







ORIGINAL RESEARCH

Decade-Long Nationwide Trends and Disparities in Use of Comfort Care Interventions for Patients With Ischemic Stroke

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BACKGROUND: Stroke remains one of the leading causes of disability and death in the United States. We characterized 10-year nationwide trends in use of comfort care interventions (CCIs) among patients with ischemic stroke, particularly pertaining to acute thrombolytic therapy with intravenous tissue-type plasminogen activator and endovascular thrombectomy, and describe in-hospital outcomes and costs.

METHODS AND RESULTS: We analyzed the National Inpatient Sample from 2006 to 2015 and identified adult patients with ischemic stroke with or without thrombolytic therapy and CCIs using validated *International Classification of Diseases, Ninth Revision (ICD-9)* codes. We report adjusted odds ratios (ORs) and 95% CI of CCI usage across five 2-year periods. Of 4 249 201 ischemic stroke encounters, 3.8% had CCI use. CCI use increased over time (adjusted OR, 4.80; 95% CI, 4.15–5.55) regardless of acute treatment type. Advanced age, female sex, White race, non-Medicare insurance, higher income, disease severity, comorbidity burden, and discharge from non-northeastern teaching hospitals were independently associated with receiving CCIs. In the fully adjusted model, thrombolytic therapy and endovascular thrombectomy, respectively, conferred a 6% and 10% greater likelihood of receiving CCIs. Among CCI users, there was a significant decline in in-hospital mortality compared with all other dispositions over time (adjusted OR, 0.46; 95% CI, 0.38–0.56). Despite longer length of stay, CCI hospitalizations incurred 16% lower adjusted costs.

CONCLUSIONS: CCI use among patients with ischemic stroke has increased regardless of acute treatment type. Nonetheless, considerable disparities persist. Closing the disparities gap and optimizing access, outcomes, and costs for CCIs among patients with stroke are important avenues for further research.

Key Words: brain ischemia ■ comfort care ■ healthcare disparities ■ outcome assessment ■ services use ■ stroke ■ thrombolytic therapy

While advances in acute stroke care, rehabilitation, and secondary prevention have resulted in reduced stroke mortality, stroke remains one of the leading causes of death and adult disability in the United States.¹ In 2017, there were 146 383 stroke-related deaths, with ≈63% of these deaths occurring outside of an acute care hospital.² The sudden and life-altering nature of the disease often necessitates goals

of care conversations with surrogate decision makers, leading to either an early death from withdrawal of life-sustaining treatments or survival with varying levels of disability.³ The comfort care needs of patients and families with stroke are therefore immense.⁴ Broadly, comfort care encompasses hospice or palliative care (PC). Both services offer compassionate comfort care with an idea of holistic patient management in terms

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CLINICAL PERSPECTIVE

What Is New?

- Across the United States, use of comfort care interventions among adult patients with ischemic stroke steadily increased between 2006 and 2015, including greater use in those treated with intravenous tissue-type plasminogen activator and endovascular thrombectomy.
- National trends in hospital outcomes demonstrate a significant decline in in-hospital mortality relative to all other discharge dispositions, with an increasing proportion of patients with ischemic stroke with comfort care interventions receiving long-term care and home health/hospice care.
- Use of comfort care interventions among patients with ischemic stroke does not prolong length of hospital stay and is associated with lower adjusted costs.

What Are the Clinical Implications?

- Use of comfort care interventions is an increasingly important component of stroke care despite the increase in acute treatment options.
- Further studies and efforts are warranted to reduce disparities and optimize patient-centered outcomes as well as costs for patients with ischemic stroke who are eligible for comfort care interventions.

Nonstandard Abbreviations and Acronyms

| | |
|-------------|----------------------------|
| CCIs | comfort care interventions |
| EVT | endovascular therapy |
| IS | ischemic stroke |
| NIS | National Inpatient Sample |
| PC | palliative care |

of pain and symptom relief. However, hospice care is reserved for patients with terminal illness, whereas PC can be helpful at any stage of illness.⁵ According to the National Consensus Project for Quality Palliative Care, the definition of PC is “patient and family-centered care that optimizes quality of life by anticipating, preventing, and treating suffering.”⁶ In a 2016 policy statement, the American Heart Association/American Stroke Association recognized the value of comfort/palliative care in meeting priority needs of patients with stroke and improving quality of care and outcomes, supporting a system of care that provides patients with access to such interventions in conjunction with specialist-level stroke care.⁷ However, persistent disparities in comfort care use among patients with stroke have

been identified with respect to sex, race, region, and hospital characteristics.⁸

The goal of this study was to characterize 10-year nationwide trends in use of comfort care interventions (CCIs), including palliative and hospice care, for patients with ischemic stroke (IS) and describe in-hospital outcomes such as mortality, discharge disposition, length of stay (LOS), and costs for patients with IS receiving CCIs, particularly in relation to acute thrombolytic therapy with intravenous tissue-type plasminogen activator (IV tPA) and endovascular thrombectomy (EVT). We hypothesized an increase in CCI use and a decrease in in-hospital mortality across categories of patients with IS who receive CCI.

