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BRIEF COMMUNICATION

# Functional Impairment and Postacute Care Discharge Setting May Be Useful for Stroke Survival Prognostication

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**BACKGROUND:** The aim of this study was to discussions about post-stroke outcomes related to post-stroke function and post-acute care discharge setting.inform patient-provider.

**METHODS AND RESULTS:** We conducted a retrospective cohort study of Medicare beneficiaries with acute ischemic stroke or intracerebral hemorrhage in 2013. Our primary outcome was mortality within at least 1-year post discharge. We performed multivariate logistic regression to estimate 90-day odds ratios (ORs) and Cox proportional hazards regression to estimate post 90-day hazard ratios on mortality, adjusting for demographics, procedures, comorbidities, discharge setting (inpatient rehabilitation facility, skilled nursing facility, or home health care agency), post-stroke function (measured by the Functional/Pseudo-Functional Independence Measure) and setting-function interactions. There were 167 000 patients with a mean follow-up of 441 days. Mortality within 90 days was associated with post-stroke function (OR, 0.23; 95% CI, 0.19–0.27 comparing highest to lowest quintile of post-stroke function) and discharge setting (OR, 4.05; 95% CI, 3.78–4.33 for skilled nursing facility versus inpatient rehabilitation facility). Among the highest functioning patients, those discharged to inpatient rehabilitation facility had a 1-year mortality of 9% and those discharged with home health had 11% mortality at 1 year. The lowest functioning survivors of stroke discharged to a skilled nursing facility had 64% mortality at 1 year and those discharged to an inpatient rehabilitation facility had 29.6% mortality at 1 year.

**CONCLUSIONS:** Nearly two thirds of the lowest functioning survivors of stroke discharged to a skilled nursing facility die within a year. This finding should inform discussions between providers and patients/caregivers in aligning goals of care with the care survivors of stroke receive.

**Key Words:** mortality ■ post-stroke function ■ post-stroke discharge setting ■ stroke

It is important that patients receive medical care that is consistent with their values, goals, and preferences during serious and chronic illness. This process of advance care planning may be particularly important for patients with stroke. Although previously declining, stroke death rates may be declining more slowly or plateauing in the United States.[1] At the same time, survivors of stroke live with disability and suffer post-stroke medical complications and recurrent stroke leading to hospital readmission.[2] For example, a patient with a malignant middle cerebral artery stroke might survive after a hemicraniectomy but require a tracheostomy and percutaneous endoscopic gastrostomy tube. Yet, these types of decisions are made with limited data regarding the likelihood of long-term survival.

During the acute stroke hospitalization, post-stroke function and discharge location are often used informally to inform patient–provider discussions about post-stroke outcomes. These measures are used because they are readily available on every patient and because they incorporate many other factors related to post-stroke outcomes. For example, post-stroke function takes into account pre-stroke function and discharge location is partly determined by age,

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comorbidities, and cognition. Similarly, discharge location is influenced by a variety of factors that influence prognosis and are often difficult to measure—including baseline function, social support, frailty, medical complexity, psychological factors, and patient preferences. Providers intuitively know that a patient with severe post-stroke disability being discharged to a skilled nursing facility (SNF) has a relatively poor prognosis,[3–6] but the absolute magnitude of the risk of mortality may not be known. In this context, using a national US data set we sought to estimate the absolute risk of mortality based on the discharge setting and post-stroke function of a survivor of stroke. Our goal was not to estimate the true causal effect of post-stroke function or discharge setting on mortality. We simply wanted to estimate the magnitude of the association between post-stroke function and discharge setting with mortality, knowing that both post-stroke function and discharge setting reflect a variety of prognosis-related elements. These results will inform patient–provider discussions to ensure that medical care is aligned with patients' goals.

# METHODS

## Overview

We performed a retrospective cohort study of patients discharged after a primary stroke admission, using Medicare data. Medicare data are available through www.cms.gov. The primary outcome was mortality. Key exposures included post-acute care (PAC) setting and initial function in the first rehabilitation setting after discharge. This study was approved by the University of Michigan Institutional Review Board. JB has full access to all the data in the study and takes responsibility for the data and analysis.

## Study Population

We identified Medicare patients aged 65 years or greater who were hospitalized for acute ischemic stroke or intracerebral hemorrhage, identified by primary *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9 CM*) codes 431, 433.x1, 434.x1, and 436 between January 1, 2013 and December 31, 2013. Patients were followed for at least 1 year from the date of admission to the PAC setting or until death, whichever came first. Patients were excluded if they died during the index hospitalization, were discharged to hospice, or had <1 year of data following admission to the PAC setting.

## Outcomes

Our primary outcome was all-cause mortality within and after 90 days of the PAC setting index, which is the beginning of the post-acute care stay. Information about vital status was taken from Medicare. Mortality was assessed until December 31, 2014.

## Exposures

The PAC setting of the survivor of acute stroke was defined as the first setting after hospital discharge identified by rehabilitation claims or assessments (Inpatient Rehabilitation Facility-Patient Assessment Instrument, Long Term Care Minimum Data Set 3.0, and Home Health Outcome and Assessment Information Set). The PAC setting of the survivor of acute stroke was identified using the Medicare Beneficiary Identifier, which is a unique code (11 numbers/letters) assigned to each Medicare beneficiary. Each Medicare data source used in the study includes the Medicare Beneficiary Identifier, which was therefore used to link the survivor of acute stroke to his/her PAC setting. Post-acute care settings included inpatient rehabilitation facility (IRF), skilled nursing facility (SNF), home health care agency (HHA), long-term acute care hospital, and home. Survivors of acute stroke not captured in rehabilitation claims or assessments were assigned a PAC setting of home.

Initial post-stroke function was measured by Functional/Pseudo-Functional Independence Measure (FIM/Pseudo-FIM) identified in the first PAC setting (IRF, SNF, HHA) up to 14 days after the discharge date of the stroke hospitalization. The FIM is an 18-item assessment of activities of daily living, motor function, cognitive function, and continence and has good inter-rater reliability.[7] Lower scores on the FIM denote worse function (score range from 6–42). SNFs and HHAs use a FIM-like instrument within the Minimum Data Set and Outcome and Assessment Information Set assessments to measure function, which we converted using crosswalks to analogous FIM scores, termed the pseudo-FIM.[8] We categorized FIM scores into quintiles (<11, 11–14.5, 14.5–18, 18–22, >22) in order to create categories of function (low to high) (see Data S1 for additional details about the FIM and pseudo-FIM).

