



# Complications Arising During Hospitalization for Hemorrhagic or Ischemic Stroke: Evidence From a Large Administrative Database

Sean D Candrilli, Sudeep J Karve, Peter E Wirth  
RTI Health Solutions, Research Triangle Park, NC, United States

## BACKGROUND

- Annually approximately 800,000 people in the United States (US) experience a new or recurrent stroke, with over 87% being ischemic stroke (IS) cases and 13% hemorrhagic stroke (HS) cases.<sup>1</sup>
- In 2006, approximately 900,000 hospital discharges with stroke listed as a primary diagnosis were reported in the US.<sup>1</sup>
- High rates of complications, such as musculoskeletal pain, urinary tract infections, depression, chest infections, pneumonia, and falls, have often been reported among hospitalized stroke patients.<sup>2-5</sup>
- However, limited data exist regarding the economic burden and resource utilization related to complications arising during stroke-related hospitalizations.

## OBJECTIVE

- To document the rate of complications arising during IS- or HS-related hospitalizations (i.e., defined as diagnoses recorded upon discharge but not observed at admission) and assess the economic burden and resource utilization associated with the complications.

## METHODS

### Data Source and Patient Selection

- This was a retrospective cohort analysis of the the 2008 Healthcare Cost and Utilization Project (HCUP) Michigan State Inpatient Database (SID).
- The 2008 Michigan SID contains approximately 1.29 million discharge records from 144 contributing community hospitals (defined as “all nonfederal, short-term, general and other specialty hospitals, excluding hospital units of institutions”).
- Data provide details on patient demographic (e.g., age, sex, race, location) and clinical characteristics (e.g., diagnosis, comorbidities), and resource utilization (e.g., length of stay [LOS], total charges) during an inpatient stay.
- We selected hospitalizations with evidence for primary diagnosis of HS (ICD-9-CM codes 430.xx, 431.xx, or 432.xx) or IS (433.x1, 434.xx, or 436.xx).
- A unique aspect of the Michigan SID is that the data enable the assessment of disorders or complications that occurred during the hospitalization but that were not recorded upon admission.
- For this study, IS- or HS-related hospitalizations with evidence of diagnosis code(s) listed at discharge but not recorded upon admission were categorized as “complicated hospitalizations,” whereas hospitalizations where no additional diagnoses were listed at discharge compared with those recorded upon admission were categorized as “uncomplicated hospitalizations.”

### Study Measures

- The following study measures were assessed among complicated and uncomplicated hospitalizations:
  - Patient characteristics, including age, sex, race, and primary payer (i.e., Medicare, Medicaid, private insurance, self-pay, no charge, other)
  - Discharge disposition (i.e., died vs. alive)
  - LOS in the intensive care unit, overall inpatient LOS
  - Inpatient costs, converted from charges using hospital-specific cost-to-charge ratios and updated to US \$2009 using the medical care component of the Consumer Price Index.
- We also reported the top five complications developed during hospitalization among patients with a primary diagnosis of HS or IS.

## Statistical Analyses

- Univariate differences in death rate, LOS, and inpatient costs between complicated and uncomplicated hospitalizations were compared using Student’s t-test for continuous variables and chi-square (or Fisher’s exact) test for categorical variables.
- All statistical analyses were conducted using the SAS 9.2 statistical software package (Cary, NC).

## RESULTS

### Background Characteristics (Table 1)

- Of the 1.3 million hospitalizations occurring in Michigan in 2008, 19,065 had a primary diagnosis of HS or IS.
  - Of these, 20.6% were classified as “complicated.”
- No differences in stroke patient age (mean, 70.4 vs. 70.7 years;  $P = 0.3293$ ) or sex distribution (53% vs. 54% female;  $P = 0.3476$ ) between complicated and uncomplicated hospitalizations were observed.
- Medicare was the primary payer for over 65% of patients in this population.
- A significantly greater proportion of stroke patients with a complicated hospitalization died during the inpatient stay compared with patients with uncomplicated hospitalizations (11.4% vs. 6.6%;  $P < 0.0001$ ).