METHODS

Data Disclosure Statement

All data used in this project are publicly available from Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality (<https://www.hcup-us.ahrq.gov/db/nation/nis/nisdbdocumentation.jsp>) upon completion of requisite training and data use agreements. All data used for this project were fully deidentified and publicly available, thus not constituting human subjects research; therefore, institutional review board approval was not merited.

Study Design, Data Source, and Case Identification

We conducted a cross-sectional analysis of the National Inpatient Sample (NIS) including data from the years 2006 to 2015. The NIS is a stratified sample of ≈20% of all discharges from US community hospitals and is the largest publicly available all-payer (including the uninsured) inpatient healthcare database in the United States. After applying appropriate sampling weights, it represents 90% of US hospitalizations. The NIS is made available by assimilation of state-level data by the Agency for Healthcare Research and Quality under its Healthcare Costs and Utilization Project. We identified discharge events for adult patients (aged ≥18) with a principal diagnosis of IS using validated *International Classification of Diseases, Ninth Revision (ICD-9)* codes.⁹ Among the adult IS discharge encounters, we tagged records with *ICD-9* procedure codes for use of either IV tPA or EVT and for use of CCI services, as has been previously reported.^{8,10,11} To avoid coding inconsistencies between *ICD-9* and *International Classification of Diseases, Tenth Revision (ICD-10)*, we did not include data from the fourth quarter of 2015. For identification of CCI encounters, we used *ICD-9* code V66.7, which is flagged when various CCIs such as comfort care, hospice care or PC are used during hospitalization. Prior reports have used this code to identify the influence of PC use on estimates

of in-hospital mortality, and to describe the use of PC among patients with intracerebral hemorrhage.^{12,13}

Outcomes

We explored the association between CCI use and in-hospital outcomes of death, LOS, and discharge disposition. These outcomes are consistently provided in the NIS across all years of analysis. In addition to in-hospital deaths, we classified discharge disposition into the following categories: home discharge, transfer to acute care hospital, transfer to long-term care facility, and home health care. As per the coding in NIS, long-term care facilities include skilled nursing care facilities, hospice, long-term acute care, and inpatient rehabilitation facilities. LOS is calculated by subtracting the admission date from the discharge date, and same-day events are coded as zero. We calculated cost of hospitalization for each encounter by converting total hospital charges to costs using the Healthcare Costs and Utilization Project's cost-to-charge ratio files.¹⁴ Costs were inflation adjusted for 2015 US dollars using the Chained Consumer Price Index for all urban consumers and medical care services from the US Bureau of Labor Statistics.¹⁵

Covariates

Rates of CCI use by each year of analysis were analyzed while describing and adjusting for several demographic, healthcare system, comorbidity, and clinical disease severity variables. We included age, sex, race, insurance type, and socioeconomic status as demographic variables. Hospital bed size, hospital location, and teaching status were included as health system factors. The Charlson comorbidity index, hypertension, diabetes mellitus, heart failure, atrial fibrillation, renal failure, cancer, and coagulopathies were included as comorbidities. The all-patient refined diagnosis-related group is a disease severity measure that incorporates severity of illness subclass and risk of mortality with base diagnosis-related group and is calculated in the NIS using specialized software. Values of all-patient refined diagnosis-related group range from 0 to 4 with increasing level of loss of function. We used all-patient refined diagnosis-related group along with procedures such as ventilator support, tracheostomy, gastric tube, and hemicraniotomy as measures of disease severity.