## Covariates

Demographic variables included age at hospital discharge, sex, and race or ethnicity (White, Black, Hispanic, and Other [defined as American Indian/Asian/Native Hawaiian/Pacific Islander]). Race and ethnicity were self-reported. Clinical variables included length of stay (defined as number of days of the index hospitalization), intensive care unit stay (yes/no), diagnosis of intracerebral hemorrhage (yes/no), preexisting diagnosis of Charlson comorbidities (yes/no),[9] total number of hospital complications, acute stroke treatments, and life-prolonging procedures performed during hospitalization (see Data S1 for additional details). Demographic variables, except age, were extracted from Medicare beneficiary summary files. Age

at discharge from the initial stroke hospitalization and clinical variables were taken from inpatient claims data.

## Statistical Analysis

Demographic and clinical characteristics were compared by PAC setting and post-stroke function (FIM/PseudoFIM) with the use of chi-square test for categorical variables and pairwise *t* tests for continuous variables.

We intended to use Cox proportional hazards regression analysis to evaluate the relationship of PAC setting and post-stroke function with mortality, but the proportional hazards assumption was violated for the first 90 days of the follow-up period (Figure S1). We therefore performed multivariate logistic regression for mortality within the first 90 days of the follow-up period and a Cox proportional hazards regression for the remainder of the follow-up period (post 90 days). (see Data S1 for additional details). Patients with missing data on post-stroke function were included as a separate category of the post-stroke function variable in the regression model. In both regression models, we controlled for the demographic and clinical covariates stated previously as they could be potential confounders in the relationship between the exposure (PAC setting or post-stroke function) and the outcome (mortality). We performed an unadjusted regression model to predict mortality from the interaction between PAC setting and post-stroke function.

# RESULTS

## Population Description

A total of 167 000 patients who discharged alive to long-term acute care hospital (1.23%), IRF (23.0%), SNF (29.5%), HHA (14.4%), or home (31.9%) and met the study criteria were included (Figure S2). During a mean follow-up of 441±209 days, 49 032 patients died (29.4%). Patients discharged to SNF had the highest observed rate of 90-day mortality (22.9%), compared with IRF (7.7%) and HHA (6.7%). There were no missing data for PAC setting, as patients not captured in rehabilitation settings were assigned a discharge destination of home. There were 3973 patients missing data on post-stroke function. As described in Table 1, patients discharged home were more likely to be male, younger, had shorter length of stay, and were less likely to have a gastric feeding tube or tracheostomy. Patients at IRF were more likely to have received disability reducing treatments such as tissue plasminogen activator (8.1%) and thrombectomy (2.7%), compared with patients at SNF (tissue plasminogen activator 5.2%, thrombectomy 1.4%). Of the patients with the lowest post-stroke function (as reflected by a FIM/Pseudo-FIM score <11), over half (51%) were discharged to IRF and 42% were discharged to SNF. Of the patients in the second lowest quintile of poststroke function (as reflected by a FIM/Pseudo-FIM score between 11 and 14.5), 31% were at IRF and 61% were at SNF (Table S1).

## Association of PAC Setting With Mortality

Adjusted for demographic and clinical variables, compared with being discharged to IRF, the odds of death within 90 days was higher in those discharged to SNF or HHA (Figure [A]). In the post 90-day analysis, patients discharged to SNF had higher risk of death throughout the post-90 day follow-up period, compared with those at IRF and HHA adjusted for demographic and clinical variables (Figure [B]).

## Association of Initial Poststroke Function With Mortality

Adjusted for demographic and clinical variables, compared with being in the lowest function quintile at time of discharge to a given setting, those with better function had a significantly higher probability of survival in the first 90 days. The effect of function on survival within the first 90 days was similar at higher levels of functional independency (Figure [A]). This pattern persisted after 90 days: hazard ratio (HR), 95% CI, comparing quintiles of function to the lowest quintile (FIM score <11): FIM 11–14.5, HR, 0.69, 95% CI, 0.65–0.74; FIM 14.5–18, HR, 0.59; 95% CI, 0.55–0.63; FIM 18–22, HR, 0.51; 95% CI, 0.47–0.55; FIM>22, HR, 0.40; 95% CI, 0.37–0.44.

## Association of Post-stroke Function and PAC Setting With Mortality

Adjusting for demographic and clinical characteristics, the effect of the PAC setting on post 90-day mortality was modified by the level of the initial post-stroke function at discharge. Table 2 contains unadjusted estimates of 90 day, 1 year, and 2 year mortality for different levels of function at IRF, SNF, and HHA post-acute care settings. Patients discharged to SNF with the lowest function had a 90-day mortality of 44.5% and a 1-year mortality of 64.1% compared with 13.6% and 29.6% mortality respectively for the lowest functioning patients at IRF. After 90 days, mortality was higher in patients in the lowest function quintile at SNF compared with those with the same functional status at IRF, whereas the relationship between PAC setting and mortality did not differ greatly for patients with higher functional status (Figure [C]).

Other clinical and demographic factors associated with mortality are described in Table S2.

# DISCUSSION

In a national cohort of older adults, we found that both post-stroke function and PAC setting are associated

