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The One-Year Attributable Cost of Post-Stroke Dysphagia

Heather Shaw Bonilha,
Department of Health Sciences and Research, Medical University of South Carolina, Charleston, SC, USA. Evelyn Trammell Institute of Voice and Swallowing, Medical University of South Carolina, Charleston, SC, USA. Department of Otolaryngology – Head and Neck Surgery, Medical University of South Carolina, Charleston, SC, USA. Medical University of South Carolina, Department of Health Science and Research, 77 President St., Charleston, SC 29425, USA

Annie N. Simpson,
Department of Otolaryngology – Head and Neck Surgery, Medical University of South Carolina, Charleston, SC, USA. Department of Healthcare Leadership and Management, Medical University of South Carolina, Charleston, SC, USA

Charles Ellis,
Department of Health Sciences and Research, Medical University of South Carolina, Charleston, SC, USA

Patrick Mauldin,
Division of General Medicine and Geriatrics, Department of Medicine, Medical University of South Carolina, Charleston, SC, USA

Bonnie Martin-Harris, and
Department of Health Sciences and Research, Medical University of South Carolina, Charleston, SC, USA. Evelyn Trammell Institute of Voice and Swallowing, Medical University of South Carolina, Charleston, SC, USA. Department of Otolaryngology – Head and Neck Surgery, Medical University of South Carolina, Charleston, SC, USA. VA Center for Disease Prevention and Health Interventions for Diverse Populations, Ralph H. Johnson VA Medical Center, Charleston, SC, USA

Kit Simpson
Department of Healthcare Leadership and Management, Medical University of South Carolina, Charleston, SC, USA

Heather Shaw Bonilha: bonilhah@musc.edu

Abstract

With the recent emphasis on evidence-based practice and healthcare reform, understanding the cost of dysphagia management has never been more important. It is helpful for clinicians to understand and objectively report the costs associated with dysphagia when they advocate for their services in this economy. Having carefully estimated cost of illness, inputs are needed for cost-effectiveness analyses that help support the value of treatments. This study sought to address this

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issue by examining the 1-year cost associated with a diagnosis of dysphagia post-stroke in South Carolina. Furthermore, this study investigated whether ethnicity and residence differences exist in the cost of dysphagia post-stroke. Data on 3,200 patients in the South Carolina Medicare database from 2004 who had ICD-9 codes for ischemic stroke, 434 and 436, were retrospectively included in this study. Differences between persons with and without dysphagia post-stroke were compared with respect to age, gender, ethnicity, mortality, length of stay, comorbidity, rurality, discharge disposition, and cost to Medicare. Univariate analyses and a gamma-distributed generalized linear multivariable model with a log link function were completed. We found that the 1-year cost to Medicare for persons with dysphagia post ischemic stroke was $4,510 higher than that for persons without dysphagia post ischemic stroke when controlling for age, comorbidities, ethnicity, and proportion of time alive. Univariate analysis revealed that rurality, ethnicity, and gender were not statistically significantly different in comparisons of individuals with or without dysphagia post-stroke. Post-stroke dysphagia significantly increases post-stroke medical expenses. Understanding the expenditures associated with post-stroke dysphagia is helpful for optimal allocation and use of resources. Such information is needed to conduct cost-effectiveness studies.

Keywords

Deglutition; Deglutition disorders; Dysphagia; Cost; Stroke Length of stay; Discharge Severity

Introduction

The annual incidence of stroke in the United Sates is approximately 795,000 [1]. In 2008, the total cost of stroke (direct and indirect) was $34.3 billion (2012 AHA Statistical Update), with the majority of those costs (70 %) consisting of first-year inpatient hospital costs [2]. With the increasing age of the population, it is expected that the incidence of stroke and related post-stroke conditions will rise, increasing the burden of care to the US health system [3]. Dysphagia is a common post-stroke condition, with a reported incidence between 37 and 78 % [3].

Post-stroke dysphagia is associated with increased mortality, comorbidities, dehydration, poorer long-term outcomes, and greater risk of complications such as aspiration pneumonia [3]. Dysphagia persists at 6 months after stroke in 50 % of patients [4]. Furthermore, Heckert et al. [5] found that 64 % of patients in an inpatient rehabilitation facility had post-stroke dysphagia. It is generally believed that an underreporting of dysphagia via ICD-9 codes exists and that the number of patients with post-stroke swallowing impairment may be even higher than previous reports [6]. Given the frequency of post-stroke dysphagia and the expected growing burden to the US health system, it is helpful to understand the influence of dysphagia on stroke-related healthcare utilization in this time of healthcare reform.

