Skilled Nursing and Inpatient Rehabilitation Facility Use by Medicare Fee-for-Service Beneficiaries Discharged Home After a Stroke: Findings From the COMPASS Trial

Janet K. Freburger, PT, PhD, FAPTA,[a] Amy M. Pastva, PT, MA, PhD,[b] Sylvia W. Coleman, MPH, RN, BSN, CLNC, FAHA,[c] Kennedy M. Peter,[d] Anna M. Kucharska-Newton, PhD, MPH,[d,e] Anna M. Johnson, PhD, MSPH,[d] Matthew A. Psioda, PhD,[f] Pamela W. Duncan, PhD, PT, FAHA, FAPTA,[c] Cheryl D. Bushnell, MD, MHS, FAHA,[c] Wayne D. Rosamond, PhD, MS,[d] Sara B. Jones, PhD, MPH[d] on behalf of the COMPASS team

From the [a]School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA; [b]Duke University School of Medicine, Durham, NC; [c]Department of Neurology, Wake Forest Baptist Health, Medical Center Blvd, Winston-Salem, NC; [d]Department of Epidemiology, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC; [e]Department of Epidemiology, College of Public Health, University of Kentucky, Lexington, KY; and [f]Department of Biostatistics, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC.

Abstract

Objectives: To examine the effect of a comprehensive transitional care model on the use of skilled nursing facility (SNF) and inpatient rehabilitation facility (IRF) care in the 12 months after acute care discharge home following stroke; and to identify predictors of experiencing a SNF or IRF admission following discharge home after stroke.

Design: Cluster randomized pragmatic trial

Setting: Forty-one acute care hospitals in North Carolina.

Participants: 2262 Medicare fee-for-service beneficiaries with transient ischemic attack or stroke discharged home. The sample was 80.3% White and 52.1% female, with a mean (SD) age of 74.9 (10.2) years and a mean ± SD National Institutes of Health stroke scale score of 2.3 (3.7).

Intervention: Comprehensive transitional care model (COMPASS-TC), which consisted of a 2-day follow-up phone call from the postacute care coordinator and 14-day in-person visit with the postacute care coordinator and advanced practice provider.

Main Outcome Measures: Time to first SNF or IRF and SNF or IRF admission (yes/no) in the 12 months following discharge home. All analyses utilized multivariable mixed models including a hospital-specific random effect to account for the non-independence of measures within hospital. Intent to treat analyses using Cox proportional hazards regression assessed the effect of COMPASS-TC on time to SNF/IRF admission. Logistic regression was used to identify clinical and non-clinical predictors of SNF/IRF admission.

Results: Only 34% of patients in the intervention arm received COMPASS-TC per protocol. COMPASS-TC was not associated with a reduced hazard of a SNF/ IRF admission in the 12 months post-discharge (hazard ratio, 1.20, with a range of 0.95-1.52) compared to usual care. This estimate was robust to additional covariate adjustment (hazard ratio, 1.23) (0.93-1.64). Both clinical and non-clinical factors (ie, insurance, geography) were predictors of SNF/IRF use.

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Conclusions: COMPASS-TC was not consistently incorporated into real-world clinical practice. The use of a comprehensive transitional care model for patients discharged home after stroke was not associated with SNF or IRF admissions in a 12-month follow-up period. Non-clinical factors predictive of SNF/IRF use suggest potential issues with access to this type of care.
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Each year, approximately 795,000 people in the United States are hospitalized for a new or recurrent stroke. Of those that survive, 70% are discharged home[1] with risk for complications due to immobility and poor risk factor management.[2,3] Even individuals with mild stroke or transient ischemic attack (TIA) can have physical and cognitive deficits that increase their risk for adverse events.[4-7] Patients with stroke and TIA are often discharged from the hospital without lifestyle coaching, individualized self-management plans, or information about available community-based resources.[8,9] Furthermore, access to community-based, post-acute rehabilitation services is highly variable,[10,11] leaving many stroke survivors feeling abandoned when they return home.[9,12]

Several transitional care (TC) models have been evaluated for patients hospitalized with acute cardiovascular conditions, including stroke, who are discharged home.[13,14,15] Studies in Europe and Canada provide strong evidence on the use of early supported discharge models to manage the complex needs of stroke patients.[16] These models encourage early discharge from the acute care hospital to home where a coordinated, multidisciplinary team of health care providers manages the patient's recovery. Other models support the concept of timely follow-up with the patient after discharge home to identify and address unmet needs and to make appropriate referrals.[13,14]

In 2013, the Centers for Medicare and Medicaid Services implemented a transitional care management (TCM) reimbursement protocol and billing codes to improve care transitions from the acute care hospital to home. Use of TCM billing codes requires contact with the patient via email, phone, or in person within 2 days of discharge and an in-person visit by an advanced practice provider (nurse practitioner or physician assistant) or physician within 7-14 days of discharge. Services supported by TCM include assessing the patient's functional status and establishing or re-establishing rehabilitation care, if needed.

