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Authors

Ifejika, Nneka L
Vahidy, Farhaan
Reeves, Mathew
et al.

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Association between 2010 Medicare Reforms and Utilization of Post-Acute Inpatient Rehabilitation in Ischemic Stroke

Nneka Ifejika, MD, MPH[1,2,3], **Farhaan Vahidy, PHD, MBBS, MPH**[4], **Mathew Reeves, PhD**[5], **Ying Xian, MD, PHD**[6,7], **Li Liang, PHD**[7], **Roland Matsouaka, PHD**[7], **Gregg C. Fonarow, MD**[8], **Sean I Savitz, MD**[9,10]

[1]Department of Physical Medicine and Rehabilitation, UT Southwestern Medical Center, Dallas TX

[2]Department of Neurology and Neurotherapeutics, UT Southwestern Medical Center, Dallas TX

[3]Department of Population and Data Sciences, UT Southwestern Medical Center, Dallas TX

[4]Centers for Outcomes Research, Houston Methodist Research Institute, Houston TX

[5]Department of Epidemiology and Biostatistics, College of Human Medicine, Michigan State University, Lansing MI

[6]Department of Neurology, Duke University Hospital, Durham, NC

[7]Duke Clinical Research Institute, Durham NC

[8]Division of Cardiology, Ahmanson - UCLA Cardiomyopathy Center, University of California, Los Angeles Medical Center, Los Angeles, CA

[9]Institute for Stroke and Cerebrovascular Disease, UTHealth, Houston, TX

[10]Department of Neurology, McGovern Medical School at UTHealth, Houston, TX

Abstract

Objective—Investigate whether the elimination of trial admissions and the initiation of documentation requirements, via the 2010 Centers for Medicare and Medicaid Services (CMS) Inpatient Rehabilitation Facility (IRF) Prospective Payment System (PPS) Rule, limited IRF access while increasing skilled nursing facility (SNF) utilization compared to home discharge (HD) in ischemic stroke (IS) patients.

Design—Retrospective observational study using Get with the Guidelines - Stroke hospital data between 1/1/2008 and 12/31/2015 (n=1,643,553).

Results—Between 1/1/2008 and 12/31/2009, 54.1% of patients went home, 25.4% to IRF, 20.5% to SNF. Between 1/1/2010 and 12/31/2015, there was a 1.4% absolute increase in HD, a 1.1% IRF decline, and a 0.3% SNF decline.

Corresponding Author: Nneka L. Ifejika MD MPH, 5323 Harry Hines Blvd, Dallas, TX 75390-9055, Phone (214) 648-8762, Nneka.Ifejika@utsouthwestern.edu.

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Within the 1.1% absolute decline in IRF discharge, the adjusted odds of IRF versus HD decreased 12% post 2010 Rule (aOR 0.88, 95% CI 0.87 – 0.89; P<0.0001). There was no statistically significant change in SNF versus HD.

Lower adjusted odds of IRF discharge versus HD were identical across age groups and were present in all geographic regions.

Conclusions—In populations with ischemic stroke, the CMS 2010 IRF PPS Rule was associated with a 1.1% absolute decrease in IRF discharge, with a concomitant increase in HD rather than to SNF.

Keywords

Stroke; Inpatient Rehabilitation Facility; Health Reform; Skilled Nursing Facility; Centers for Medicare and Medicaid Services

Introduction

Post-acute care at an inpatient rehabilitation facility (IRF) is associated with improved outcomes, including greater functional recovery[1], higher likelihood of return to the community[2], and lower rehospitalization rates[3] compared to care at a skilled nursing facility (SNF). IRF Rehabilitation for persons with stroke results in higher costs; in a study of Medicare spending and stroke outcomes, the median payment per Medicare patient for IRF Rehabilitation was 58% higher than SNF Rehabilitation (i.e., $23,219 versus $14,098 per stay)[4].

The goal of the Centers for Medicare and Medicaid Services (CMS) 2010 IRF prospective payment system (PPS) Rule is to select a population with complex needs, expected to receive “reasonable benefit” from IRF treatment[5]. IRF Rehabilitation patients are required to participate in three hours of therapy, five days a week (physical therapy and occupational therapy or speech and language pathology) and have unspecified hospital level medical acuity requiring daily physician oversight[6].

To facilitate compliance with these requirements, the CMS 2010 IRF PPS Rule requires completion of a series of documents – (1) Pre-Admission Screening (PAS) within 48 hours of IRF Rehabilitation admission, detailing the persons’ prior level of function, risk of clinical complications, combination of needed treatments, conditions that caused the need for rehabilitation, expected level of improvement and estimated length of stay, (2) Post-Admission Physician Evaluation (PAPE) within 24 hours, documenting any relevant changes that have occurred since the pre-admission screening and (3) the Individualized Overall Plan of Care (IOPOC) during the first 4 days, synthesizing a customized treatment regimen and providing broad treatment goals for each discipline (Nursing, Therapy Services, Case Management, Social Work). The CMS 2010 IRF PPS Rule eliminated “trial admissions” of less than 10 days, a time period previously used to assess rehabilitation potential[7].