**Table 1. Baseline Characteristics, Stratified by Postacute Care Setting**

| Variable | Overall | Long-term acute care hospital | Inpatient rehabilitation facility | Skilled nursing facility | Home health care agency | Home | *P* value |
|---|---|---|---|---|---|---|---|
| | N=167000 | N=2053 | N=38346 | N=49298 | N=24069 | N=53234 | |
| Age, y (median[Q1,Q3]) | 79 (72, 86) | 77 (71, 83) | 79 (72, 85) | 84 (77, 89) | 80 (73, 86) | 75 (70, 82) | <0.001 |
| Sex | | | | | | | |
| Male | 72405 (43.36%) | 954 (46.47%) | 17294 (45.10%) | 17240 (34.97%) | 9356 (38.87%) | 27561 (51.77%) | <0.001 |
| Female | 94595 (56.64%) | 1099 (53.53%) | 21052 (54.90%) | 32058 (65.03%) | 14713 (61.13%) | 25673 (48.23%) | |
| Race or ethnicity | | | | | | | |
| White | 138395 (82.87%) | 1446 (70.43%) | 31786 (82.89%) | 40766 (82.69%) | 19243 (79.95%) | 45154 (84.82%) | <0.001 |
| Black | 19156 (11.47%) | 427 (20.80%) | 4470 (11.66%) | 5986 (12.14%) | 3279 (13.62%) | 4994 (9.38%) | |
| Hispanic | 2794 (1.67%) | 61 (2.97%) | 594 (1.55%) | 788 (1.60%) | 566 (2.35%) | 785 (1.47%) | |
| American Indian/Asian/Native Hawaiian/Pacific Islander | 6655 (3.99%) | 119 (5.80%) | 1496 (3.90%) | 1758 (3.57%) | 981 (4.08%) | 2301 (4.32%) | |
| Transfer from a skilled nursing facility or intermediate care facility* | 3886 (2.33%) | 59 (2.87%) | 251 (0.65%) | 3062 (6.21%) | 152 (0.63%) | 362 (0.68%) | <0.001 |
| Transfer from another type of health care facility† | 1932 (1.16%) | 45 (2.19%) | 412 (1.07%) | 736 (1.49%) | 213 (0.88%) | 526 (0.99%) | <0.001 |
| Length of stay at indexed hospitals, days (median[Q1,Q3]) | 4 (2, 6) | 11 (7, 18) | 4 (3, 6) | 5 (3, 8) | 3 (2, 5) | 2 (2, 4) | <0.001 |
| Complications at indexed hospitals (median[Q1,Q3]) | 0 (0, 0) | 0 (0, 1) | 0 (0, 0) | 0 (0, 0) | 0 (0, 0) | 0 (0, 0) | <0.001 |
| Intensive care unit usage | 50085 (29.99%) | 1564 (76.18%) | 18768 (48.94%) | 20789 (42.17%) | 8964 (37.24%) | 0 (0.00%) | <0.001 |
| Intracerebral hemorrhage | 13587 (8.14%) | 518 (25.23%) | 3723 (9.71%) | 4669 (9.47%) | 1348 (5.60%) | 3329 (6.25%) | <0.001 |
| Comorbidities | | | | | | | |
| History of myocardial infarction | 12643 (7.57%) | 134 (6.53%) | 2904 (7.57%) | 3552 (7.21%) | 1972 (8.19%) | 4081 (7.67%) | <0.001 |
| Congestive heart failure | 28614 (17.13%) | 575 (28.01%) | 6258 (16.32%) | 11258 (22.84%) | 4351 (18.08%) | 6172 (11.59%) | <0.001 |
| Peripheral vascular disease | 16224 (9.71%) | 202 (9.84%) | 3751 (9.78%) | 4883 (9.91%) | 2496 (10.37%) | 4892 (9.19%) | <0.001 |
| Chronic obstructive pulmonary disease | 31838 (19.06%) | 527 (25.67%) | 7065 (18.42%) | 10377 (21.05%) | 5076 (21.09%) | 8793 (16.52%) | <0.001 |
| Dementia | 12278 (7.35%) | 120 (5.85%) | 1668 (4.35%) | 6869 (13.93%) | 1759 (7.31%) | 1862 (3.50%) | <0.001 |
| Diabetes | 49039 (29.36%) | 669 (32.59%) | 11776 (30.71%) | 14481 (29.37%) | 7446 (30.94%) | 14667 (27.55%) | <0.001 |
| Mild liver disease | 611 (0.37%) | 10 (0.49%) | 129 (0.34%) | 186 (0.38%) | 105 (0.44%) | 181 (0.34%) | 0.187 |
| Peptic ulcer disease | 1589 (0.95%) | 47 (2.29%) | 355 (0.93%) | 641 (1.30%) | 212 (0.88%) | 334 (0.63%) | <0.001 |
| Rheumatologic disease | 4891 (2.93%) | 51 (2.48%) | 1071 (2.79%) | 1539 (3.12%) | 810 (3.37%) | 1420 (2.67%) | <0.001 |

(*Continued*)

**Table 1. Continued**

| Variable | Overall | Long-term acute care hospital | Inpatient rehabilitation facility | Skilled nursing facility | Home health care agency | Home | *P* value |
|---|---|---|---|---|---|---|---|
| | N=167000 | N=2053 | N=38346 | N=49298 | N=24069 | N=53234 | |
| Hemiplegia or paraplegia | 48622 (29.11%) | 1100 (53.58%) | 17511 (45.67%) | 17524 (35.55%) | 4125 (17.14%) | 8362 (15.71%) | <0.001 |
| Moderate-severe renal disease | 29348 (17.57%) | 467 (22.75%) | 6481 (16.90%) | 10164 (20.62%) | 4745 (19.71%) | 7491 (14.07%) | <0.001 |
| Diabetes with complications | 8906 (5.33%) | 121 (5.89%) | 2203 (5.75%) | 2695 (5.47%) | 1527 (6.34%) | 2360 (4.43%) | <0.001 |
| Moderate-severe liver disease | 298 (0.18%) | 7 (0.34%) | 59 (0.15%) | 99 (0.20%) | 49 (0.20%) | 84 (0.16%) | 0.097 |
| AIDS | 130 (0.08%) | 1 (0.05%) | 32 (0.08%) | 35 (0.07%) | 21 (0.09%) | 41 (0.08%) | 0.917 |
| Hospital procedures | | | | | | | |
| Receipt of intravenous tissue plasminogen activator | 10090 (6.04%) | 190 (9.25%) | 3106 (8.10%) | 2560 (5.19%) | 1173 (4.87%) | 3061 (5.75%) | <0.001 |
| Receipt of thrombectomy | 2357 (1.41%) | 96 (4.68%) | 1020 (2.66%) | 682 (1.38%) | 150 (0.62%) | 409 (0.77%) | <0.001 |
| Life prolonging procedures | | | | | | | |
| Gastrostomy tube insertion | 8702 (5.21%) | 990 (48.22%) | 1816 (4.74%) | 5045 (10.23%) | 315 (1.31%) | 536 (1.01%) | <0.001 |
| Hemicraniectomy | 734 (0.44%) | 135 (6.58%) | 275 (0.72%) | 201 (0.41%) | 31 (0.13%) | 92 (0.17%) | <0.001 |
| Ventriculostomy | 15 (0.01%) | 4 (0.19%) | 6 (0.02%) | 3 (0.01%) | 0 (0.00%) | 2 (0.00%) | …‡ |
| Tracheostomy | 1144 (0.69%) | 775 (37.75%) | 74 (0.19%) | 219 (0.44%) | 7 (0.03%) | 69 (0.13%) | <0.001 |
| Intubation | 4439 (2.66%) | 1008 (49.10%) | 1004 (2.62%) | 1487 (3.02%) | 175 (0.73%) | 765 (1.44%) | <0.001 |
| Hemodialysis | 2280 (1.37%) | 100 (4.87%) | 421 (1.10%) | 856 (1.74%) | 418 (1.74%) | 485 (0.91%) | <0.001 |
| Cardiopulmonary resuscitation | 121 (0.07%) | 30 (1.46%) | 21 (0.05%) | 39 (0.08%) | 7 (0.03%) | 24 (0.05%) | <0.001 |