Healthcare reform has increased the focus on hospital responsibility for patient outcomes and cost containment. Specifically, US hospitals with high Medicare rehospitalization rates within 1 year after hospitalization will incur fines as a means to hold them responsible for patient outcomes [7]. Medicare is the primary insurer for the majority of US stroke patients [8]. Therefore, hospitals are likely to focus their policies and procedures to meet Medicare’s

requirements for care, and stroke patients who are covered by other insurance types are likely to be treated similarly to Medicare patients. While hospitals and clinicians continuously strive to improve patient swallowing outcomes after stroke, the new fines highlight the need to manage resources to improve outcomes. Therefore, hospitals are keen to reduce the costs and improve the outcomes of stroke patients with dysphagia. At the same time, reimbursements for these services are not changing necessitating greater cost-effectiveness of clinical care. Cost-effectiveness can be gained by careful patient selection, optimal timing of evaluations and treatments, and the use of the best evaluation and treatment protocols [9]. Clinicians are increasingly being asked to offer evidence of the cost-effectiveness of dysphagia management as well as the short- and long-term costs that may be incurred without such care.

To date there is a paucity of studies designed to examine the costs associated with post-stroke dysphagia. A literature search of PubMed (August 2013) to ascertain the current state of knowledge on the cost of dysphagia post-stroke yielded 32 articles of which 5 provided data on the cost of an evaluation or intervention [10–14], while 3 provided data on the cost of a diagnosis related to dysphagia (aspiration pneumonia) [15–17]. The majority of the articles (20 of 32) speculated that their findings may have an impact on cost or may be cost effective, or they stated that evaluating cost-effectiveness was an important future goal but did not provide new cost data. No studies reported specific information about the cost of dysphagia in the first year after stroke. The lack of concrete cost-related data with the frequent conclusion that there is a need for such data is reflective of a significant need to examine and demonstrate the cost balance or savings of the management approaches associated with the evaluation and treatment of patients with dysphagia.

In the absence of cost studies, it is unclear which clinical practices and patient-related variables contribute most to the cost of dysphagia management. Good estimates of the cost of dysphagia are also needed as baseline input for future studies that examine the cost versus benefit of dysphagia treatment regimens, i.e., cost-effectiveness analyses. Previous studies have shown higher rates of mortality, morbidity, longer length of stay (LOS), and differences in discharge disposition among patients with dysphagia compared to those without dysphagia. In addition, recent data have suggested that post-stroke dysphagia outcomes and associated costs may also differ based on ethnicity and residence [18–20]. In summary, the cost of dysphagia may be related to a range of patient-related (patient health, sociodemographics, comorbidity) and environmental factors (residence). Thus, these factors should be carefully examined in an assessment of the cost of post-stroke dysphagia.

Given that Medicare is the primary payer for approximately 72 % of stroke patients in the US [8], we chose to use Medicare billing data to examine the cost of post-stroke dysphagia. Standard Medicare billing data files contain both charge and payment data; this enabled us to identify actual cost (as represented by payments) to the insurer. This approach avoids the use of hospital cost-to-charge ratios and enables us to report costs from the perspective of the major US payer for stroke care. The specific research questions we sought to answer were (1) What is the 1-year cost burden of dysphagia post ischemic stroke? (2) Does the burden of dysphagia post ischemic stroke differ by patient-related and environmental factors?

Methods

Database and Study Population

Data for this study were extracted by staff at the South Carolina Office of Research and Statistics (ORS) from a state-wide cohort of Medicare participants from South Carolina which was made available to the researchers as part of the EXCEED grant (South Carolina EXCEED Project is funded by AHRQ under DUA #16339 EDG #4081) to examine health disparities in minority populations. This study was completed using data for 6,408 patients with a hospital admission in 2004 with a primary ICD-9 diagnosis code for stroke.