List of abbreviations:

CMS	**Centers for Medicare and Medicaid Services**
COMPASS	**COMprehensive Post-Acute Stroke Services**
COMPASS-TC	**COMprehensive Post-Acute Stroke Services transitional care**
FFS	**fee-for-service**
HbA1C	**glycated hemoglobin**
ICD-10	**International Classification of Diseases, 10th Revision**
IRF	**inpatient rehabilitation facility**
LOS	**length of stay**
NIHSS	**National Institutes of Health Stroke Scale**
PAC	**postacute care**
PCORI	**Patient-Centered Outcomes Research Institute**
SNF	**skilled nursing facility**
TC	**transitional care**
TCM	**transitional care management**
TIA	**transient ischemic attack**
UC	**= usual care**

The COMPASS trial is the first large, pragmatic trial to examine the effectiveness of a novel, evidence-based comprehensive TC model (COMPASS-TC) versus usual care (UC) for patients with stroke or TIA discharged directly home after an acute care admission.[9,17] COMPASS-TC was modeled after components of early supported discharge (ie, multidisciplinary care, secondary prevention) and TC management models (ie, 2-day and 14 day follow-up) for stroke and other cardiovascular diseases.[18] The primary outcome of the COMPASS trial, patient-reported functional status 90 days after acute care discharge, was not affected by the intervention in intention-to-treat analyses.[9] However, blood pressure management was greater for individuals receiving the intervention. Findings of the per-protocol analysis also demonstrated benefit of COMPASS-TC.

In this article, we examine the effect of COMPASS-TC on the utilization of skilled nursing facility (SNF) and inpatient rehabilitation facility (IRF) care in the 12 months following acute care discharge home, using fee-for-service (FFS) Medicare claims linked to COMPASS data. We hypothesized that COMPASS-TC would decrease the risk of a SNF or IRF admission through better care management and timely and appropriate referrals to community-based post-acute services. Secondary objectives of our study were to characterize the clinical characteristics of these SNF and IRF events and identify predictors of experiencing a SNF/IRF admission following discharge home after stroke.

Methods and materials

COMPASS study design overview

Details of the COMPASS study and intervention have been published.[9,17-19] Briefly, the COMPASS study is a large, pragmatic, trial of 41 diverse acute care hospitals in North Carolina that were randomized to receive COMPASS-TC or maintain their UC. The effectiveness of the intervention on patient-reported outcomes was assessed 90 days post-discharge.[9]

Hospital randomization and patient enrollment

Randomization of hospitals was stratified by annual volume of patients with stroke and stroke center certification. Patients were enrolled from July 2016 to March 2017 and were followed for 12 months through March 2018.[9] Patients were eligible if they were 18 years or older; English- or Spanish-speaking; and discharged home following new-onset ischemic or hemorrhagic stroke or TIA.

Intervention

COMPASS-TC was delivered at each site by a post-acute care nurse coordinator (PAC) and an advanced practice provider (APP) who was a nurse practitioner, physician assistant, or physician. As a "real-world" pragmatic trial, COMPASS was primarily

implemented using participating hospitals' existing staff; however, at a small number of hospitals with limited eligible staff, the APP/PAC were hired to deliver COMPASS-TC. Additional details on the structure of the COMPASS-TC model[18] and implementation have been published.[20,21]

Briefly, the intervention included telephone follow-up within 2 days of discharge by the PAC and a clinic visit with the APP and PAC targeted to occur ~14 days post-discharge. Standardized clinical assessments facilitated real-time generation of an individualized, electronic care plan at the clinic visit.[19] The care plan supported education, secondary prevention, rehabilitation, recovery, and referrals to community-based resources and caregiver support services. Care plans were made available to the patient's primary care physician and post-acute care providers and uploaded into their respective electronic health records in PDF format.[18]

Baseline COMPASS data and linkages

Nursing staff extracted baseline data, including demographics, medical history, and stroke severity (National Institutes of Health Stroke Scale, or NIHSS), from the patient's acute care medical record. Information on the patient's ambulatory status at discharge and referrals to home health and outpatient therapy (ie, physical, occupational, and speech) were also collected.

COMPASS data were linked with Medicare FFS claims using a deterministic approach where we linked on the following identifiers: discharging hospital (based on provider number), patient date of birth, sex, and discharge date/service dates. COMPASS data were also linked to NC mortality data to obtain information on death up to one year following the index hospitalization discharge. A deterministic linkage of the mortality data with COMPASS data were performed using patient name, address, sex, and date of birth as the identifier variables. Two independent members of our team identified matches and a third person adjudicated any differences.

Outcomes

Our primary outcome was a SNF/IRF admission in follow-up, identified in Medicare institutional claims files and measured as days from the acute care hospital discharge date to the first SNF/IRF admission. Details of our methods for identifying these events are provided in supplemental table S1 (available online only at http://www.archives-pmr.org/).