Statistical Analysis

All analyses used survey design variables with appropriate discharge and trend weights in the NIS to yield nationally representative estimates. We provide descriptive rates of CCI use across 2-year time intervals as a proportion of IS discharges with or without IV tPA and EVT during the same 2-year interval. Mean (SD)

and proportions were compared for each covariate across stroke encounters with and without CCI use. A multivariable logistic regression model was fitted to assess independent factors associated with CCI use along with providing trend estimates, with the year 2006 as the reference. The final model included all variables that were statistically ($P < 0.05$) and clinically significant. We fit multivariable logistic, ordinal, and modified Poisson models to estimate the likelihood of death, nonhome discharge disposition, and longer LOS among IS encounters with CCI use as compared with those without CCI use. We report adjusted odds ratios (aORs) and adjusted rate ratios along with 95% CI. Hospitalization costs associated with CCI use were estimated on the basis of coefficients derived from negative binomial generalized linear models. All analyses were conducted using STATA version 16 (StataCorp, College Station, TX). We observed a total of 873 231 encounters with CCI use, which provided adequate power for our multivariable analyses.

RESULTS

Based on our inclusion and exclusion criteria, we identified a total of 4 249 201 IS encounters between January 1, 2006, and September 30, 2015, in the NIS. The mean age was 70.9 (95% CI, 70.9–71.1) years, 52% were women, and 70% were White. Among total IS encounters, 3.8% were coded for CCI use.

Trends in CCI Use

CCI use increased over the 10-year study period, with patients with IS in the 2-year time period of 2014 through 2015 being 4.8 times more likely to receive CCI compared with those in 2006 through 2007 (aOR, 4.80; 95% CI, 4.15–5.55). The increase in CCI use occurred in a stepwise fashion, with significantly higher odds across all five 2-year time periods (aOR, 1.87 for 2008–2009, 3.07 for 2010–2011, 4.15 for 2012–2013, and 4.80 for 2014–2015; compared with the reference time period of 2006–2007). Furthermore, the increase in CCI use was observed for all acute treatment types (Figure 1) and across all age groups, particularly those aged >65 (Figure 2). In the fully adjusted model, accounting for all variables including years of analysis, patients with IV tPA treatment had a 6% higher likelihood of receiving CCI (aOR, 1.06; 95% CI, 1.01–1.11), whereas patients with EVT were 10% more likely to receive CCI (aOR, 1.10; 95% CI, 1.00–1.21) as compared with patients with IS who received neither IV tPA nor EVT treatment.

CCI and Patient/Hospital Characteristics

Bivariate and multivariate analyses of pertinent variables are presented in Table 1. Proxies of overall illness

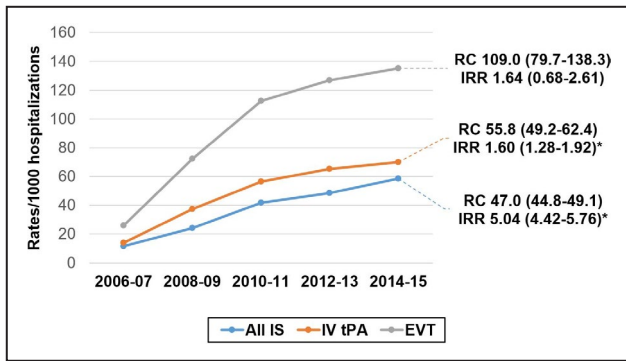


Figure 1. Trends in use of comfort care interventions among patients with ischemic stroke between 2006 and 2015, by treatment type.

EVT indicates endovascular thrombectomy; IS, ischemic stroke; IRR, incident rate ratio; IV tPA, intravenous tissue-type plasminogen activator; and RC, Relative Change.

severity, including all-patient refined diagnosis-related group severity subclass and Charlson comorbidity index, were associated with increased CCI use. Patients who received CCIs had a lower rate of invasive procedures such as percutaneous gastrostomy tube (aOR, 0.32, 95% CI, 0.30–0.35) and tracheostomy (aOR, 0.81; 95% CI, 0.70–0.93).

In the multivariate analysis, several patient and hospital characteristics were independently associated with CCI use, including older age and female sex. CCI use was significantly lower in all non-White races/ethnicities (Black [aOR, 0.59; 95% CI, 0.55–0.62], Hispanic [aOR, 0.72; 95% CI, 0.67–0.78], Asian [aOR, 0.72; 95% CI, 0.66–0.79], and Native American [aOR, 0.74; 95%

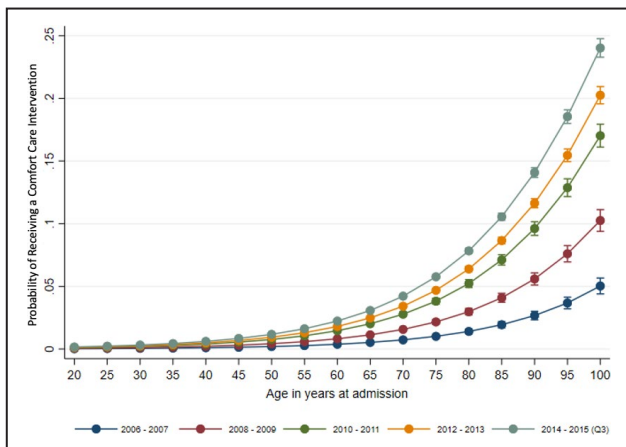


Figure 2. Likelihood of receiving a comfort care intervention among patients with ischemic stroke for five 2-year time periods across the age spectrum.