To identify patients with ischemic stroke for this study, we used International Classification of Diseases and Health Related Problems (ICD-9) codes for stroke. ICD-9 codes are published by the World Health Organization and are used to classify disease and related signs and symptoms. Patients are assigned ICD-9 codes upon discharge from hospitals as a mechanism to track morbidity and mortality statistics and to support reimbursement of disease-related services. ICD-9 codes for ischemic stroke (434.xx, 436.xx) were used based on sensitivity and specificity analyses of these codes in correctly identifying patients diagnosed with ischemic stroke in administrative claims data [21].

The start date for the analysis was the date of the index admission. All billing data for patients in this inception cohort for any time, up to 365 days post index date, were used in the analysis. This collection of retrospective administrative data includes files originating from six different healthcare provider sources that bill Medicare separately: (1) hospitals, (2) Medicare Part B providers (called Carrier files), (3) nursing homes, (4) outpatient, (5) home health, and (6) durable medical equipment. An analytical data set was created by summarizing resource use for each individual patient and linking the summaries from these multiple administrative files from the 2004–2005 Medicare database.

A total of 4,065 subjects had a primary diagnosis of ischemic stroke at their index admission. The cohort population was further reduced when participants under 65 years of age and patients with a complication associated with a previous stroke were excluded (n = 588). Participants under 65 years of age were excluded since they are on Medicare due to a disability or terminal illness and, thus, may have dysphagia unrelated to their stroke. Twenty-two individuals with missing ethnicity data were also excluded. An additional 255 individuals did not have any cost data available in the year following index stroke and thus were excluded from the final study sample. The final sample included 3,200 individual Medicare patients who were hospitalized in South Carolina in 2004 with a primary diagnosis of ischemic stroke.

To identify those stroke patients with dysphagia, we used ICD-9 code 787.2x. Using the codes for stroke and dysphagia, we identified (1) the number of patients discharged with a diagnosis of ischemic stroke only, (2) the number of patients discharged with a diagnosis of ischemic stroke and dysphagia, (3) select demographic and clinical variables for all identified patients, (4) the mean LOS (days), and (5) total charges (US$) submitted to and paid by Medicare for all identified patients. Demographic variables included age, gender, ethnicity, Charlson comorbidity score, and residence (urban/rural), and relevant clinical

variables included major stroke-related diagnoses such as dysarthria, aphasia, sensory impairment, hemianopia, neglect, memory loss, or hemiplegia.

Classifying Stroke Severity

To classify stroke severity, we created a novel proxy index of severity for administrative data. Stroke severity was defined as mild if no major stroke-related diagnoses (dysarthria, aphasia, sensory impairment, hemianopia, neglect, memory loss, or hemiplegia) were coded at discharge, moderate if at least one stroke-related diagnosis was coded (excluding hemiplegia), and severe if hemiplegia or two or more stroke-related diagnoses (excluding dysphagia) were coded [22].

Determining Attributable Costs of Dysphagia

The costing perspective of this study is that of Medicare, which is the primary payer for about 72 % of all strokes in the US [8], and who pays for the hospital care of nearly all stroke patients over age 65. Attributable costs of dysphagia were defined as Medicare's payment for care. Thus, our use of the term cost is from the perspective of the major US payer. Attributable cost of caring for patients with dysphagia after stroke is defined as all costs that were over and above the cost of general care for stroke patients with no diagnosis of dysphagia. The actual charges billed for the care and the total payments made by Medicare were reported in 2004 dollars. Total cost calculations include the following subcategories: acute inpatient hospital care, clinical Part B providers, nursing home care, home healthcare, outpatient services, and durable medical equipment. Finally, the attributable cost of dysphagia was calculated and defined as the difference between the cost of care (payments) for individuals with stroke only and individuals with stroke and associated dysphagia.

Discharge Disposition

Discharge disposition was classified into six categories: (1) discharged to home/self-care, (2) discharged/transferred to skilled nursing facility (SNF), (3) discharged/transferred to inpatient rehabilitation facility (IRF), (4) discharged/transferred to organized home health organization, (5) expired, or (6) other.

Statistical Analysis

This study was reviewed and approved by the university's Institutional Review Board (IRB). The effect that each patient characteristic had on total costs (charges and payments) for the 2004 SC Medicare sample of ischemic stroke patients was initially assessed by univariate analysis. The normality of the distribution of total 1-year charges and total 1-year payments was assessed by graphical assessment and the use of the Kolmogorov-Smirnov test for normality. Since it was determined that these outcomes were each non-normally distributed, the univariate analysis assessing payments and charges between patients with and without dysphagia was evaluated using the nonparametric Wilcoxon test statistic. To assess 1-year attributable LOS and total payments and charges of dysphagia, multivariable analyses were conducted.