Values in the table represent N(%) unless otherwise indicated.
*N(%) of patients residing in a skilled nursing facility or intermediate care facility before the index hospitalization.
†N(%) of patients residing in a rehabilitation facility, other than skilled nursing or intermediate care, before the index hospitalization.
‡Chi-square test not appropriate because at least 50% of the cells have an expected count <5.

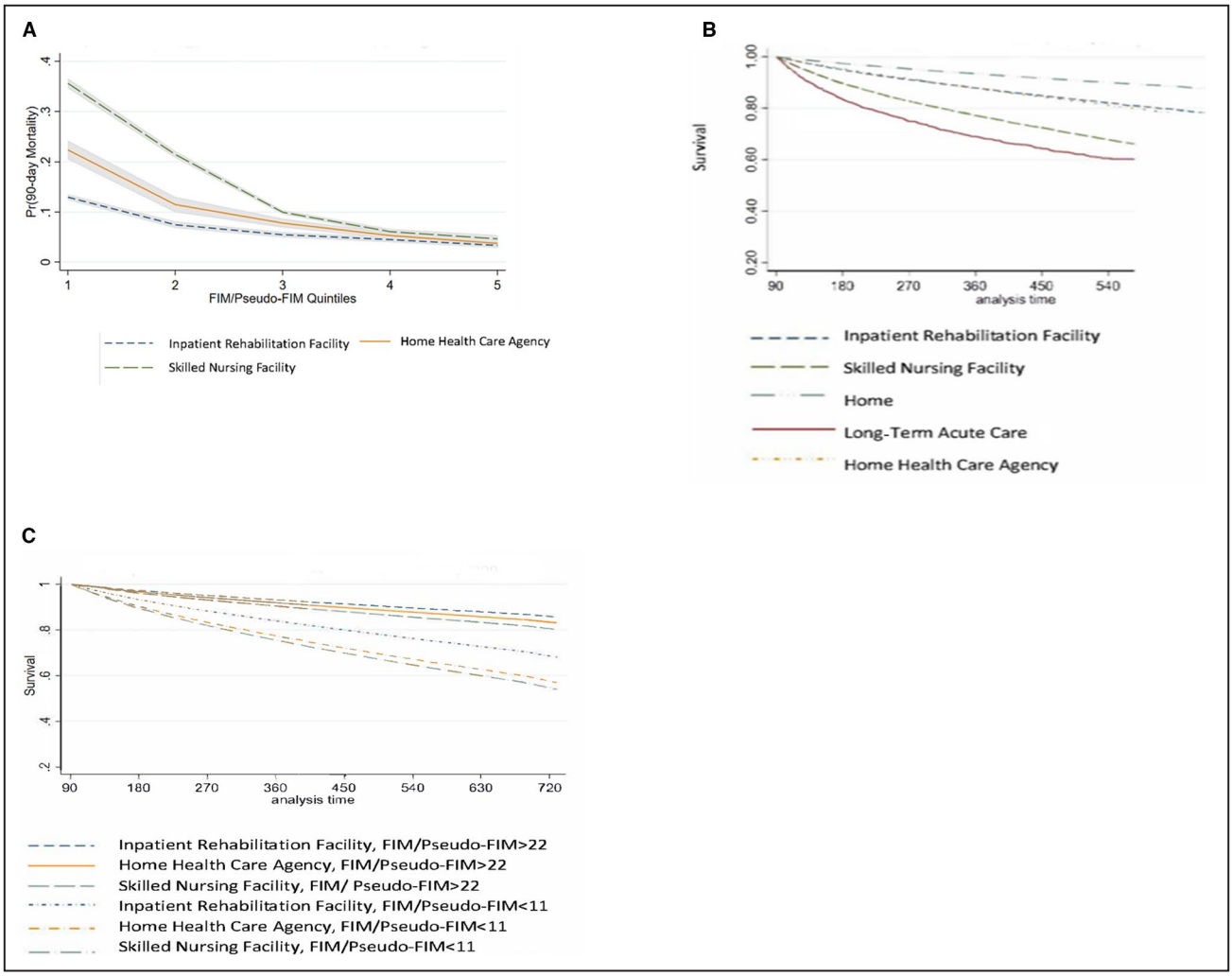


**Figure. Relationship between post-acute care setting, post-stroke function, and mortality.**
**A**, 90-day mortality. The line graph shows the relationship between poststroke function and the probability of 90-day mortality for different post-acute care settings adjusted for demographic and clinical variables. The shaded area around each line is the 95% CI. **B**, Post 90-day mortality. The line graph shows post 90-day mortality over time by unadjusted post-acute care setting, where the *y*-axis is the probability of survival. **C**, Post 90-day mortality. The line graph shows post 90-day mortality over time by post-acute care setting in stroke survivors with a FIM/Pseudo-FIM score <11 or a FIM/Pseudo-FIM score >22, where the *y*-axis is the probability of survival. The relationship between post-acute care setting and mortality is adjusted for demographic and clinical variables. FIM indicates functional independence measure.

with intermediate and long-term mortality. We found that mortality among patients with the lowest post-stroke function discharged to SNF was 64.1% in 1 year, which is double that of patients with the lowest post-stroke function discharged to IRF. The absolute rate of mortality in this group is striking and higher than we expected.