Likelihood is represented as the probability (scale 0–1) and 95% CI (vertical bars) on the y axis, and the patient age at hospitalization encounter is represented on the x axis. The 5 curves represent five 2-year time periods analyzed. Probabilities obtained from fully adjusted multivariable logistic regression models.

CI, 0.58–0.93]). Non-Medicare types of insurance and higher income were independently associated with increased CCI use. Hospital characteristics associated with increased CCI use included large hospitals (aOR, 1.13; 95% CI, 1.06–1.21, compared with small hospitals), urban teaching (aOR, 1.13; 95% CI, 1.04–1.22, compared with rural), and Western states (aOR, 1.27; 95% CI, 1.18–1.38, compared with Northeast).

CCIs and In-Hospital Outcomes (Mortality, Discharge Disposition, LOS, and Cost)

CCI use was associated with higher in-hospital mortality (aOR, 15.14; 95% CI, 14.36–15.96). However, 10-year trends in disposition outcomes demonstrate a significant decline in in-hospital mortality relative to all other discharge dispositions (aOR, 0.46; 95% CI, 0.38–0.56), with an increasing proportion of CCI patients with IS receiving long-term care and home health care relative to all other dispositions (aOR, 2.42; 95% CI, 2.03–2.88; Figure 3). Unadjusted analyses indicated that CCI patients with IS were more likely to transfer to acute care hospitals (3.2 times), receive long-term care or home health care (11.3 and 11.7 times), and die in-hospital (174 times) than be discharged home (Table 2).

The mean LOS for CCI patients with IS was 5.9 days, compared with 5.1 days for non-CCI patients (OR, 1.01; 95% CI, 1.01–1.01). Adjusting for all variables except for mortality, the odds of longer LOS in CCI versus non-CCI patients was 0.90 (95% CI, 0.88–0.91). Adjusting for all variables including mortality, the odds of longer LOS in CCI versus non-CCI patients was 0.97 (95% CI, 0.95–0.98).

Average cost per hospitalization in CCI patients was ~16% higher compared with non-CCI patients (\$14 988.21 and \$12 873.25, respectively; Table 3). Adjusting for LOS, death, age, and disease severity, average cost per hospitalization in CCI patients was ~16% lower compared with non-CCI patients (\$8724 and \$10 405, respectively).

DISCUSSION

Using the largest available database of inpatient health care in the United States, we found a rising trend in CCI use between 2006 and 2015 regardless of acute treatment type, with greater CCI use in patients with IS treated with IV tPA and EVT. Our findings are consistent with prior studies that demonstrate an increase in CCI use among patients with stroke over time.^{8,13} We additionally report that CCI use increased despite acute IS treatment with IV tPA or EVT. In addition, we found significant changes in in-hospital mortality and discharge disposition associated with CCI encounters over the study time period, with a decreasing proportion of CCI patients with IS dying in the hospital and an increasing proportion receiving long-term

Table 1. Patient and Hospital Characteristics of Patients With Ischemic Stroke With and Without Comfort Care Interventions