To correct for the non-normal distribution of the LOS and payments, gamma-distributed generalized linear models using a logarithmic transformation [23] were specified for the dependent variables through the use of the PROC GENMOD module in the SAS statistical software ver. 9.2 (SAS Institute, Inc., Cary, NC). The use of a gamma-distributed generalized linear model with a log-transformed link function has been shown to be a good method to estimate healthcare cost distributions that are generally right-skewed, especially when the log-transformed dependent variables do not have heavy tails or excessive heteroscedasticity such as in our case [24].

The results of this statistical analysis led to an interpretation of the dependent variable changes by the coefficient (valued in percent) for a 1-unit increase in the value of the independent variable, while controlling for the remaining covariates in the model. Thus, for the primary analysis of the presence of dysphagia post-stroke (yes or no) on the total 1-year cost of stroke, the interpretation would be that dysphagia would result in an *x* percent change in the total 1-year cost of stroke when compared to ischemic stroke patients without dysphagia. This was the methodology used to estimate attributable cost (in payments).

For the multivariable analysis, multicolinearity was assessed using Pearson correlation coefficients. No independent variables were found to be highly correlated in our analyses (*r* italic> 0.2). Primarily, clinically relevant variables were used to determine which covariates were initially included in the models to control for possible population differences. Original covariates considered for inclusion in the model included approximate age (age was approximated as the middle of the age group indicated by the data, i.e., if the subject was in the 65–69.9 age group, they were assigned an age of 67.5 years); ethnicity; Charlson comorbidity score; fraction of time the subject was alive in the year after index stroke (calculated as number of days alive up to 365.25 days, divided by 365.25); and stroke severity category. Finally, a manual backwards selection process was employed to determine which covariates remained in the final parsimonious model [25]. Variables with significance greater than the 0.10 level were excluded from the final parsimonious model. All analyses were performed using SAS statistical software (ver. 9.2), and statistical significance was determined at the 0.05 level.

Results

Patient Characteristics and Outcomes

Of the 3,200 individual Medicare patients who were hospitalized in South Carolina in 2004 with a primary diagnosis of ischemic stroke, 317 had a diagnosis of dysphagia. The patients with post-stroke dysphagia were slightly older and had a longer LOS than those without dysphagia. Patients with post-stroke dysphagia had a higher frequency of post-stroke complications such as aphasia and dysarthria than those without. These findings indicate that patients with post-stroke dysphagia had more severe medical complications/issues, which supports the additional finding of a higher rate of mortality in those with than those without post-stroke dysphagia. Finally, the ethnicity and residence profile of patients with dysphagia were not significantly different from those without post-stroke dysphagia (see Table 1 for a summary of patient characteristics).

Cost of Care and Related Factors

In univariate analyses, patients with post-stroke dysphagia had $9,297 higher 1-year unadjusted/crude charges and $3,819 higher unadjusted/crude payments than those without post-stroke dysphagia (Table 2). The estimated adjusted costs (payments) attributable to dysphagia were $4,510. Multivariable model results of adjusted charges are not shown as they were very similar to the cost to the insurer (payment) model. The higher costs for patients with post-stroke dysphagia were driven by higher hospital and durable medical equipment expenses (Table 2). Patients with post-stroke dysphagia were also significantly less likely to be discharged home and more likely to be discharged to a skilled nursing facility than persons without post-stroke dysphagia (Table 3). In multivariable analyses, having a diagnosis of dysphagia, being African American, and greater morbidity independently had an effect on hospital costs and LOS (Table 4). The presence of dysphagia resulted in a 23 % increase in costs and a 30 % longer LOS after controlling for relevant covariates. African Americans with post-stroke dysphagia incurred 7 % more costs and had a 16 % longer length of stay. A higher Charlson comorbidity score resulted in 9 % higher costs and a 4 % longer LOS. Finally, having a severe stroke was associated with a 31 % longer LOS; however, stroke severity category did not significantly contribute as an independent predictor in the final parsimonious cost model.