Our findings are a step toward enabling families and patients to make more informed decisions about goals of care. Prior research has shown that post-stroke functional ability and PAC setting predict outcomes after stroke.[6,10,11] Our data show that there is also an interaction between the two, such that outcomes for patients with the lowest post-stroke function differ by PAC setting with 64.1% mortality in 1 year when discharged to SNF, 1-year mortality of 51% when discharged to HHA, and 1-year mortality of 29.6% when discharged to IRF. Our findings can aid decision making during and after the acute stroke hospitalization. The American Society of Clinical Oncology practice guidelines cite likelihood of death within 12 months as one criterion for referral for palliative care services established by the Center to Advance Palliative Care.[12] With 64.1% mortality at 1 year in the lowest functioning SNF patients and almost 50% in the next quintile of function, it is crucial that physicians ensure that care is consistent with patients' treatment goals and preferences—or discuss palliative care services with families and patients with low function anticipated to be discharged to SNF.

**Table 2. Mortality Estimates by Poststroke Function and Postacute Care Setting**

| | 1st Quintile (low) | 2nd Quintile | 3rd Quintile | 4th Quintile | 5th Quintile (high) | Overall |
|---|---|---|---|---|---|---|
| FIM/Pseudo-FIM score range | <11 | 11–14.5 | 14.5–18 | 18–22 | >22 | |
| 90-d mortality (%) (95% CI) | | | | | | |
| IRF | 13.6 (13.0–14.2) | 7.3 (6.7–8.0) | 5.2 (4.7–5.7) | 4.1 (3.6–4.6) | 2.8 (2.5–3.3) | 7.7 (7.5–8.0) |
| SNF | 44.5 (43.5–45.5) | 27.2 (26.4–28.0) | 12.2 (11.7–12.8) | 6.8 (6.2–7.5) | 4.6 (3.9–5.4) | 22.9 (22.5–23.3) |
| HHA | 27.5 (25.4–29.7) | 13.0 (11.3–14.8) | 8.3 (7.4–9.3) | 5.1 (4.6–5.7) | 3.3 (3.0–3.6) | 6.7 (6.4–7.0) |
| 1-y mortality (%) (95% CI) | | | | | | |
| IRF | 29.6 (28.8–30.4) | 18.9 (17.9–19.8) | 15.1 (14.3–16.0) | 12.7 (11.9–13.6) | 9.1 (8.4–9.8) | |
| SNF | 64.1 (63.1–65.0) | 48.6 (47.7–49.5) | 29.8 (29.1–30.5) | 20.9 (19.9–21.9) | 14.6 (13.4–15.9) | |
| HHA | 51.0 (48.6–53.5) | 32.1 (29.8–34.6) | 22.8 (21.4–24.3) | 17.4 (16.5–18.4) | 11.4 (10.8–11.9) | |
| 2-y mortality (%) (95% CI) | | | | | | |
| IRF | 42.0 (40.6–43.4) | 30.5 (28.6–32.4) | 27.5 (25.2–29.9) | 22.2 (20.7–23.7) | 16.3 (15.0–17.7) | |
| SNF | 74.3 (73.1–75.5) | 62.5 (61.1–63.9) | 47.1 (45.5–48.7) | 36.3 (33.8–39.1) | 27.2 (24.5–30.1) | |
| HHA | 68.4 (64.8–72.0) | 52.4 (48.0–57.0) | 35.7 (33.2–38.4) | 30.2 (28.4–32.2) | 21.7 (20.4–23.1) | |

Values in the table are unadjusted estimates. FIM indicates Functional Independence Measure; HHA, home health care agency; IRF, inpatient rehabilitation facility; and SNF, skilled nursing facility.

Our study had some limitations. First, our results are limited to survivors of acute stroke over the age of 65 years and therefore may not generalize to younger survivors. We also acknowledge that our study was limited to survivors of stroke and that hospitalization for acute conditions besides stroke can similarly influence post-discharge mortality, particularly for patients residing in a nursing or rehabilitation facility before hospitalization.[13] Second, it is likely that the degree and quality of rehabilitation and medical care vary across rehabilitation facilities at the same level of care (eg, different subacute rehabilitation or different inpatient rehabilitation facilities) and thus mortality rates may differ across individual facilities. Third, our measure of post-stroke function occurred at the PAC setting. However, we believe that this measure reflects the survivor of stroke's function at the end of acute care hospitalization, given that patients are transferred directly to their PAC setting, and therefore can be used to inform future outcomes.

## CONCLUSIONS

The post-stroke functional ability and discharge destination of survivors of acute stroke inform their risk of mortality. Survivors of acute stroke with poor functional ability have a 1-year mortality of 64.1% when discharged to SNF and 29.6% when discharged to IRF. Our findings might aid in informing outcomes after stroke and could be used to help ensure that care is consistent with patients' values and preferences.

## ARTICLE INFORMATION

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### Disclosures

None.

### Supplemental Material

Data S1
Tables S1–S2
Figures S1–S2
References 14,15

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# SUPPLEMENTAL MATERIAL

**Data S1.**

## SUPPLEMENTAL METHODS

### Exposures

Inpatient rehabilitation facilities use the FIM to assess patients' level of function. Each item on the FIM is rated from 1 (total dependence) to 7 (total independence). We scored 6 functional areas including eating, toileting, bathing, dressing, transfers, and walking. Therefore, total scores on the FIM ranged from 6 to 42. The pseudo-FIM score (analogous FIM score for skilled nursing facilities and home health aide agencies) is comparable to the FIM score (used by inpatient rehabilitation facilities) as we have previously shown that functional assessments measured across different rehabilitation settings are comparable and correlate with criterion-standard functional assessments as used in the National Health and Aging Trends Study.[13]

### Covariates

We included the following Charlson comorbidities: myocardial infarction, congestive heart failure, peripheral vascular disease, chronic obstructive pulmonary disease, dementia, diabetes, mild liver disease, peptic ulcer disease, rheumatological disease, paralysis, renal disease, complications for diabetes, moderate/severe liver disease, and AIDS (yes/no for each comorbidity). Hospital complications included pneumonia, urinary tract infection, sepsis, deep venous thrombosis, pulmonary embolism, myocardial infarction/ coronary artery disease, dysrhythmia, and congestive heart failure (summed to obtain total number of hospital complications).[14] Acute stroke treatments included tissue plasminogen activator (tPA) and endovascular treatment for stroke. Life-prolonging procedures performed during hospitalization included hemicraniectomy, gastrostomy, ventriculostomy, tracheostomy, intubation, hemodialysis, and cardiopulmonary resuscitation (CPR).[15]

### Statistical Analysis

For the cox proportional hazards regression of post 90-day mortality, the regression was performed among post 90-day survivors.