| Patient Characteristics | No Comfort Care Intervention | Received Comfort Care Intervention | OR (95% CI) | aOR (95% CI)* |
|---------------------------|------------------------------|------------------------------------|---------------------|---------------------|
| Total IS, n | 4 089 140 | 160 061 | | |
| Age, y | | | | |
| 18–34 | 1.15 | 0.22 | Ref | Ref |
| 35–44 | 3.24 | 0.65 | 1.05 (0.80–1.38) | 1.32 (0.98–1.78) |
| 45–54 | 10.36 | 2.78 | 1.40 (1.09–1.79) | 1.88 (1.44–2.45) |
| 55–64 | 18.13 | 7.11 | 2.04 (1.60–2.60) | 2.69 (2.07–3.50) |
| 65–74 | 22.21 | 13.48 | 3.16 (2.48–4.02) | 5.85 (4.49–7.62) |
| 75–84 | 26.06 | 28.58 | 5.70 (4.48–7.26) | 10.96 (8.39–14.31) |
| ≥85 | 18.85 | 47.16 | 13.01 (10.22–16.56) | 23.44 (17.95–30.61) |
| Sex | | | | |
| Female | 52.00 | 63.47 | 1.60 (1.56–1.64) | 1.56 (1.51–1.60) |
| Race/Ethnicity | | | | |
| White | 69.77 | 80.70 | Ref | Ref |
| Black | 16.89 | 8.70 | 0.45 (0.42–0.47) | 0.59 (0.55–0.62) |
| Hispanic | 7.54 | 5.35 | 0.61 (0.57–0.66) | 0.72 (0.67–0.78) |
| Asian/Pacific Islander | 2.66 | 2.49 | 0.81 (0.74–0.89) | 0.72 (0.66–0.79) |
| Native American | 0.52 | 0.37 | 0.62 (0.49–0.78) | 0.74 (0.58–0.93) |
| Other† | 2.62 | 2.39 | 0.79 (0.72–0.87) | 0.80 (0.73–0.89) |
| Insurance status | | | | |
| Medicare | 65.68 | 75.13 | Ref | Ref |
| Medicaid | 7.24 | 3.25 | 0.39 (0.37–0.42) | 1.41 (1.30–1.53) |
| Private | 19.66 | 14.11 | 0.63 (0.59–0.66) | 1.70 (1.58–1.84) |
| Self-pay | 4.79 | 2.33 | 0.42 (0.38–0.48) | 2.10 (1.81–2.43) |
| No charge | 0.47 | 0.19 | 0.36 (0.24–0.53) | 1.82 (1.17–2.84) |
| Other | 2.17 | 4.98 | 2.01 (1.80–2.24) | 6.09 (5.32–6.98) |
| Income | | | | |
| Quartile 1 | 30.32 | 24.49 | Ref | Ref |
| Quartile 2 | 26.45 | 25.52 | 1.19 (1.15–1.24) | 1.07 (1.02–1.11) |
| Quartile 3 | 23.36 | 25.66 | 1.36 (1.30–1.42) | 1.14 (1.08–1.19) |
| Quartile 4 | 19.86 | 24.33 | 1.52 (1.44–1.60) | 1.19 (1.13–1.26) |
| Hospital size | | | | |
| Small | 12.59 | 11.07 | Ref | Ref |
| Medium | 25.65 | 25.65 | 1.14 (1.06–1.22)† | 1.08 (1.00–1.17) |
| Large | 61.76 | 63.28 | 1.16 (1.09–1.25)† | 1.13 (1.06–1.21)† |
| Hospital type | | | | |
| Rural | 12.13 | 8.99 | Ref | Ref |
| Urban nonteaching | 38.91 | 34.13 | 1.18 (1.10–1.27) | 0.97 (0.89–1.05) |
| Urban teaching | 48.96 | 56.88 | 1.57 (1.46–1.68) | 1.13 (1.04–1.22) |
| Hospital region | | | | |
| Northeast | 17.87 | 17.85 | Ref | Ref |
| Midwest | 22.56 | 22.56 | 1.00 (0.93–1.08) | 1.12 (1.03–1.21) |
| South | 41.24 | 37.06 | 0.90 (0.84–0.97) | 1.03 (0.96–1.11) |
| West | 18.34 | 22.52 | 1.23 (1.14–1.33) | 1.27 (1.18–1.38) |
| Loss-of-function subclass | | | | |
| Unspecified | 0.01 | 0.01 | Ref | Ref |
| Minor | 11.41 | 2.78 | 0.16 (0.05–0.53) | 0.33 (0.07–1.51) |

(Continued)