Table 1. Stroke Patient Characteristics

Characteristic	Complicated Hospitalization <sup>a</sup>		Uncomplicated Hospitalization		P Value
	n	%	n	%	
<b>All patients</b>	3,922	100.0	15,143	100.0	
<b>Age (years), mean (SD)</b>	70.7 (14.9)		70.4 (15.2)		0.3293
<b>Sex</b>					
Male	1,804	46.0	7,093	46.9	0.3476
Female	2,118	54.0	8,050	53.1	
<b>Race</b>					
White	2,453	72.6	9,093	74.8	0.0278
Black	809	24.0	2,721	22.4	
Hispanic	35	1.0	95	0.8	
Asian or Pacific Islander	22	0.7	58	0.5	
Native American	2	0.1	24	0.2	
Other	56	1.7	168	1.4	
<b>Primary payer</b>					
Medicare	2,629	67.1	10,124	66.9	< 0.0001
Medicaid	319	8.1	1,096	7.2	
Private	847	21.6	3,264	21.6	
Self-pay	79	2.0	522	3.5	
No charge	0	0.0	13	0.1	
Other	47	1.2	124	0.8	
<b>Discharge disposition</b>					
Dead	445	11.4	998	6.6	< 0.0001
Alive	3,477	88.6	14,145	93.4	

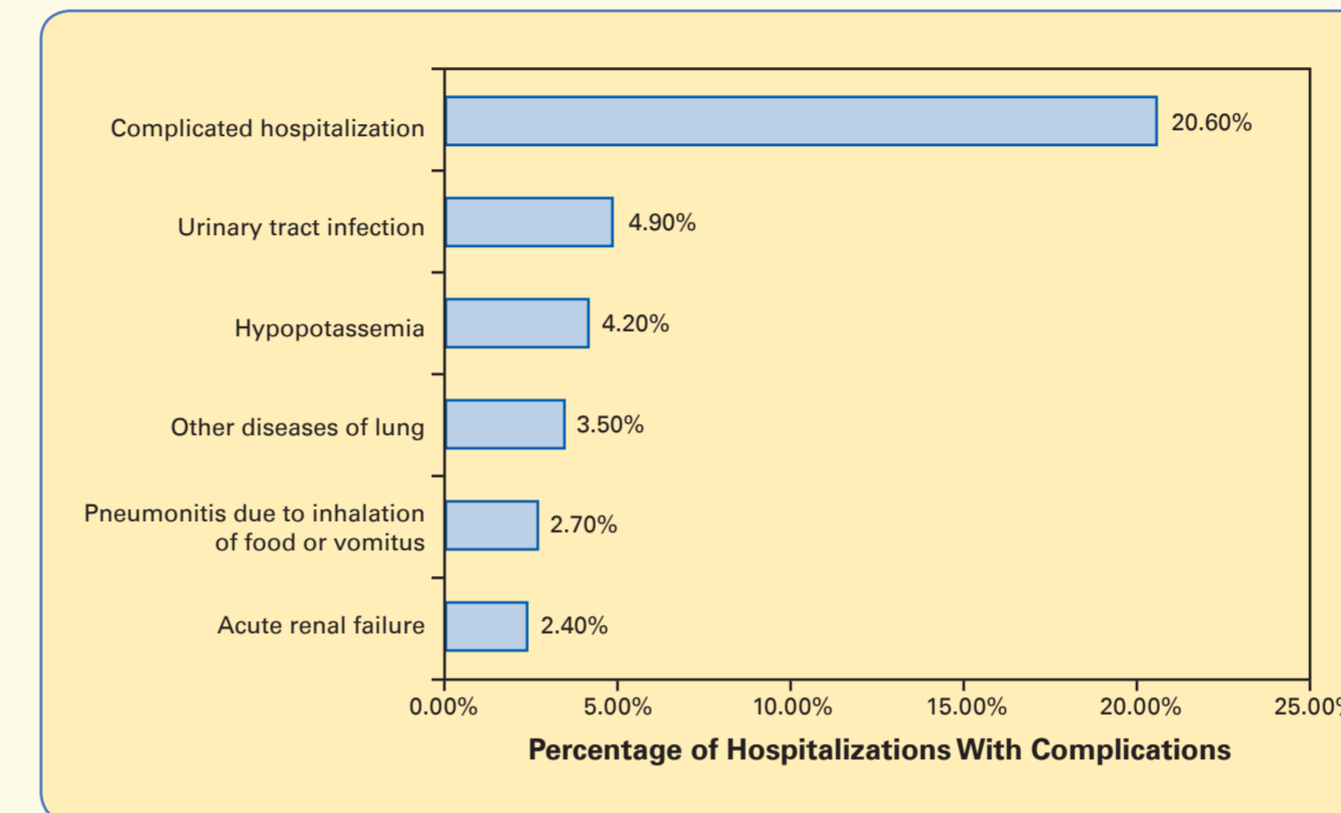
SD = standard deviation.