The purpose of this study is to provide rehabilitation clinicians evidence-based information about the effect of the CMS 2010 IRF PPS Rule on IRF treatment access for stroke patients. Using Get With The Guidelines-Stroke (GWTG-Stroke) registry data, we hypothesize

compared to home discharge, the CMS 2010 IRF PPS Rule decreased utilization of IRF rehabilitation, while increasing SNF utilization for populations diagnosed with ischemic stroke. The GWTG-Stroke registry has advantages over prior CMS reports[8], in that it provides data on patients under and over age 65.

Methods

Manuscript Preparation

We analyzed prospectively collected clinical registry data for people diagnosed with ischemic stroke (IS), treated at GWTG-Stroke participating hospitals. Initiated by the American Heart Association, GWTG-Stroke is an ongoing, voluntary registry and performance improvement initiative for acute hospitals. The registry collects demographic and socioeconomic characteristics, results of diagnostic testing, treatments, in-hospital outcomes and discharge destination of people hospitalized with acute stroke[9,10]. Participating hospitals received either human subjects' research approval to enroll cases without individual consent under the common rule or a waiver of authorization and exemption from subsequent review by their Institutional Review Board (IRB). Outcome Sciences, Inc. serves as the data collection coordination center. The Duke Clinical Research Institute (Durham, NC) served as the data analysis center and has IRB approval to analyze the aggregate data for research purposes. This study conforms to all STROBE guidelines and reports the required information accordingly (see Supplementary Checklist).

Study Group

We evaluated adult (≥ 18 years) acute stroke hospital discharges, with at least 75% complete data for medical history, in the GWTG-Stroke registry between January 1, 2008 and December 31, 2015 (n=2,361,126). Stroke discharges with >25% missing data for medical history could not be used in the multivariable models. The study cohort is defined in Figure 1. People with hemorrhagic stroke, comfort measures, hospice care, left against medical advice, transferred to other level of hospital care or other level of post-acute care, died or unknown discharge location were excluded. Hemorrhagic stroke discharges will be analyzed separately and included in a future manuscript. Among the remaining group of people with documented discharge disposition (n=1,682,070), we excluded discharges to long-term acute care and intermediate care. The likelihood of receiving intensive stroke rehabilitation therapy services was low at these locations, and the CMS 2010 IRF PPS Rule did not apply to either destination. The final study group therefore included 1,643,553 people with acute ischemic stroke, discharged to home, IRF Rehabilitation, or SNF Rehabilitation between January 1, 2008 and December 31, 2015.

Outcomes

The outcome of interest was the proportion of people with ischemic stroke discharged to three discharge destinations– home, IRF Rehabilitation and SNF Rehabilitation.

Primary Exposures and Covariates

The primary exposure variable was the CMS 2010 IRF PPS Rule – a national health policy change that was implemented on January 1, 2010[11]. Patient level data on sociodemographic characteristics and medical history were abstracted according to GWTG procedures[10].

Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS) score. Mode of hospital arrival, time from symptom onset to arrival and arrival off-hours was evaluated. Ability to ambulate at Day Two of hospitalization, dysphagia screening and rehabilitation assessment by physical and occupational therapy was analyzed. Treatments such as intravenous tissue plasminogen activator (IV t-PA) and the number of annual t-PA cases at each center were abstracted. Participating hospitals were categorized by geographic region and other hospital characteristics (Table 1).

Statistical Analysis

The proportion of IS hospital discharges to home, SNF and IRF were determined for each of the 8 years and using pre and post CMS 2010 IRF Rule categorization (pre CMS 2010 IRF Rule = 2008 to 2009; post CMS 2010 IRF Rule = 2010 to 2015). Differences in patient and hospital characteristics were evaluated by discharge destination. A multinomial model incorporating home, SNF and IRF was not used; the CMS 2010 IRF PPS Rule and documentation requirements apply to a select population recommended for IRF rehabilitation, requiring hospital level medical acuity and exhibiting three hour of therapy/ five days a week activity tolerance. Furthermore, differences in federal legislation directing clinician oversight and rehabilitation intensity at SNFs and IRFs preclude SNF to IRF comparisons[6]. The effect of the CMS 2010 IRF Rule was assessed using two binary multivariable hierarchical logistic regression models (IRF Rehabilitation versus Home and SNF Rehabilitation versus Home), with hospital random effects to account for the clustering of patients within hospitals.