Data analysis

The sample for analysis included all FFS Medicare patients from intervention and control hospitals who had Medicare FFS coverage (Parts A and B) in the month of index discharge.

Assessing the effect of COMPASS-TC on SNF/IRF use

All analyses were conducted as intent-to-treat and utilized multivariable mixed models that included a hospital-specific random effect and that adjusted for the following baseline patient characteristics: race (white; non-white), age (quadratic), sex, index hospitalization diagnosis of stroke or TIA, evidence of prior stroke or TIA, and the NIHSS score. Missing data for the NIHSS score, race, and other potential confounders considered in sensitivity analysis were imputed using multiple imputation. We estimated the cause-specific hazard ratio for time to first SNF/IRF admission censoring for death or loss of insurance coverage.[22] Analysis was performed using a Cox proportional hazards regression model that adjusted for the covariates specified above and included randomization arm as the treatment effect.

We evaluated the robustness of the treatment effect estimate to covariate adjustment by adding additional patient-level (eg, comorbidities, history of smoking, home health referral made, rural residence, has a primary care provider, ambulatory status at discharge) and hospital-level variables (eg, urban hospital, primary stroke center certification) using a backward selection procedure. To address the competing risk of being in a long-term care hospital, hospice, or psychiatric hospital during follow-up, we conducted analyses censoring individuals if they experienced any of these events prior to the first SNF or IRF admission. Due to the low rate of these events, we did not conduct a competing risk analysis.[23] We also did not censor for acute hospitalizations since a SNF or IRF admission is typically preceded by an acute care hospitalization.

Characterizing SNF/IRF use and predictors of SNF/IRF use

To further understand the use of SNF/IRF care, we examined the number of events per patient, the length of stay (LOS) for the first SNF/IRF episode, and the primary diagnoses associated with the events. We used a multivariable, mixed model (similar to the one used to assess effectiveness of COMPASS-TC) to estimate the cause-specific hazard ratio for the time to the first SNF/IRF admission using the following predictor variables: demographic (ie, age, sex, race [white, non-white], place of residence [metropolitan, non-metropolitan], dually enrolled in Medicaid); clinical (ie, ambulation status at admission, stroke versus TIA diagnosis, NIHSS); comorbidities (ie, cardiovascular disease, depression, smoking, history of stroke, history of TIA); and health care use (ie, patient has a primary care provider, patient was referred to home health physical therapy at discharge, patient was referred to outpatient therapy at discharge, and patient was referred to home health speech or occupational therapy at discharge). Before specifying the model, we examined collinearity among the predictor variables.

All analyses were conducted using SAS v9.4. This study was approved by the Wake Forest University Health Sciences central institutional review board or through local hospital institutional review boards.[24] The study met criteria for a waiver of consent and Health Insurance Portability and Accountability Act authorization; therefore, eligible patients were enrolled at hospital discharge without consent. Patients or their proxies provided verbal informed consent over the telephone for collection of outcomes data 90 days postdischarge.[17]

Results

Of the 6024 patients enrolled in Phase 1, 37.5% matched to FFS Medicare claims data (1069 patients from 19 intervention hospitals and 1193 patients from 20 UC hospitals). Most of those who did not match (n=3762) were under the age of 65 years or self-reported insurance as Medicare Advantage (supplemental fig S1, available online only at http://www.archives-pmr.org/).

Patient and hospital characteristics

A greater proportion of intervention hospitals had primary stroke center certification and were in a rural location relative to UC hospitals (table 1). Patient characteristics were similar between arms