Discussion

We examined data from approximately 3,200 Medicare patients who suffered an ischemic stroke in the state of South Carolina in 2004. We found that 9.9 % of these patients had a diagnosis of dysphagia and the cost of dysphagia was $4,510 in actual payments received from Medicare. That is, a diagnosis of dysphagia, after accounting for relevant covariates, was found to directly influence LOS and 1-year post-stroke healthcare costs. This is the first study, to our knowledge, to calculate the 1-year cost of dysphagia post-stroke. For comparison, our team recently reported that the attributable 1-year cost of aphasia post-stroke is estimated to be $1,703 [22]. This information is useful as healthcare providers face healthcare reform and pressure to justify the cost of their services for management of patients with dysphagia. Furthermore, this baseline cost can help inform cost-effectiveness studies.

A range of factors were associated with costs, including comorbidity, ethnicity, and mortality. Greater morbidity and mortality, which are linked to increased healthcare utilization, were found to independently influence costs as expected. Engel-Nitz and colleagues [26] found that the presence of comorbidity (hypertension, diabetes, congestive heart failure) was associated with a 20–60 % increase in costs, depending on the coexisting conditions. These comorbidities may have contributed to the higher hospital and nursing home costs for patients with a diagnosis of dysphagia.

We also found that ethnicity was independently associated with increased cost. This finding is important because general stroke risk is greater among ethnic minorities and studies have shown greater initial severity and post-stroke morbidity among ethnic minorities, both of which contribute to greater costs. The contributions of these diverse patient-related and

clinical factors highlight the complexity of issues that must be considered when examining the costs of post-stroke conditions such as dysphagia.

Interestingly, the rate of dysphagia found in this study was considerably less than previously reported [3, 4]. This difference was likely due to the approach used to identify patients with post-stroke dysphagia: ICD-9 coding. In a study investigating the accuracy of ICD-9 coding of dysphagia for patients who underwent modified barium swallow studies (MBSSs), the code had a positive predictive value (PPV) of 94.4 and a negative predictive value (NPV) of 12.9 [6]. This indicates that when used, the code is accurate but that the code is often not used when a patient does indeed have dysphagia. It is possible that the NPV of the 787.2 code would be even lower when one includes patients that did not undergo an instrumental swallowing examination. The high PPV provides reassurance that patients included in our post-stroke dysphagia group likely did have dysphagia. However, we may have underestimated the attributable cost of dysphagia since it is likely that some patients in the post-stroke nondysphagia group actually had dysphagia.

Our results did indicate the coexistence of dysphagia and post-stroke communication deficits such as aphasia and dysarthria occurred in approximately 10 % of the patients in line with previous findings [3, 18]. These findings provide further evidence that assessments of patients post-stroke should be comprehensive, including speech, language, and swallowing function. However, we did not find the relationship between dysphagia and hemiplegia that Gonzalez-Fernandez et al. [18] found, possibly because of the low occurrence of a diagnosis of hemiplegia in our sample. There is evidence that hemiplegia is poorly coded, with a 36 % PPV of coding hemiplegia when it exists [27].

Limitations

There were five main limitations to this study: (1) reliance on ICD-9 coding for determining the presence of dysphagia which can underrepresent the diagnosis and does not provide information about the physiological swallowing impairment of the patient, (2) LOS is influenced by more than just patient status, (3) this study does not include all possible variables that could influence costs, (4) the measure of stroke severity is novel and has not been validated, and (5) only direct costs recorded by Medicare were used. Despite these limitations, this study provides a unique, preliminary assessment of dysphagia-related costs post-stroke.

Conclusions

We determined the cost of dysphagia for up to 1 year post-stroke to be $9,297 in charges and $4,510 in payments in patients following stroke. Cost was also influenced by overall health status and personal factors. Further research is needed to identify specific costs related to condition-specific care of patients with dysphagia post-stroke. Future research should extend beyond the first year and beyond medical expenses. Future research should also calculate the cost-to-charge ratio in addition to using Medicare data to better understand the difference between actual costs and payments. The findings of this study may be helpful as speech-language pathologists gather evidence to advocate for their services in this age of healthcare reform.

