS also collects key demographic information that allows the survey's data to be linked to NDI, so that postdischarge mortality can be studied. Of the stroke patients who were admitted as IPs, 6.8% died in the hospital. Approximately 4.7% of stroke patients died within 30 days after discharge. More than 9% of stroke patients aged 85 and over died at the hospital, and 13% died after discharge from the hospital, compared with approximately 7.4% of stroke patients aged 75–84 who died at the hospital and 5.6% within 30 days of discharge.

As NHCS continues to collect data from more hospitals and moves toward the collection of electronic health records, the benefit to researchers and the public of NHCS data and its linkage capability continue to grow.

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Table 1. Percentage of inpatient discharges with first-listed stroke diagnosis, by admittance to intensive care unit: National Hospital Care Survey, 2014

Characteristic	Number	Percent
Intensive care unit stay	20,888	53.7
No intensive care unit stay	17,977	46.3
Total	38,865	100.0

SOURCE: NCHS, National Hospital Care Survey, 2014.

Table 2. Average length of stay in days for inpatient encounters with first-listed stroke diagnosis, by age and admittance to intensive care unit: National Hospital Care Survey, 2014

Age group	Total inpatient stay with first-listed stroke diagnosis	Intensive care unit stay	No intensive care unit stay
Total	5.4	6.7	3.9
Under 45	7.6	9.4	4.5
45–54	6.7	8.3	4.2
55–64	6.1	7.4	4.5
65–74	4.9	6.1	3.6
75–84	4.7	5.8	3.6
85 and over	4.4	5.2	3.7

SOURCE: NCHS, National Hospital Care Survey, 2014.

Table 3. Age distribution for inpatient encounters with first-listed stroke diagnosis, by admittance to intensive care unit: National Hospital Care Survey, 2014

Age group	Total inpatient stay with first-listed stroke diagnosis	Intensive care unit stay	No intensive care unit stay
Under 45	6.5	7.5	5.2
45–54	10.8	12.1	9.4
55–64	19.5	20.6	18.2
65–74	24.8	25.2	24.4
75–84	22.9	21.6	24.4
85 and over	15.5	13.1	18.4

SOURCE: NCHS, National Hospital Care Survey, 2014.

Table 4. Mortality status in 2015 for inpatient encounters with first-listed stroke diagnosis, by age group: National Hospital Care Survey, 2014, and National Death Index, 2014 and 2015

Characteristic	Total	Under 45	45–54	55–64	65–74	75–84	85 and over
Total	36,519	2,368	3,945	7,053	9,037	8,412	5,704
				Percent			
Alive	77.5	89.6	88.5	86.0	81.0	72.9	55.6
Died in hospital	6.8	6.3	5.5	5.5	6.5	7.4	9.2
1–90 days after discharge	7.1	*	2.3	3.3	5.2	8.6	18.3
1–30 days	4.7	*	*	1.8	3.2	5.6	13.2
31–60 days	1.4	*	*	0.9	1.2	1.7	3.1
61–90 days	1.0	*	*	*	0.8	1.3	2.0

* Estimate does not meet NCHS standards of reliability; encounters had fewer than 60 cases and are not reported.

SOURCES: NCHS, National Hospital Care Survey, 2014, and National Death Index, 2014 and 2015.

Technical Notes

Data collection

Although hospitals are required to submit Uniform Bill (UB)–04 claims to the Centers for Medicare & Medicaid Services (CMS) in the 837 file format, submission of the claims in this format to the National Center for Health Statistics (NCHS) has been challenging. First, many hospitals use clearinghouses to process and submit their claims to CMS and commercial insurance companies. In many instances, the small payment that NCHS offers for each year of data collection is not enough to offset the cost of clearinghouse charges for constructing a file for the National Hospital Care Survey (NHCS). As an alternative, NCHS has accepted nonadjudicated data files directly from hospitals, which are cleaned and processed by the NHCS data collection contractor.

Second, hospitals that process their own UB–04 claims sometimes do not know how to output the data from their systems for submission to NHCS. Even among hospitals that can output digital data in-house, some are not able to output the data in the 837 format to the data collection contractor. Although not preferred, other file formats such as XML, Excel, and ASCII are accepted.

Finally, hospitals with many patients handle volume by archiving their claims data daily, which made obtaining the data for this study difficult, costly, or both. With the technological capabilities of the NHCS data collection contractor, automation of daily data transmission has provided a solution for obtaining archived data. All inpatient (IP) and ambulatory claims data are transmitted through the contractor's secure transfer system. These data are compiled, processed, and sent to NCHS.

Claims deduplication

Using UB–04 claims data also presents a challenge because one encounter, for IP discharges and ambulatory visits, can have multiple claims. Therefore, deduplication processes need to be developed. Initial deduplication was performed at the hospital level using processes to identify duplicate claims for the same encounter, whether IP or emergency department (ED), within a hospital. To develop the deduplication method for a hospital, claims were grouped in three ways: 1) by patient control number (PCN), 2) by beginning date of encounter and medical record number (MRN), and 3) by beginning date of encounter, date of birth, and patient name. The purpose of this processing was to evaluate whether PCN could be used to accurately identify duplicate claims for the same encounter, controlling for matching data elements for the beginning date of encounter, MRN, date of birth, and patient name. If the number of duplicate groups of claims identified by PCN was close to the other counts produced, PCN was used to deduplicate the claims. However, if the values of these variables in a group of duplicates were not similar, then the hospital's claims were further assessed through a manual review of the duplicate groups, and a final determination of the deduplication method to be used at that hospital was made.