Table 1 Hospital and patient-level characteristics of the analytic cohort

Characteristics	Intervention	Usual Care
Hospital-level		
No. of hospital units	19	20
Primary stroke center, n (%)	12 (63)	11 (55)
Academic affiliation, n (%)*	3 (16)	5 (25)
Geographic location, n (%)		
Central Piedmont	9 (47)	8 (40)
West	6 (32)	5 (25)
East	4 (21)	7 (35)
Urban/rural designation, n (%)		
Metro	9 (47)	12 (60)
Micro	7 (37)	7 (35)
Rural	3 (16)	1 (5)
Annual Stroke Discharge Volume, n (%)		
0-99 patients	4 (21)	5 (25)
100-299 patients	9 (47)	9 (45)
300+ patients	6 (32)	6 (30)
Patient-level		
No of patients	1069	1193
Per protocol and FFS Medicare, n (%)	366 (34.2)	1193 (100)
Age in years (mean ± SD)	74.9 (10.2)	73.9 (10.5)
Women, n (%)	525 (49.1)	652 (54.7)
White, n (%)	912 (85.7)	905 (76.6)
Missing	5	11
Dual eligible (Medicare and Medicaid)	144 (13.5)	169 (14.2)
Geographic area of residence, n (%)		
Metropolitan (population ≥50,000)	584 (54.7)	937 (78.6)
Micropolitan (population 10,000-49,999)	303 (28.4)	179 (15.0)
Small town or rural (population <10,000)	181 (16.9)	77 (6.5)
Missing	1	0
Stroke Diagnosis, n (%)		
Stroke	648 (60.6)	702 (58.8)
TIA	421 (39.4)	491 (41.2)
Aphasia at presentation, n (%)	236 (22.1)	305 (25.6)
NIHSS score, n (%)		
0	417 (39.3)	436 (37.8)
1-4	494 (46.6)	552 (47.9)
5-15	135 (12.7)	142 (12.4)
16-42	15 (1.5)	22 (1.9)
Missing	8	41
Admission status, n (%)		
Inpatient	835 (78.1)	943 (79.0)
Emergency department	27 (2.5)	52 (4.4)
Observation	206 (19.3)	198 (16.6)
Other	1 (0.1)	0 (0)
Hospital length of stay, median (IQR)	2 (1-3)	2 (1-3)
Missing	234	251
Ambulatory status at admission, n (%)		
Ambulate independent	983 (93.8)	1104 (93.8)
Unable to ambulate	22 (2.1)	20 (1.7)
With assistance	43 (4.1)	53 (4.6)
Missing	21	16
Rehabilitation needed at discharge, n (%)	463 (47.0)	459 (40.2)
Missing	83	52
Home health OT referral at discharge, n (%)	139 (14.1)	154 (13.5)
Home health PT referral at discharge, n (%)	286 (29.0)	299 (26.2)
Home health ST referral at discharge, n (%)	78 (7.9)	62 (5.4)

* Academic affiliation includes limited, graduate, and major, as defined by the Centers for Medicare and Medicaid ServicesAbbreviations: IQR, interquartile range; OT, occupational therapy; PT, physical therapy; ST, speech therapy.

Table 2 Incidence of 1 or more institutional events in the 1-year follow-up and mean days to the event

Event Type	Intervention(n=1069)	Usual Care(n=1193)
Skilled nursing facility or inpatient rehabilitation facility		
Patients with one or more admissions, n (%)	150 (14.0)	142 (11.9)
Days to first admission,* mean ± SD	145 (109.7)	144 (109.4)
Skilled nursing facility		
Patients with one or more admission, n (%)	133 (12.4)	123 (10.3)
Days to first admission,* mean ± SD	155 (108.4)	148 (107.5)
Inpatient rehabilitation facility		
Patients with one or more admission, n (%)	28 (2.6)	32 (2.7)
Days to first admission,* mean ± SD	107 (109.4)	116 (106.8)
Loss of coverage or administrative censoring, n (%)	64 (6.0)	94 (7.9)
Deaths, n (%)	88 (8.2)	105 (8.8)

* Conditional on having an admission

except for a slightly lower proportion of females and non-White patients and a higher proportion of rural residence in the intervention arm. Approximately 40% of patients in both arms had an NIHSS score of 0. A slightly higher proportion of patients in the intervention arm needed rehabilitation at discharge (47% vs 40%).

Incidence of SNF and IRF events

The rate of a SNF/IRF admission was slightly higher in the intervention arm (14%) relative to UC (12%) and was primarily due to a slightly higher rate of SNF events (table 2). The mean number of days to the first SNF/IRF admission was similar. Comparing SNF and IRF events separately, the mean days to a SNF event was slightly higher in the intervention arm and the mean days to an IRF event was slightly higher in the UC arm. Rates of censoring were similar.

Effect of COMPASS-TC on SNF/IRF events

COMPASS-TC had no effect on the hazard of a SNF/IRF admission (HR=1.20 [0.95-1.52]) compared to UC. This estimate was robust to additional covariate adjustment (HR=1.23 [0.93-1.64]) and did not change when censoring for individuals who entered a long-term care hospital, psychiatric hospital, or hospice facility (HR=1.22 [0.97-1.54]). Results of the full primary model are presented in supplemental table S2 (available online only at http://www.archives-pmr.org/).

Predictors of SNF/IRF use

A total of 292 (13%) patients had one or more SNF and/or IRF events in the 12-month follow-up period (table 3). Eight percent (n=24) of those who had a SNF or IRF event had both types of events, with 22 of the 24 patients having an IRF event prior to the SNF event. Most SNF/IRF users had only one event. Of those who had a SNF event (n=256), 66% had only one event, 16% had 2 events, and 12% had 3 or more events. Of those who had an IRF event (n=60), 90% had one event, and 10% had two.

Mean LOS for first SNF/IRF event was 39 days and 15 days, respectively (table 4). The most common primary diagnosis for the SNF/IRF admission was cerebrovascular disease. Factors positively associated with increased hazard of SNF/ IRF admission were older age, living in a metropolitan area, dual enrollment in Medicaid, needing assistance with ambulation at admission, history of cardiovascular disease, prior stroke, prior TIA, and discharge referral to home health for physical therapy (table 5).