### Data Availability

The Medicare dataset that we used is linked to the National Health and Aging Trends Study (NHATS) and is a restricted dataset. It is available through NHATS (nhatsdata@westat.com).

## SUPPLEMENTAL RESULTS

### Other factors associated with mortality

Besides PAC setting and post-stroke function, there were other clinical and demographic factors associated with mortality. Factors significantly associated with a greater risk of death within 90 days were older age, longer hospitalization, and medical conditions including intracerebral hemorrhage, myocardial infarction, congestive heart failure, peripheral vascular disease, chronic obstructive pulmonary disease, dementia, diabetes, liver disease, rheumatologic disease, paralysis and renal disease (Table S2). These factors also predicted mortality post 90 days except for paralysis (OR 1.26, 95% CI 1.21-1.31 within 90 days, HR 1, 95% CI 0.97-1.03 post 90 days). Receipt of tPA or endovascular reduced the likelihood of mortality within (OR 0.86, 95% CI 0.80-0.92 and OR 0.72, 95% CI 0.62-0.84 respectively) and post-90 days (HR 0.92, 95% CI 0.87-0.97 for tPA), although the relationship between endovascular treatment and mortality after 90 days was not statistically significant (HR 1, 95% CI 0.89-1.12). The association between life-prolonging procedures performed during

hospitalization and the risk of death was mixed, although were generally associated with greater increases in long-term mortality than in 90 day mortality (Table S2).

**Table S1. Baseline Characteristics, Stratified by Post-stroke function.**

| Variable | Overall (N=109793) | Pseudo FIM <11 (N=24502) | Pseudo FIM 11-14.5 (N=19729) | Pseudo FIM 14.5-18 (N=25734) | Pseudo FIM 18-22 (N=18642) | Pseudo FIM 22+ (N=21186) | P-Value |
|---|---|---|---|---|---|---|---|
| **Age** (median(Q1,Q3)) | 81 (74, 87) | 81 (74, 87) | 83 (76, 88) | 82 (75, 88) | 80 (74, 86) | 78 (72, 84) | <.001 |
| **Sex** | | | | | | | |
| **Male** | 43253 (39.40%) | 9505 (38.79%) | 7310 (37.05%) | 9734 (37.83%) | 7482 (40.14%) | 9222 (43.53%) | <.001 |
| **Female** | 66540 (60.60%) | 14997 (61.21%) | 12419 (62.95%) | 16000 (62.17%) | 11160 (59.86%) | 11964 (56.47%) | |
| **Race** | | | | | | | |
| **White** | 90192 (82.15%) | 18921 (77.22%) | 16025 (81.23%) | 21680 (84.25%) | 15650 (83.95%) | 17916 (84.57%) | <.001 |
| **Black** | 13517 (12.31%) | 3810 (15.55%) | 2576 (13.06%) | 2809 (10.92%) | 2044 (10.96%) | 2278 (10.75%) | |
| **Hispanic** | 1909 (1.74%) | 620 (2.53%) | 369 (1.87%) | 350 (1.36%) | 294 (1.58%) | 276 (1.30%) | |
| **Other** | 4175 (3.80%) | 1151 (4.70%) | 759 (3.85%) | 895 (3.48%) | 654 (3.51%) | 716 (3.38%) | |
| **Rehabilitation** | | | | | | | |
| **Inpatient Rehabilitation** | 38346 (34.93%) | 12597 (51.41%) | 6171 (31.28%) | 7031(27.32%) | 6463 (34.67%) | 6084 (28.72%) | <.001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Facility** | | | | | | | |
| **Skilled Nursing Facility** | 47511 (43.27%) | 10307 (42.07%) | 12107 (61.37%) | 15522 (60.32%) | 6475 (34.73%) | 3100 (14.63%) | |
| **Home Healthcare Agency** | 23936 (21.80%) | 1598 (6.52%) | 1451 (7.35%) | 3181 (12.36%) | 5704 (30.60%) | 12002 (56.65%) | |
| **ICU Usage** | 47834 (43.57%) | 12841 (52.41%) | 8932 (45.27%) | 10321 (40.11%) | 7430 (39.86%) | 8310 (39.22%) | <.001 |
| **Intracerebral Hemorrhage** | 9563 (8.71%) | 2989 (12.20%) | 1974 (10.01%) | 2081 (8.09%) | 1282 (6.88%) | 1237 (5.84%) | <.001 |
| **Acute Myocardial Infarction** | 2369 (2.16%) | 731 (2.98%) | 495 (2.51%) | 577 (2.24%) | 295 (1.58%) | 271 (1.28%) | <.001 |
| **History of Myocardial Infarction** | 8299 (7.56%) | 1688 (6.89%) | 1407 (7.13%) | 1971 (7.66%) | 1514 (8.12%) | 1719 (8.11%) | <.001 |
| **Congestive Heart Failure** | 21354 (19.45%) | 5312 (21.68%) | 4035 (20.45%) | 5302 (20.60%) | 3478 (18.66%) | 3227 (15.23%) | <.001 |
| **Peripheral Vascular Disease** | 10932 (9.96%) | 2349 (9.59%) | 1876 (9.51%) | 2639 (10.25%) | 1866 (10.01%) | 2202 (10.39%) | 0.004 |
| **Chronic Obstructive Pulmonary Disease** | 22109 (20.14%) | 4612 (18.82%) | 3856 (19.54%) | 5367 (20.86%) | 3971 (21.30%) | 4303 (20.31%) | <.001 |
| **Dementia** | 9926 (9.04%) | 2766 (11.29%) | 2603 (13.19%) | 2514 (9.77%) | 1191 (6.39%) | 852 (4.02%) | <.001 |
| **Diabetes** | 33125 (30.17%) | 7599 (31.01%) | 5890 (29.85%) | 7691 (29.89%) | 5677 (30.45%) | 6268 (29.59%) | 0.006 |
| **Mild Liver Disease** | 405 (0.37%) | 103 (0.42%) | 56 (0.28%) | 97 (0.38%) | 75 (0.40%) | 74 (0.35%) | 0.166 |
| **Peptic Ulcer Disease** | 1188 (1.08%) | 409 (1.67%) | 218 (1.10%) | 237 (0.92%) | 159 (0.85%) | 165 (0.78%) | <.001 |
| **Rheumatologic Disease** | 3367 (3.07%) | 621 (2.53%) | 597 (3.03%) | 862 (3.35%) | 619 (3.32%) | 668 (3.15%) | <.001 |
| **Hemiplegia or Paraplegia** | 38492 (35.06%) | 14145 (57.73%) | 8430 (42.73%) | 7478 (29.06%) | 4356 (23.37%) | 4083 (19.27%) | <.001 |
| **Moderate-Severe Renal** | 20975 (19.10%) | 4448 (18.15%) | 3833 (19.43%) | 5272 (20.49%) | 3636 (19.50%) | 3786 (17.87%) | <.001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Disease** | | | | | | | |
| **Diabetes with Complications** | 6336 (5.77%) | 1350 (5.51%) | 1109 (5.62%) | 1546 (6.01%) | 1133 (6.08%) | 1198 (5.65%) | 0.036 |
| **Moderate-Severe Liver Disease** | 204 (0.19%) | 38 (0.16%) | 45 (0.23%) | 53 (0.21%) | 33 (0.18%) | 35 (0.17%) | 0.37 |
| **AIDS** | 86 (0.08%) | 12 (0.05%) | 16 (0.08%) | 19 (0.07%) | 18 (0.10%) | 21 (0.10%) | 0.315 |
| **Receipt of IV Tissue Plasminogen Activator** | 6760 (6.16%) | 2030 (8.29%) | 1212 (6.14%) | 1256 (4.88%) | 1052 (5.64%) | 1210 (5.71%) | <.001 |
| **Receipt of Thrombectomy** | 1830 (1.67%) | 769 (3.14%) | 377 (1.91%) | 297 (1.15%) | 215 (1.15%) | 172 (0.81%) | <.001 |
| **Gastrostomy Tube Insertion** | 7087 (6.45%) | 5339 (21.79%) | 1437 (7.28%) | 221 (0.86%) | 64 (0.34%) | 26 (0.12%) | <.001 |
| **Hemicraniectomy** | 500 (0.46%) | 262 (1.07%) | 96 (0.49%) | 67 (0.26%) | 52 (0.28%) | 23 (0.11%) | <.001 |
| **Ventriculostomy** | 9 (0.01%) | 4 (0.02%) | 2 (0.01%) | 2 (0.01%) | 1 (0.01%) | 0 (0.00%) | - |
| **Tracheostomy** | 299 (0.27%) | 272 (1.11%) | 19 (0.10%) | 5 (0.02%) | 1 (0.01%) | 2 (0.01%) | <.001 |
| **Intubation** | 2616 (2.38%) | 1400 (5.71%) | 501 (2.54%) | 365 (1.42%) | 186 (1.00%) | 164(0.77%) | <.001 |
| **Hemodialysis** | 1644 (1.50%) | 396 (1.62%) | 298 (1.51%) | 439 (1.71%) | 260 (1.39%) | 251 (1.18%) | <.001 |
| **CPR** | 67 (0.06%) | 30 (0.12%) | 17 (0.09%) | 11 (0.04%) | 6 (0.03%) | 3 (0.01%) | <.001 |