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References

1. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, Bravata DM, Dai S, Ford ES, Fox CS, et al. Heart disease and stroke statistics--2013 update: a report from the American Heart Association. Circulation. 2013; 127:e6–245. [PubMed: 23239837]
2. Taylor TN, Davis PH, Torner JC, Holmes J, Meyer JW, Jacobson MF. Lifetime cost of stroke in the United States. Stroke. 1996; 27:1459–66. [PubMed: 8784113]
3. Guyomard V, Fulcher RA, Redmayne O, Metcalf AK, Potter JF, Myint PK. Effect of dysphasia and dysphagia on inpatient mortality and hospital length of stay: a database study. J Am Geriatr Soc. 2009; 57:2101–6. [PubMed: 20121954]
4. Mann G, Hankey GJ, Cameron D. Swallowing function after stroke: prognosis and prognostic factors at 6 months. Stroke. 1999; 30:744–8. [PubMed: 10187872]
5. Heckert KD, Komaroff E, Adler U, Barrett AM. Postacute reevaluation may prevent dysphagia-associated morbidity. Stroke. 2009; 40:1381–5. [PubMed: 19228843]
6. González-Fernández M, Gardyn M, Wyckoff S, Ky PK, Palmer JB. Validation of ICD-9 Code 787.2 for identification of individuals with dysphagia from administrative databases. Dysphagia. 2009; 24:398–402. [PubMed: 19399554]
7. Joynt KE, Jha AK. Thirty-day readmissions--truth and consequences. New Engl J Med. 2012; 366:1366–9. [PubMed: 22455752]
8. Prabhakaran S, McNulty M, O'Neil K, Ouyang B. Intravenous thrombolysis for stroke increases over time at primary stroke centers. Stroke. 2012; 43:775–877.
9. Gresham GE, Alexander D, Bishop DS, Giuliani C, Goldberg G, Holland A, Kelly-Hayes M, Linn RT, Roth EJ, Stason WB, Trombly CA. American Heart Association Prevention Conference. IV. Prevention and Rehabilitation of Stroke. Rehabilitation. Stroke. 1997; 28:1522–6. [PubMed: 9227710]
10. Beavan J, Conroy SP, Harwood R, Gladman JR, Leonardi-Bee J, Sach T, Bowling T, Sunman W, Gaynor C. Does looped nasogastric tube feeding improve nutritional delivery for patients with dysphagia after acute stroke? A randomised controlled trial. Age Ageing. 2010; 39:624–30. [PubMed: 20667840]
11. Kotecki S, Schmidt R. Cost and effectiveness analysis using nursing staff-prepared thickened liquids vs. commercially thickened liquids in stroke patients with dysphagia. Nurs Econ. 2010; 28:106–13. [PubMed: 20446381]
12. Crary MA, Carnaby-Mann GD, Groher ME, Helseth E. Functional benefits of dysphagia therapy using adjunctive sEMG biofeedback. Dysphagia. 2004; 19:160–4. [PubMed: 15383945]
13. Wojner AW, Alexandrov AV. Predictors of tube feeding in acute stroke patients with dysphagia. AACN Clin Issues. 2000; 11:531–40. [PubMed: 11288417]
14. Odderson IR, Keaton JC, Mckenna BS. Swallow management in patients on an acute stroke pathway: quality is cost effective. Arch Phys Med Rehabil. 1995; 76:1130–3. [PubMed: 8540789]
15. Cichero JA, Heaton S, Bassett L. Triaging dysphagia: nurse screening for dysphagia in an acute hospital. J Clin Nurs. 2009; 18:1649–59. [PubMed: 19490301]
16. Wilson RD, Howe EC. A cost-effectiveness analysis of screening methods for dysphagia after stroke. PM R. 2011; 4:273–82. [PubMed: 22197380]
17. Wilson RD. Mortality and cost of pneumonia after stroke for different risk groups. J Stroke Cerebrovasc Dis. 2012; 21:61–7. [PubMed: 22225864]
18. Gonzalez-Fernandez M, Kuhlemeier KV, Palmer JB. Racial disparities in the development of dysphagia after stroke: analysis of the California (MIRCal) and New York (SPARCS) inpatient databases. Arch Phys Med Rehabil. 2008; 89:1358–65. [PubMed: 18586139]

19. Bussell SA, Gonzalez-Fernandez M. Racial disparities in the development of dysphagia after stroke: further evidence from the Medicare database. Arch Phys Med Rehabil. 2011; 92:737–42. [PubMed: 21457943]