Discussion

The primary objective of our study was to examine the association between receipt of COMPASS-TC and utilization of SNF/IRF care in follow-up. In our intention-to-treat analysis, COMPASS-TC had no effect on the rate of a SNF/IRF event. To our knowledge, no studies have examined the effectiveness of TC models in decreasing subsequent SNF/ IRF admissions in stroke survivors discharged home. The closest comparison we found were studies examining the effects of early supported discharge models for patients with stroke. In these models, patients are discharged from the acute care setting earlier than usual and received multidisciplinary care, including rehabilitation, in the home. A systematic review by Rousseaux et al found that for every 100 patients managed through early supported discharge vs standard care, 5 additional patients were at home instead of being admitted to an institution.[25] Similarly, a meta-analysis of 7 randomized controlled trials reported that referrals to nursing homes/institutions decreased by 5 percentage points among stroke patients who received early supported discharge rather than standard care after discharge home.[26]

Only 34% of the patients in the intervention arm received the intervention per protocol. This rate varied among the intervention hospitals ranging from 0 to 73.1%. Per protocol care was defined as having the 14-day visit with the APP and PAC and receiving an individualized electronic-care plan that addressed social and physical determinants of health.[19] While we did not conduct a "per protocol" analysis due to the low prevalence of SNF/IRF admissions, in the primary analysis of the effectiveness of COMPASS-TC, patients in the intervention arm who received the intervention per protocol had significantly higher measures of physical function, blood pressure monitoring, and satisfaction with care and lower levels of depression.[9] Several publications from our team have addressed the low intervention fidelity of the COMPASS trial and the challenges of incorporating this intervention into real-world settings.[9,20,21,27]

Rates of SNF/IRF admissions during the one-year follow-up in UC and intervention arms were 12% and 14%, respectively, which was somewhat surprising given the large proportion of individuals with TIAs in our sample. Rates of IRF admissions were much lower than SNF admissions, likely a function of IRF availability in NC.[11,28] For those admitted to an IRF, almost 70% had a cerebrovascular disease diagnosis.

Table 3 Characteristics of patients who had a skilled nursing facility or inpatient rehabilitation facility event

Characteristic	Had an SNF or IRF Event n=292 (12.9%)	Did Not Have an Event n=1971 (87.1%)
Age, y (mean ± SD)	77.12 (11.0)	73.97 (10.2)
Women, n (%)	154 (52.7)	1024 (52.0)
White, n (%)	233 (79.8)	1585 (81.1)
Missing	0	16
Geographic area of residence, n (%)		
Metropolitan (population ≥50,000)	192 (65.8)	1330 (67.5)
Micropolitan (population 10,000-49,999)	69 (23.6)	413 (21.0)
Small town or rural (population <10,000)	31 (10.6)	227 (11.5)
Missing	0	1
Stroke diagnosis, n (%)		
Stroke	165 (56.6)	1185 (60.1)
TIA	127 (43.5)	786 (39.9)
Aphasia at presentation, n (%)	72 (24.7)	470 (23.9)
NIHSS score		
0	99 (34.9)	754 (39.1)
1-4	134 (47.2)	912 (47.3)
5-15	46 (16.2)	232 (12.0)
16-42	5 (1.8)	32 (1.7)
Missing	8	41
Medical history and comorbidity, n (%)		
Hypertension	235 (80.5)	1560 (79.2)
Diabetes mellitus	108 (37.0)	674 (34.2)
Prior stroke	88 (30.1)	417 (21.3)
Prior TIA	45 (15.4)	234 (11.9)
Atrial fibrillation or flutter	68 (23.3)	352 (17.9)
Heart failure	47 (16.1)	183 (9.3)
Coronary artery disease	80 (27.4)	467 (23.7)
Depression	34 (11.6)	212 (10.8)
Smoking in past year	45 (15.4)	276 (14.0)
Body mass index (kg/m^2), median (IQR)	26.3 (23.0-30.0)	27.4 (24.0-31.4)
Missing	26	144
Admission status, n (%)		
Inpatient	231 (79.1)	1547 (78.5)
Emergency department	14 (4.8)	66 (3.4)
Observation status	47 (16.1)	357 (18.1)
Unknown	0	1 (0.5)
Hospital length of stay, ‡ median (IQR)	2 (1-3)	2 (1-3)
Missing	54	431
Ambulatory status at discharge, n (%)		
Ambulate independently	251 (87.5)	1836 (94.7)
With assistance	26 (9.1)	71 (3.7)
Unable to ambulate	10 (3.5)	32 (1.7)
Missing	5	32
Patient has a primary care provider, n (%)	260 (89.0)	1798 (91.2)
Rehabilitation needed at discharge, n (%)		
No	132 (47.7)	1073 (58.0)
Yes	145 (52.4)	777 (42.0)
Missing	15	121
Referred for therapy at discharge, n (%)	122 (49.4)	736 (39.1)
Types of therapy referrals (not mutually exclusive), n (%)		
Home health OT	46 (16.6)	247 (13.4)
Outpatient OT	6 (2.2)	83 (4.5)
Home health PT	106 (38.3)	479 (25.9)
Outpatient PT	15 (5.4)	169 (9.1)
Home health ST	27 (9.8)	113 (6.1)
Outpatient ST	2 (0.7)	73 (4.0)