Outpatient claims splitting—Although the vast majority of ambulatory visits involve a single day, many cases of ambulatory claims spanning two dates or more were detected among ambulatory claims. Multiple-date claims were examined and, in some cases, evidence was found justifying multiple-day visit claims. Three types of cases were identified as probably being valid multiple-day visits to the ambulatory department: a) an ED visit could span several days, and even a short ED visit that started in the late evening of one day could easily continue into the next day and would appear as a 2-day visit; b) a patient who received "observation services" was periodically monitored by hospital staff to determine the need for possible admission, and this period of monitoring could span several days; and c) patients undergoing ambulatory surgery might be kept in the ambulatory center for longer periods of time pre- or postsurgery.

A claim for multiple dates that should not have been treated as a single visit spanning multiple days was split into two or more subclaims. One example of multiple-date claims that should have been split included repeated treatments over time, as in weekly speech therapy or regular dialysis, for which some hospitals preferred to submit just one claim covering a period of time. Any claim with nonconsecutive ED or outpatient department dates was split into two or more claims for single-day stays (or for consecutive-day stays). All consecutive-day claims were then separated into one claim per day if no evidence of a justifiable longer stay was found—such as ED visits, patients receiving observation services, or patients undergoing ambulatory surgery. Any consecutive-day visits with evidence of any of these three conditions were not split.

Patient identification

After deduplication of claims was completed, a probability-based record linkage method was used to identify patients. In the first round of patient identification, two records were compared by name (first, last, and middle initial), date of birth, sex, hospital identifier, MRN, Social Security number (SSN), and zip code. If sufficient agreement of data elements was found between the two records, the records were retained as a pair (i.e., record pair) for further analysis. The second round compared the record pairs, controlling for agreement in the hospital identifier and MRN (pass 1); SSN, if reported (pass 2); and sex, year, month of birth, soundex (a phonetic coding system designed to suppress spelling variations) of last name, and state abbreviation (pass 3). The record pairs compared in the three passes had match weights assigned to 11 matching variables. The match weights were likelihood ratio scores based on the probability of agreement in the records retained as record pairs and the probability of agreement in the records that were not included in any record pairs. A match weight of 60.98 indicated perfect agreement in all of the comparison fields. Pairs with a match weight above a threshold of 30 were retained as likely matches based on selection thresholds suggested in Winglee, Valliant, and Scheuren (6). Two additional reviews were conducted for

record pairs of children under age 10 at the time of discharge.

The first review targeted newborns whose first names contained "BABY," "GIRL," "BOY," "FEMALE," or "MALE." The newborn pairs were then subject to one of three adjustments: a) Pairs that contained records in which a name like "BABYGIRL" was in one record and a real name (e.g., "JANE") was in another were accepted as a match when the hospital identifier and MRN were the same; b) pairs with the same hospital identifier, service date, and patient address but different MRNs were identified as twin or multiple-birth records and were manually split; or c) pairs with different last names and MRNs were manually reviewed and split if the pair was determined to be false.

Matching to the National Death Index

Through its data linkage program, NCHS has been able to expand the analytic utility of the data collected from NHCS by augmenting it and linking to mortality data from the National Death Index (NDI). NDI, a component of the National Vital Statistics System, is a centralized database of death record information compiled from state vital statistics offices. In collaboration with state offices, NCHS established NDI as a resource for epidemiological follow-up studies and other types of health and medical research that require determination of the mortality status of study subjects. These mortality data are provided by the states under contract agreements with NCHS that specify how these data may be used, for what purposes, and at what cost. Currently, NDI contains about 85 million records from 1979 through 2014 from 50 states, the District of Columbia, New York City, Puerto Rico, and the U.S. Virgin Islands.

To match to NDI, patients had to be deemed linkage eligible. Linkage eligibility was defined as having usable information for two of three data element groups: SSN, name (first, middle, and last), and date of birth (year, month, and day). Mortality status was then determined using a combination of deterministic and probabilistic record linkage methods. The linkage method performed weighting and link adjudication as described in the Fellegi–Sunter paradigm (9), the foundational methodology used for record linkage. It estimates the likelihood that each pair is a match before selecting the most probable match between a survey record and an NDI record. The linkage between the 2014 NHCS records and the 2014–2015 NDI records involved was based on categorizing the records into two broad linkage categories—deterministic and probabilistic approaches—which was followed by selection of the final pair included in the file. For detailed information on the linkage methodology, see the appendix in "The Linkage of the 2014 National Hospital Care Survey to the 2014/2015 National Death Index: Methodology Overview and Analytic Considerations" (10).

ED visits admitted as IP

ED visits in which patients were admitted to the IP setting did not have separate ED records; therefore, the IP record was duplicated in the ED file. However, the duplicated ED records maintained the IP discharge status. To get an accurate account of ED discharge status, IP records in the ED file had the discharge status changed to "admitted as an IP." Additionally, to avoid overcounting the services provided, services on the duplicated ED records were counted only in the IP setting.

Definition of terms

Stroke—Identified through the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD–9–CM). The first-listed diagnosis is generally understood to be the primary diagnosis and main cause of the encounter. When ICD–9–CM codes 430–438 were found in the first-listed diagnosis, the encounter was considered to be for stroke.

The following stroke comorbidities were identified by the corresponding ICD–9–CM codes:

- Hypertension: 401–405
- High cholesterol: 272
- Diabetes: 250
- History of or current tobacco use: V1582, 305.1
- Atrial fibrillation: 427.31
- Obesity: 278.0
- Heart failure: 428
- Obstructive sleep apnea: 327.23

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES

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