Values in the table represent N(%) unless otherwise indicated. Abbreviations: FIM=functional independence measure, ICU=intensive care unit, IV=intravenous, CPR=cardiopulmonary resuscitation

**Table S2. Predictors of death within and after 90 days of stroke**

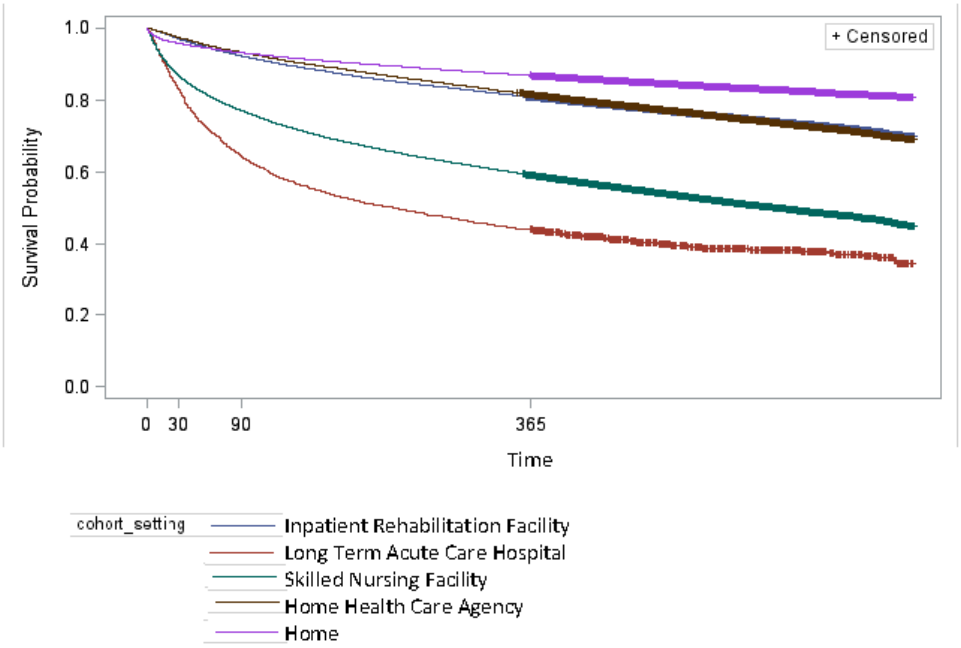
| | Predictors of death within 90 days post-stroke | | Predictors of Death After 90 Days Post-Stroke | |
|---|---|---|---|---|
| | Odds Ratio* | 95% Conf. Interval | Hazard Ratio† | 95% Conf. Interval |
| **Age** | 1.06 | 1.06-1.06 | 1.05 | 1.05-1.05 |
| **Sex (reference=male)** | 0.86 | 0.83 – 0.89 | 0.87 | 0.85-0.90 |
| **Race (reference=White)** | | | | |
| **Black** | 0.75 | 0.71- 0.79 | 1.00 | 0.96- 1.04 |
| **Hispanic** | 0.78 | 0.69 - 0.88 | 0.91 | 0.83- 0.99 |
| **Other** | 0.75 | 0.68 - 0.81 | 0.76 | 0.71-0.81 |
| **Length of Stay during index hospitalization** | 1.02 | 1.02 - 1.03 | 1.01 | 1.01-1.01 |
| **ICU Usage** | 0.90 | 0.86 - 0.93 | 0.99 | 0.96- 1.02 |
| **Complications at Indexed Hospitals** | 1.03 | 0.99 -1.06 | 1.01 | 0.99- 1.04 |
| **Intracerebral Hemorrhage** | 1.26 | 1.19 -1.33 | 0.95 | 0.91 - 0.99 |
| **Comorbidities** | | | | |
| **Acute Myocardial Infarction** | 1.74 | 1.58 -1.91 | 1.25 | 1.16 -1.34 |
| **History of Myocardial Infarction** | 1.06 | 1.00 -1.13 | 1.09 | 1.04-1.14 |