(*continued on next page*)

Table 3 (*Continued*)

Characteristic	Had an SNF or IRF Event n=292 (12.9%)	Did Not Have an Event n=1971 (87.1%)
Not referred for therapy at discharge, n (%)	143 (51.6)	1127 (60.9)
Reason not referred to rehabilitation, n (%)		
Patient not evaluated for rehabilitation	8 (5.1)	76 (6.2)
Patient did not need rehabilitation services	132 (84.6)	1073 (86.8)
Patient/family refused	10 (6.4)	54 (4.4)
Other	6 (3.9)	33 (2.7)
Missing	136	735
Incomplete 1-year coverage	73 (25.0)	278 (14.1)
Mean ± SD follow-up time in days for those with incomplete coverage	190.81 (93.5)	171.71 (108.2)

Abbreviations: IQR, interquartile range; OT, occupational therapy; PT, physical therapy; ST, speech therapy

The mean LOS for SNF events in this analysis was higher than those reported by the Medicare Payment Advisory Council.[29] In 2017, the mean LOS for all Medicare SNF admissions was 25 days (vs 39 days in this study). This difference is likely due to the wide range of conditions treated in SNFs. In 2018, the mean LOS for all Medicare IRF admissions was 14 days (vs 15 days in this study).[29] These values may be similar due to the fact that stroke is the most common diagnosis treated in IRFs.[29]

While the mean time to the first IRF/SNF event was approximately 4.5 months from the index admission, the most common primary diagnosis associated with a SNF or IRF admission was cerebrovascular disease. In addition, history of stroke or history of TIA were predictive of a SNF or IRF event. These findings in combination underscore the importance of secondary prevention following stroke. Pneumonia and fractures were other common diagnoses associated with a SNF or IRF admission and may have been secondary to complications of the stroke.

Our findings regarding predictors of SNF/IRF use were not surprising. Several measures of illness severity and comorbidities were associated with an increased hazard of experiencing the event. Of note was the positive association between dual eligibility and SNF/IRF use. These findings agree with other reports in the literature[30-32] and highlight the importance of considering both physical and social determinants of health for stroke survivors. We also found that having a primary care provider was associated with a decreased hazard of experiencing a SNF/IRF event, though the effect did not reach statistical significance. Having a primary care provider may be a proxy measure for health care access overall or may be indicative of continuity of care which may influence an individual's health care trajectory. The association between metropolitan residence and use of SNF/IRF may be due to supply differences in metropolitan vs non-metropolitan areas.

Although a comprehensive TC approach to managing patients with stroke discharged home is critical given their comorbidities,

Table 4 Characteristics of the first skilled nursing facility or inpatient rehabilitation facility event (n=292)

Characteristic	SNF Event	IRF Event
No of patients (%)	232 (79.5)	60 (20.5)
Mean ± SD time to first event, d	153.3 (108.6)	111.9 (107.2)
Median (25th-75th percentile) time to first event, d	128 [54.5 – 244.5]	68.5 [16.0 – 214.5]
Mean ± SD length of stay, d	39.0 (42.6)	14.8 (7.8)
Primary diagnosis of SNF or IRF event (%)		
Cerebrovascular disease	37 (15.9)	41 (68.3)
Other diagnoses	30 (12.9)	4 (15.3)
Pneumonia, COPD	23 (9.9)	1 (1.7)
Heart disease & hypertension	21 (9.1)	2 (3.3)
Nervous system diseases/disorders	15 (6.5)	3 (5.0)
Musculoskeletal system diseases/disorders	15 (6.5)	3 (5.0)
Femur Fractures	15 (6.5)	2 (3.3)
Infections	13 (5.6)	1 (1.7)
Genitourinary/kidney diseases/disorders	11 (4.7)	—
Other fractures	10 (4.3)	1 (1.7)
Digestive system diseases/disorder	8 (3.4)	-
Other injuries	8 (3.4)	1 (1.7)
Peripheral Vascular Disease	6 (2.6)	-
Dementia, cognitive impairment	5 (2.2)	1 (1.7)
Endocrine, nutritional, & metabolic diseases	5 (2.2)	-
Spine Fractures	5 (2.2)	-
Abnormal gait, mobility problems	5 (2.2)	-

Abbreviation: COPD, chronic obstructive pulmonary disease.