Table 1. Continued

| Patient Characteristics | No Comfort Care Intervention | Received Comfort Care Intervention | OR (95% CI) | aOR (95% CI)* |
|----------------------------------|------------------------------|------------------------------------|------------------|-------------------|
| Moderate | 49.89 | 20.18 | 0.26 (0.08–0.88) | 0.49 (0.11–2.26) |
| Major | 31.11 | 44.74 | 0.93 (0.27–3.13) | 1.59 (0.35–7.27) |
| Extreme | 7.58 | 32.29 | 2.75 (0.81–9.29) | 5.82 (1.27–26.58) |
| Charlson comorbidity index | | | | |
| 0–1 | 27.37 | 17.59 | Ref | Ref |
| 2–3 | 43.04 | 36.58 | 1.32 (1.27–1.37) | 1.06 (1.02–1.10) |
| ≥4 | 29.59 | 45.84 | 2.41 (2.31–2.51) | 1.43 (1.36–1.50) |
| Clinical characteristics | | | | |
| Atrial fibrillation | 22.47 | 46.14 | 2.96 (2.88–3.03) | 1.52 (1.48–1.56) |
| Metastatic cancer | 1.28 | 5.26 | 4.29 (4.06–4.53) | 2.48 (2.31–2.66) |
| Congestive heart failure | 13.68 | 24.44 | 2.04 (1.98–2.10) | 0.87 (0.84–0.90) |
| Depression | 9.77 | 8.75 | 0.88 (0.85–0.92) | 0.86 (0.82–0.89) |
| Other psych conditions | 3.23 | 2.37 | 0.73 (0.68–0.79) | 0.77 (0.71–0.84) |
| Diabetes mellitus, uncomplicated | 29.01 | 23.65 | 0.76 (0.74–0.78) | 0.70 (0.68–0.72) |
| Diabetes mellitus, complications | 6.08 | 3.63 | 0.58 (0.55–0.62) | 0.45 (0.42–0.49) |
| Renal failure | 12.97 | 16.89 | 1.36 (1.32–1.41) | 0.81 (0.78–0.84) |
| Coagulopathy | 2.86 | 5.08 | 1.82 (1.72–1.92) | 0.80 (0.75–0.85) |
| Acute treatment type | | | | |
| None | 94.26 | 89.81 | Ref | Ref |
| IV tPA | 4.93 | 7.43 | 1.58 (1.51–1.65) | 1.06 (1.01–1.11) |
| EVT | 0.80 | 2.76 | 3.61 (3.31–3.93) | 1.10 (1.00–1.21) |
| Inpatient procedures | | | | |
| Mechanical ventilation | 0.01 | 0.02 | 1.87 (0.64–5.44) | 0.81 (0.29–2.24) |
| PEG placement | 4.27 | 4.41 | 1.03 (0.97–1.10) | 0.32 (0.30–0.35) |
| Tracheostomy | 0.67 | 0.93 | 1.39 (1.23–1.57) | 0.81 (0.70–0.93) |
| Hemicraniectomy | 0.26 | 0.80 | 3.14 (2.74–3.59) | 1.88 (1.59–2.21) |

aOR indicates adjusted odds ratio; EVT, endovascular thrombectomy; IS, ischemic stroke; IV tPA, intravenous tissue-type plasminogen activator; OR, odds ratio; and PEG, percutaneous endoscopic gastrostomy.

* Adjusted for female sex, race, tracheostomy, hemicraniectomy, atrial fibrillation, cancer, congestive heart failure, depression, other psychological conditions, uncomplicated diabetes mellitus, diabetes mellitus with complications, renal failure, and coagulopathy.

[†]P<0.05.

[‡]Other includes mixed/multiple races as reported in the Healthcare Cost and Utilization Project database National Inpatient Sample (NIS).

care and home health care. Overall, our findings suggest that CCI is an increasingly important component of stroke care despite the rise in acute treatment options, with substantial persistent disparities as well as implications for both in-hospital and discharge outcomes.

CCIs Across Demographic and Hospital Groups

Despite the rising trend in CCI use across the study period, there were significant disparities based on patient and hospital characteristics. We found that the rate of CCI use increased with age, consistent with a prior study on hospitalized patients with stroke using the NIS, which showed that less than half of decedents aged <60 received CCI, while all those aged >90 did.⁸ This suggests a higher emphasis on life-prolonging care with lower use of CCI services before death among younger patients.

CCI use was also more common in White patients compared with patients of other racial groups. This finding is consistent with previously described racial disparities in end-of-life care. Prior studies have shown that Black patients with serious illness have lower rates of advance care planning,¹⁶ PC use,¹⁷ and end-of-life discussions,¹⁸ with higher rates of life-prolonging measures.¹⁹ Racial disparities in CCI use may in part be due to cultural preferences and practices.²⁰ Racism also plays a complex role in the risk factors that lead to poor outcomes as well as in the allocation of healthcare resources.²¹ Mechanisms of such disparities need to be further evaluated.