<sup>a</sup> Complicated hospitalization defined as the presence of any condition at discharge that was not recorded upon admission.

### Incidence of Stroke-Related Inpatient Complications (Figure 1)

- A total of 3,922 (20.6%) of the selected stroke patients had evidence of one or more complications during the hospital stay.
- The top-five most frequently observed complications were urinary tract infection (4.9%), hypotatsemia (4.2%), other diseases of lung (3.5%), pneumonitis due to inhalation of food or vomitus (2.7%), and acute renal failure (2.4%).

Figure 1. Percentage of Patients With Complications During the Stroke-Related Inpatient Admission



### Inpatient Utilization and Costs

- The mean LOS for complicated hospitalizations was significantly greater compared with uncomplicated hospitalizations (10.5 vs. 4.5 days;  $P < 0.0001$ ).
- Similarly, significantly greater inpatient costs for patients with complicated hospitalizations were observed compared with uncomplicated hospitalizations (\$28,608 vs. \$10,747;  $P < 0.0001$ ).
- Patients with one or more complications spent an additional 2.4 days in the intensive care unit compared with patients without complications ( $P < 0.0001$ ).

## LIMITATIONS

- Patient selection was based on diagnosis codes that, if recorded inaccurately, may cause some misidentification of stroke-related hospitalizations and complications.
- Analyses were limited to direct treatment costs. Additional research on the indirect costs (e.g., loss of wages for employed patients experiencing stroke; rehabilitative care provided by parents, guardians, and other caregivers) is warranted.

## DISCUSSION

- Complications observed in our study are consistent with prior studies assessing incidence of complications among patients with stroke.<sup>2-5</sup> However, the overall rate of complications observed in our study was lower compared with other studies.<sup>2-5</sup> Various factors, including definition and identification of complications, patient selection criteria, study region, patient management, and treatment, may explain the variations in rate of complications.
- Although it is unknown if death was attributed to complications, data suggest that improved care of stroke patients may be associated with lower incidence complications and reduced risk of death.
- In general, stroke (inclusive of both complicated and uncomplicated cases) is costly to payers. However, our findings suggest that presence of complications significantly increases the economic burden, especially to Medicare, which was reported to be the primary payer for approximately 67% of the complicated hospitalizations.

## CONCLUSIONS

- On average, the cost of a stroke-related hospitalization with complications is significant—nearly three times greater than a stroke-related hospitalization without complications.
- Efforts to improve inpatient stroke management strategies may help lower the incidence of complications, reduce associated costs, and improve patient outcomes.
- Our findings should serve as a useful resource for policy makers and researchers in designing and conducting cost-effectiveness evaluations of stroke management and care programs.

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## CONTACT INFORMATION

Sean D. Candrilli, PhD  
Head, Health Economics

RTI Health Solutions  
200 Park Offices Drive  
Research Triangle Park, NC 27709

Phone: +1.412.384.2790  
Fax: +1.919.541.7222  
E-mail: scandrilli@rti.org

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