Table 5 Predictors of skilled nursing facility/inpatient rehabilitation facility use in the 12-month follow-up

Characteristic	Hazard Ratio	2.5% CI	97.5% CI	*P* Value
Age	1.25	1.12	1.38	<.001
Age-squared	1.09	1.03	1.15	.002
Ambulation with assistance or unable to at admission	1.78	1.16	2.74	.008
Had a primary care provider at hospital discharge	0.71	0.44	1.17	.184
White	0.96	0.72	1.27	.765
Urban geographic area of residence	1.37	1.06	1.77	.015
Women	0.87	0.68	1.1	.247
NIHSS 1-4	1.07	0.79	1.44	.679
NIHSS 5-15	1.27	0.82	1.98	.283
NIHSS 16-42	0.94	0.33	2.64	.900
Stroke diagnosis (vs TIA)	0.91	0.70	1.20	.512
Dually enrolled in Medicaid	1.46	1.12	1.91	.006
Any history of cardiovascular diseases	1.45	1.17	1.79	.001
History of stroke	1.45	1.12	1.88	.005
History of TIA	1.23	0.86	1.76	.266
History of depression	1.16	0.76	1.75	.488
History of smoking	1.33	0.96	1.83	.085
Discharge referral for home health PT therapy	1.52	1.00	2.31	.051
Discharge referral for home health OT or ST	0.85	0.59	1.23	.390
Discharge referral for outpatient PT, OT, or ST	0.74	0.51	1.07	.113

Abbreviation: CI, confidence interval; OT, occupational therapy; ST, speech therapy

risk for complications, and need for secondary prevention, effective TC models in the United States remain elusive. Successes with TC models in Europe and Canada suggest that U.S. payment policy may be a barrier.[15] While the adoption of alternative payment models, such as bundled payments, are providing greater incentives for coordinated and team-based care, success of these models will depend upon appropriate distribution of payments to support all aspects of postacute care. A recent publication by Duncan et al provides an in-depth discussion on ways to improve transitional care in the U.S. based on findings from COMPASS and other national and international studies.[27]

To our knowledge, this is one of the first studies to examine use of institutional post-acute care following discharge home from an acute care hospitalization for stroke. A key strength of our study was the use of claims data that were supplemented with clinical data on the patient's health status at the time of discharge.

Study limitations

This analysis was conducted only among FFS Medicare beneficiaries and is not generalizable to Medicare Advantage beneficiaries, who tend to be healthier[33,34] and use less post-acute care than FFS beneficiaries.[35] Further, this study was conducted in NC hospitals; results may not be generalizable to other parts of the country. Several covariates used in our analyses were also proxies for stroke severity (eg, referral to therapy services, ambulatory status at discharge) rather than direct measures of stroke severity.

Conclusions

The use of a comprehensive transitional care model for patients discharged home after stroke was not associated with reducing SNF/IRF admissions in a 12-month follow-up period. Factors associated with having a SNF/IRF event were both clinical (eg, limited ambulation, higher NIHSS score) and non-clinical (eg, urban residence, not having a primary care provider), with the latter suggesting potential issues with access to this type of care.

Keywords

Rehabilitation; Rehabilitation centers; Skilled nursing facilities; Stroke

Corresponding author

Janet K. Freburger, PT, PhD, FAPT, School of Health and Rehabilitation Sciences, University of Pittsburgh, Bridgeside Point 1, Suite 210, 100 Technology Dr, Pittsburgh, PA 15219-3130; *E-mail address:* janet_freburger@pitt.edu.