Our results also suggest substantial variation in CCI use depending on hospital size, type, and region. The regional variability that we observed, with lowest adjusted rates in the Northeast, followed by the South, Midwest, and highest rates in the West, is

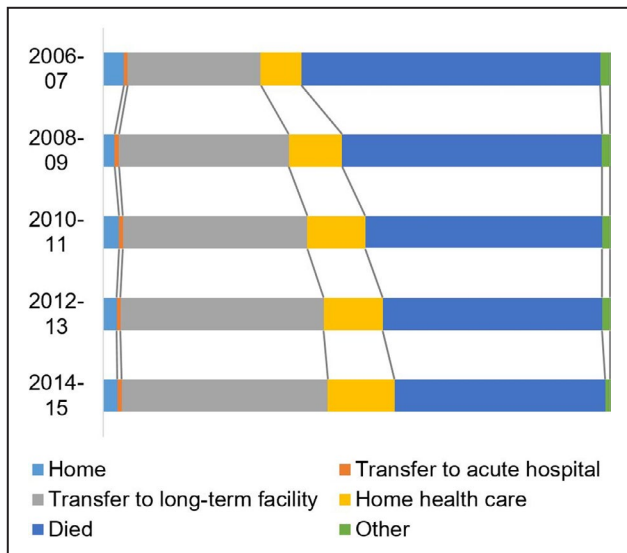


Figure 3. Trends in discharge disposition among patients with ischemic stroke with comfort care interventions between 2006 and 2015.

consistent with prior studies using the NIS to examine CCI use in stroke as well as systemic lupus erythematosus and geriatric patients with colorectal cancer.^{8,22,23} While these variations may be a reflection of the availability of hospital comfort care programs, a prior study found PC penetration to be highest in the New England states, followed by Pacific, Mid-Atlantic, and lowest in South Central states.²⁴ This suggests a possible gap in the use of available comfort care services in Northeast hospitals for certain conditions such as stroke.

Changing Trends in Mortality and Discharge Disposition with CCI

Significant changes in in-hospital outcomes, including mortality and discharge disposition, were observed across the study time period. In-hospital mortality of CCI patients with IS declined by >50% over the 10-year study period compared with all

other discharge dispositions. Concurrently, the proportion of CCI patients with IS going on to receive long-term care and home health care increased by >2 times. These findings are consistent with a prior study describing changes in site of death among Medicare fee-for-service patients between 2000 and 2015, which found a steady decrease in overall deaths in acute care hospitals from 32.6% in 2000 to 19.8% in 2015.²⁵ Among those who died while receiving hospice services, this study found that more deaths occurred in free-standing hospice inpatient units and in the home or community setting in 2015 compared with 2000. The shifting trend in place of death indicates that while fewer patients with stroke are dying in the hospital (in-hospital mortality is decreasing because of improved acute treatment and management), there may still be a significant number of patients with stroke who die in the postacute, long-term care, or community setting following discharge. This may be in line with the wishes and preferences of patients and their families, with the preferred setting for death being at home in the presence of loved ones.²⁶⁻²⁹ The provision of and access to postdischarge care options are essential to comfort care’s impact on in-hospital outcomes as well as patient-centered goals of care.

CCI, LOS, and Cost

CCI use was found to have significant implications for LOS and hospitalization costs. The mean LOS for CCI patients with IS was 5.9 days compared with 5.1 days for non-CCI patients. The difference between 5.9 and 5.1 days may seem negligible, but an average increase in LOS of ≈1 day (reduction in 1 overnight stay) is likely to have important resource implications at the population level. When adjusted for all variables except for mortality, the odds of longer LOS in CCI versus non-CCI patients was 0.90, then moved to 0.97 when adjusted for mortality as well, trending toward at least an equal, if not shorter, LOS in CCI patients compared with non-CCI patients. This finding is consistent with a prior study on

Table 2. Discharge Disposition Among Patients With Acute Ischemic Stroke With and Without Comfort Care Interventions

| Discharge Disposition | No Comfort Care Intervention, % | Received Comfort Care Intervention, % | OR (95% CI)* |
|-----------------------------------------------|---------------------------------|---------------------------------------|------------------------|
| Home | 36.83 | 2.87 | Ref |
| Transfer to short-term hospital | 3.21 | 0.80 | 3.20 (2.70–3.80) |
| Transfer to skilled nursing or other facility | 42.97 | 37.80 | 11.29 (10.22–12.48) |
| Home health care | 12.83 | 11.73 | 11.74 (10.55–13.05) |
| Died | 3.36 | 45.47 | 173.89 (156.94–192.69) |
| Other | 0.81 | 1.33 | 21.17 (17.10–26.20) |

OR indicates odds ratio.
*Unadjusted estimates.