20. Smithard DG, Smeeton NC, Wolfe CD. Long-term outcome after stroke: does dysphagia matter? Age Ageing. 2007; 36:90–4. [PubMed: 17172601]

21. Reker DM, Hamilton BB, Duncan PW, Yeh SJ, Rosen A. Stroke. Who's counting what? J Rehabil Res Dev. 2001; 38:281–9. [PubMed: 11392661]

22. Ellis C, Simpson AN, Bonilha HS, Mauldin PD, Simpson KN. One year cost of post-stroke aphasia. Stroke. 2012; 43:1429–31. [PubMed: 22343643]

23. Montez-Rath M, Christiansen CL, Ettner SL, Loveland S, Rosen AK. Performance of statistical models to predict mental health and substance abuse cost. BMC Med Res Methodol. 2006; 6:53–63. [PubMed: 17067394]

24. Manning WG, Basu A, Mullahy J. Generalized modeling approaches to risk adjustment of skewed outcomes data. J Health Econ. 2005; 24:465–88. [PubMed: 15811539]

25. Kutner, MH.; Nachtscheim, CJ.; Neter, J.; Li, W. Applied Linear Statistical Models. 5. Chicago, IL: McGraw Hill/Irwin; 2004.

26. Engel-Nitz NM, Sander SD, Harley C, Rey GG, Shah H. Costs and outcomes of noncardioembolic ischemic stroke in a managed care population. Vasc Health Risk Manag. 2010; 6:905–13. [PubMed: 20957133]

27. Spolaore P, Brocco S, Fedeli U, Visentin C, Schievano E, Avossa F, Milan G, Toso V, Vanuzzo D, Pilotto L, Pessina AC, Bonita R. Measuring accuracy of discharge diagnoses for a region-wide surveillance of hospitalized strokes. Stroke. 2005; 36:1031–4. [PubMed: 15790948]

Table 1

Demographics and characteristics of ischemic stroke patients

	Overall (*n* = 3,200)	**Dysphagia (*n* = 317)**	**No dysphagia (*n* = 2,883)**	***p* value***
Approximate age (years)[a]	78.1 (6.9)	79.4 (6.7)	78.0 (6.9)	bold>0.001
Male[b]	1,228 (38.4)	118 (37.2)	1,110 (38.5)	0.66
Caucasian[b]	2,284 (71.4)	214 (67.5)	2,070 (71.8)	0.11
Died[b]	1,284 (40.1)	178 (56.2)	1,777 (38.4)	<0.0001
Proportion of time alive (1 year)[a]	0.76 (0.38)	0.66 (0.40)	0.77 (0.37)	<0.0001
Length of stay (days)[a]	8.4 (7.0)	11.2 (7.1)	8.1 (6.9)	<0.0001
Charlson comorbidity score[a]	3.3 (1.8)	3.5 (1.7)	3.3 (1.8)	0.02
Urban/rural designation				
Small town[b]	356 (11.1)	30 (9.5)	326 (11.3)	0.16
Micropolitan[b]	749 (23.4)	64 (20.2)	685 (23.8)	
Metropolitan[b]	2,095 (65.5)	223 (64.9)	1,872 (64.9)	
Major coded diagnoses at hospital discharge				
Dysphagia[b]	317 (9.9)			
Aphasia[b]	398 (12.4)	73 (23.0)	325 (11.3)	<0.0001
Dysarthria[b]	326 (10.2)	56 (17.7)	270 (9.4)	<0.0001
Sensory impairment[b]	36 (1.1)	1 (0.3)	35 (1.2)	0.25
Hemianopia[b]	25 (0.8)	1 (0.3)	24 (0.8)	0.51
Neglect[b]	9 (0.3)	0 (0.0)	9 (0.3)	1.0
Memory loss[b]	4 (0.13)	0 (0.0)	4 (0.1)	1.0
Hemiplegia[b]	1 (0.03)	0 (0.0)	1 (0.04)	1.0
Stroke severity[c]				
Mild[b]	2,435 (76.1)	188 (59.3)	2,247 (77.9)	<0.0001
Moderate[b]	731 (22.8)	127 (40.1)	604 (21.0)	
Severe[b]	34 (1.1)	2 (0.6)	32 (1.1)	

[a] Values are mean (SD)