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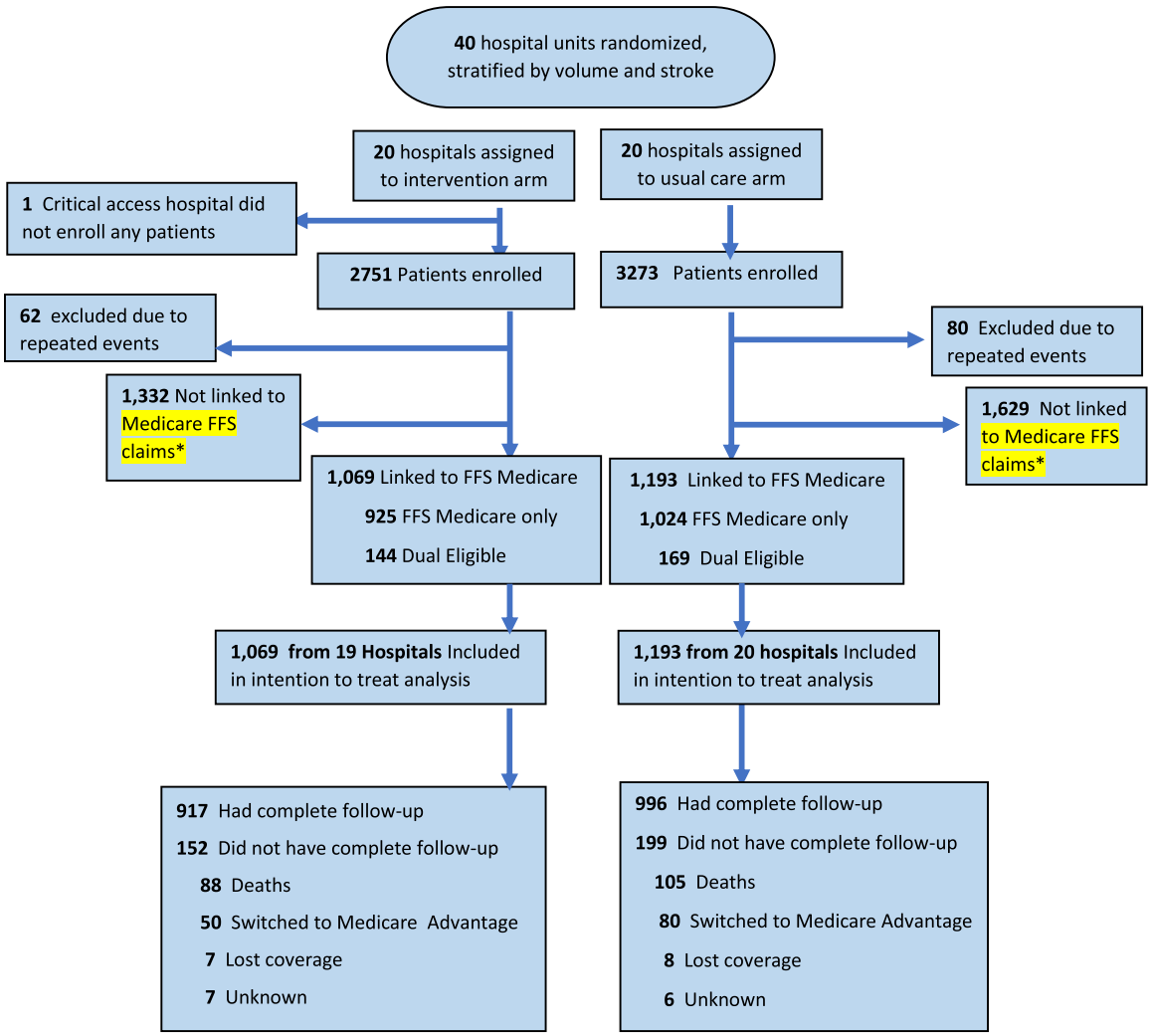
Supplemental Table 1 Identification of Skilled Nursing Facility (SNF) and Inpatient Rehabilitation Facility (IRF) Events

Inpatient Event	File	Identification
SNF or SNF swing bed	SNF Base File	Last 4 digits of PRVDR_NUM=5000-6499 **OR** if 3rd character of PRVDR_NUM=" U", "W", "Y", "Z"
IRF or IRF unit	Inpatient Base File	Last 4 digits of PRVDR_NUM= 3025-3099 **or** 3rd character of PRVDR_NUM=" R", "T"
Short-term Acute Care Hospitalization	Inpatient Base File	Last 4 digits of PRVDR_NUM = 0001-0879
Long-term Acute Care Hospitalization	Inpatient Base File	Last 4 digits of PRVDR_NUM= 2000-2299 **and** no alpha character in the third position
Psychiatric Hospitalization	Inpatient Base File	Last 4 digits of PRVDR_NUM=4000-4499
Inpatient Hospice	Hospice Base File	CLM_FAC_TYPE_CD=1, 2, or 8 AND if 8, retain if CLM_SRVC_CLSFCTN_TYPE_CD=1 or 2; Last 4 digits of PRVDR_NUM=1500-1799

IRF = inpatient rehabilitation facility; SNF = skilled nursing facility



*58% of participants who did not match were<65 years of age; 14% self-reported insurance as Medicare Advantage; 14% self-reported insurance as private or Medicare and private; 10% self-reported insurance as Medicare FFS; and 4% self-reported insurance as Medicaid, Medicaid & Medicare, uninsured, or missing

Supplemental Figure 1 CONSORT Diagram

Supplemental Table 2 Variables included in full primary model for skilled nursing facility / inpatient rehabilitation facility use in the 12-month follow-up

Variable	Hazard Ratio (95% CI)	*P* Value
Intervention arm (vs. Usual care)	1.20 (0.95, 1.52)	0.121
Age	1.17 (1.06, 1.30)	0.003
Age-squared	1.11 (1.05, 1.18)	0.000
White race	0.78 (0.60, 1.01)	0.057
Female sex	0.92 (0.73,1.14)	0.436
History of stroke	1.60 (1.24, 2.05)	0.000
History of TIA	1.15 (0.82, 1.62)	0.419
NIHSS score 1-4	1.14 (0.84, 1.55)	0.397
NIHSS score 5-15	1.53 (1.00, 2.34)	0.050
NIHSS score 16-42	1.12 (0.41, 3.06)	0.819
Stroke diagnosis (vs. TIA)	0.93 (0.70, 1.23)	0.600

CI = confidence interval; NIHSS = National Institutes of Health Stroke Scale score; TIA = transient ischemic attack