Table 3. Cost/Hospitalization (in 2015 US Dollars) Among Patients With Ischemic Stroke With and Without Comfort Care Interventions

| | Cost/Hospitalization, 2015 US Dollars (95% CI) | OR (95% CI) | Adjusted Cost/Hospitalization, 2015 US Dollars (95% CI) | aOR (95% CI)* |
|-----------------------------------|------------------------------------------------|------------------|---------------------------------------------------------|------------------|
| Without comfort care intervention | 12 873.25 (12 742.53–13 003.96) | Ref | 10 405.62 (10 327.67–10 483.57) | Ref |
| With comfort care intervention | 14 988.21 (14 645.71–15 330.71) | 1.16 (1.14–1.19) | 8724.07 (8599.30–8848.85) | 0.84 (0.83–0.85) |

aOR indicates adjusted odds ratio; and OR, odds ratio.
*Adjusted for length of stay, death, age, and disease severity.

hospitalized patients with stroke using the NIS, which found that PC encounters were associated with a shorter LOS, suggesting an earlier death through PC and fewer days of aggressive life-sustaining treatment.⁸ Previously published systematic reviews have also demonstrated a pattern of reduced intensive care unit as well as hospital LOS with early PC consultations, decreasing costs as well without impacting mortality.^{30,31}

Average unadjusted cost per hospitalization in CCI patients was ≈16% higher compared with non-CCI patients. Adjusting for LOS, death, age, and disease severity, average cost per hospitalization in CCI patients was ≈16% lower compared with non-CCI patients. Prior studies have found that estimating the association of PC consultation with hospital costs requires incorporating time from admission to consultation.^{32,33} Our use of *ICD-9* coding to identify CCI encounters within the NIS limits our ability to know when these encounters took place, whether early or late during each hospitalization. Our findings suggest that patients IS perhaps receive CCI services late during their hospitalization, given that cost per hospitalization changes from relatively higher to relatively lower with CCI versus non-CCI when adjusted for LOS and variables of disease severity. While early PC consultation has been shown to result in decreased costs as well as earlier referral to more appropriate levels of care, one prospective cohort study of patients with advanced cancer found that early as well as late PC consultation resulted in cost savings from both reduced LOS and intensity of treatment.^{34–36}

Limitations

Limitations of this study include its observational design using retrospective analysis of the NIS database. Adjusted estimates therefore represent associations. Nonetheless, the NIS is the largest all-payer inpatient database in the United States, representing 90% of US hospitalizations, and is ideally suited to provide national trend estimates. The NIS does not include information regarding patients’ baseline level of function or whether they have advance directives, both of which are important factors that influence CCI use.

It is noteworthy that within our study time period, the NIS underwent redesign, raising the possibility that trend estimates across 2011 and 2012 may not be stable. To address this possibility, we used trend weights. In addition to the above limitations, we used *ICD-9* coding to identify IS as well as CCI encounters. *ICD-9* coding is usually performed by the billing departments of hospitals on the basis of provider documentation, which may vary across hospitals and geographic regions. Prior studies have shown that *ICD-9* codes for IS have consistently high (at least >80%) positive predictive value.^{9,37} The use of the V66.7 code for PC has been shown in one study to have low sensitivity and high specificity in the identification of PC consultation, while another study showed a 98% positive predictive value.^{38,39} It is possible that patients with the V66.7 procedure code did not receive PC services, especially since specialty PC is not available at all hospitals. Moreover, *ICD-9* coding and documentation of PC encounters does not fully reflect the degree of PC services that patients receive. PC services encompass more than what is identified through billing and include holistic and patient- and family-centered care that focuses on quality of life and symptom management. Therefore, our results more precisely indicate trends and associates of a broader category of comfort care. It is also possible that our observations indicate an increase in the coding of CCI itself rather than an increase in the actual use of CCI, but the trends observed in this study correlate with other studies, suggesting proper use of the *ICD-9* code.

CONCLUSIONS

CCI use among patients with IS has increased over time regardless of acute treatment type. Acute treatment with IV tPA and EVT was associated with higher CCI use. Despite increased trends in CCI use, considerable sex, race, and geographic disparities persist at the national level. Outcome trends over time indicate lower in-hospital mortality with higher rates of discharge to long-term care and home health/hospice with CCI use. Comfort care is becoming an increasingly important

component of stroke care, and further studies are warranted to reduce disparities and optimize access, outcomes, and costs for those who need it.

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