[b] Values are *n* (%)

[c] Stroke severity is measured as mild if no (excluding dysphagia), moderate if one (excluding dysphagia and hemiplegia), and severe if hemiplegia or two or more major diagnoses (excluding dysphagia) are coded at hospital discharge

* *p* values were calculated using nonparametric Wilcoxon scores for continuous measures, χ^2 or Fisher's exact test for categorical measures (as appropriate)

Table 2

One-year Medicare charges and payments for ischemic stroke patients[a]

	Overall (*n* = 3,200)	Dysphagia (*n* = 317)	No dysphagia (*n* = 2,883)	*p* value*
Hospital	6,549 (5,364)	6,637 (4,003)	6,539 (5,493)	0.03
Nursing home	4,741 (8,679)	7,990 (10,296)	4,383 (8,409)	<0.0001
Provider	3,586 (4,061)	3,306 (3,015)	3,617 (4,159)	0.68
Home health	1,899 (3,356)	2,059 (3,785)	1,881 (3,305)	0.91
Outpatient	1,478 (3,547)	1,349 (3,018)	1,492 (3,600)	0.19
Durable medical equipment	686 (1,607)	1,038 (2,039)	648 (1,548)	0.46
Unadjusted total charges	49,648 (39,605)	58,024 (35,254)	48,727 (39,954)	<0.0001
Unadjusted total payments	18,938 (14,455)	22,379 (14,250)	18,560 (14,429)	<0.0001
Adjusted total payments[b]		22,266	17,756	<0.0001
95% confidence intervals		(20,839–23,787)	(17,372–18,150)	
Adjusted LOS[b]		11.9 days	8.9 days	<0.0001
95% confidence intervals		(10.8–13.1)	(8.3–9.5)	

[a] All payments are expressed in 2004 constant US$ and are reported as mean (SD); payments have been rounded to the nearest dollar

[b] Covariate adjusted log linked gamma model estimates

* Except for adjusted total payments, *p* values were calculated using nonparametric Wilcoxon 2-sided normal approximations

Table 3

Discharge disposition of ischemic stroke patients[a]

	Overall (*n* = 3,200)	Dysphagia (*n* = 317)	No dysphagia (*n* = 2,883)	*p* value*
Discharged to home/self-care	847 (26.47)	30 (9.46)	817 (28.34)	<0.0001
Discharged/transferred to skilled nursing facility (SNF)	776 (24.25)	147 (46.37)	629 (21.82)	
Discharge/transferred to an inpatient rehabilitation facility (IRF)	625 (19.53)	63 (19.87)	562 (19.49)	
Discharged/transferred to organized home health service organization	442 (13.81)	31 (9.78)	411 (14.26)	
Expired	316 (9.88)	26 (8.20)	290 (10.06)	
Other	194 (6.06)	20 (6.31)	174 (6.04)	

[a] Values are *n* (%)

* *p* values were calculated using χ^2

Table 4

Effect of patient characteristics on hospital cost[a] and LOS by multivariable analysis

Variable	Total hospital cost (log) (*n* = 3,200)		LOS (log) (*n* = 3,200)	
	Parameter estimate (95% CI)	*p* value[b]	Parameter estimate (95% CI)	*p* value[b]
Intercept	9.15 (9.06, 9.24)	<0.0001	3.00 (2.64, 3.35)	<0.0001
Nondysphagic	−0.23 (−0.30, −0.16)	<0.0001	−0.30 (−0.37, −0.22)	<0.0001
Age			−0.004 (−0.007, −0.0003)	0.03
African American	0.07 (0.02, 0.03)	<0.002	0.16 (0.11, 0.21)	<0.0001
Charlson comorbidity score	0.09 (0.07, 0.10)	<0.0001	0.04 (0.02, 0.05)	<0.0001
Fraction time alive (2004)	0.73 (0.68, 0.79)	<0.0001	−0.28 (−0.34, −0.22)	<0.0001
Stroke severity (mild)[c]			Ref.	
Stroke severity (moderate)			0.03 (−0.02, 0.08)	0.26
Stroke severity (severity)			0.31 (0.10, 0.52)	0.004

[a] All costs (payments) are expressed in 2004 constant dollars

[b] Significance was determined at the 0.05 level

[c] Stroke severity was not included in the model for cost based on the results of the backward selection process