| | | | | |
|---|---|---|---|---|
| **Congestive Heart Failure** | 1.46 | 1.40-1.51 | 1.45 | 1.41 -1.49 |
| **Peripheral Vascular Disease** | 1.15 | 1.09-1.21 | 1.13 | 1.09 -1.17 |
| **Chronic Obstructive Pulmonary Disease** | 1.26 | 1.21-1.31 | 1.33 | 1.29 - 1.36 |
| **Dementia** | 1.26 | 1.20-1.33 | 1.39 | 1.34 - 1.44 |
| **Diabetes** | 1.05 | 1.02-1.09 | 1.12 | 1.09 - 1.15 |
| **Mild Liver Disease** | 1.57 | 1.24-2.00 | 1.63 | 1.38 - 1.91 |
| **Peptic Ulcer Disease** | 1.13 | 0.98-1.30 | 1.18 | 1.06 - 1.30 |
| **Rheumatologic Disease** | 1.11 | 1.01-1.22 | 1.20 | 1.13 - 1.28 |
| **Hemiplegia or Paraplegia** | 1.26 | 1.21-1.31 | 1.00 | 0.97 - 1.03 |
| **Moderate-Severe Renal Disease** | 1.35 | 1.29-1.41 | 1.35 | 1.31 - 1.39 |
| **Diabetes with Complications** | 1.03 | 0.95-1.11 | 1.16 | 1.11 - 1.22 |
| **Moderate-Severe Liver Disease** | 3.06 | 2.28-4.11 | 2.26 | 1.82 - 2.80 |
| **AIDS** | 1.22 | 0.63-2.35 | 1.85 | 1.29 - 2.67 |
| **Hospital Procedures** | | | | |
| **Receipt of IV Tissue Plasminogen Activator** | 0.86 | 0.80 - 0.92 | 0.92 | 0.87 - 0.97 |
| **Receipt of Thrombectomy** | 0.72 | 0.62 - 0.84 | 1.00 | 0.89 - 1.12 |

| | | | | |
|---|---|---|---|---|
| **Life-prolonging Procedures** | | | | |
| **Gastrostomy Tube Insertion** | 0.99 | 0.93-1.05 | 1.22 | 1.16 - 1.28 |
| **Hemicraniectomy** | 0.82 | 0.64-1.04 | 0.91 | 0.75 - 1.10 |
| **Ventriculostomy** | 1.52 | 0.38-6.05 | 1.45 | 0.54 - 3.88 |
| **Tracheostomy** | 0.52 | 0.43 - 0.62 | 1.22 | 1.04 - 1.41 |
| **Intubation** | 1.87 | 1.70 - 2.06 | 1.02 | 0.94 - 1.11 |
| **Hemodialysis** | 1.72 | 1.53 - 1.94 | 1.89 | 1.75 - 2.04 |
| **CPR** | 1.21 | 0.78 - 1.86 | 0.82 | 0.56 - 1.20 |
| **Cohort Setting (reference=IRF)** | | | | |
| **Long-Term Acute Care Hospital** | 2.17 | 1.43 - 3.29 | 2.27 | 1.51 - 3.41 |
| **Skilled Nursing Facility** | 4.05 | 3.78- 4.33 | 1.60 | 1.52 - 1.70 |
| **Home Health Care Agency** | 2.01 | 1.77- 2.28 | 1.46 | 1.33 - 1.61 |
| **Home** | 0.42 | 0.28 - 0.64 | 0.68 | 0.45 - 1.01 |
| **FIM/Pseudo-FIM function (reference<11)** | | | | |
| **11 - 14.5** | 0.53 | 0.48 – 0.59 | 0.69 | 0.65 – 0.74 |
| **14.5 – 18** | 0.38 | 0.34 – 0.43 | 0.59 | 0.55 - 0.63 |
| **18 – 22** | 0.31 | 0.27 - 0.35 | 0.51 | 0.47 – 0.55 |
| **>22** | 0.23 | 0.19 – 0.27 | 0.40 | 0.37 – 0.44 |

***** Each odds ratio is adjusted for the other variables in the multivariate logistic regression. **†**Each hazard ratio is adjusted for the other variables in the cox proportional regression model. *Abbreviations:* ICU=intensive care unit, IV=intravenous, CPR=cardiopulmonary resuscitation, IRF=inpatient rehabilitation facility, FIM=functional independence measure

**Figure S1. Hazard of Mortality over time by post-acute care setting.**




The graph shows the hazard of mortality over the follow-up period for different post-acute care settings. The graph shows that the proportional hazards assumption is violated for the first 90 days of the follow-up period.

**Figure S2. Flow Chart.**