Covariates were selected based on clinical relevance as detailed in Table 2. Stroke severity as measured by NIHSS score was not included in the models due to the high percentage of missing data (28%). For categorical data with < 3% missing fields included in the multivariable models (ambulation at Day 2 of Hospitalization), we used single imputation to the dominant (most common) level. Insurance type (6% missing) and arrival mode (9% missing) were included in the models, but not imputed. All other included variables had < 3% missing data.

We conducted separate pre-specified subgroup analyses to examine the effect of the CMS 2010 IRF Rule on discharge disposition by age (≥ 65 and < 65 years), geographic region (West, South, Midwest, and East) and hospital teaching status.

For the primary model, we completed sensitivity analyses, using the subset of cases with complete NIHSS data (n=1,206,592; 228,836 SNF, 305,273 IRF and 648,041 Home discharges). All statistical analyses were performed using SAS software (version 9.2; SAS Institute Inc., Cary, NC).

Results

A total of 1,643,553 IS hospital discharges were included in the primary analysis. Among 289,635 people with IS discharged between Jan 1, 2008 and Dec 31, 2009, 54.1% went Home, 25.4% to IRF and 20.5% to SNF. After implementation of the CMS IRF Rule on January 1, 2010, there was little change in discharge destination. The small absolute increase in discharge to home (1.4%) was reflected by a 1.1% decline in discharge to IRF Rehabilitation and 0.3% decline in discharge to SNF Rehabilitation (Figure 2).

Differences in patient characteristics by discharge destination are shown in Table 1. People discharged to home were younger (mean age 66 years), more likely to be male (53%), and have Private or VA insurance. They also had the lowest NIHSS scores, higher percentage of ability to ambulate at Day 2 of hospitalization (68%) and had the shortest length of hospital stay (3 days). People discharged to IRF Rehabilitation were more likely to be treated with IV t-PA (11%), to be discharged from larger, academic or teaching hospitals and were more likely to be from the Northeast (28%) or Midwest US (21%). People discharged to SNF Rehabilitation were older (mean age 78 years), female (60.5%), with Medicare insurance (55%). They also had the highest NIHSS score, however, they also had higher rates of missing NIHSS data (31%). People discharged to SNF Rehabilitation were most likely to have a history of atrial fibrillation (26%), previous stroke or TIA (38%), coronary artery disease or prior MI (29%), peripheral vascular disease, hypertension or heart failure. The rate of missing NIHSS was highest in the SNF Rehabilitation group (31%) and lowest in the IRF Rehabilitation group (24%) (Table 1).

Primary Analysis

Within the 1.1% absolute decline in IRF discharge for patients with acute ischemic stroke, the unadjusted odds of discharge to IRF Rehabilitation (compared to home) were 4% lower during the post CMS IRF Rule period (OR 0.96, 95% CI 0.95 – 0.97; P<0.0001, Table 2). This difference increased to 12% in the adjusted analysis (aOR 0.88, 95% CI 0.87 – 0.89; P<0.0001, Table 2). There were no statistically significant differences between SNF Rehabilitation and home discharge during the post CMS IRF Rule period in the unadjusted (OR 0.99, 95% CI 0.98 – 1.00; P=0.1729) or adjusted analyses (aOR 0.99, 95% CI 0.98 – 1.00; P=0.2225, Table 2).

Pre-Specified Multivariable Subgroup Analyses

Within the 1.1% absolute decline in IRF discharge for patients with acute ischemic stroke, the adjusted odds of IRF Rehabilitation (versus home) following the CMS IRF Rule change in those aged ≥ 65 and < 65 yrs were identical to that observed in the primary analysis (aOR 0.88; 95% CI 0.87–0.90; P<0.0001, Table 3). Large decreases in the adjusted odds of discharge to IRF Rehabilitation (compared to home) following the CMS IRF Rule were noted in the South (aOR 0.85, 95% CI 0.84 – 0.87; P<0.0001) and West (aOR 0.83, 95% CI 0.81–0.85, P<0.0001) compared to other regions (Table 3). The adjusted odds of discharge to IRF Rehabilitation (compared to home) was also slightly larger at non-teaching hospitals (aOR 0.85, 95% CI 0.83–0.86; P<0.0001, Table 3) compared to teaching hospitals.

Sensitivity Analysis

In the primary analysis, the adjusted odds of discharge to IRF Rehabilitation (compared to home) following the CMS IRF Rule change were 12% lower (aOR 0.88, 95% CI 0.87 – 0.89; P<0.0001, Table 2). This difference was attenuated in the population with recorded NIHSS score (aOR 0.94, 95% CI 0.92–0.95; P<0.0001, Table 4). These decreases are within the 1.1% absolute decline in IRF discharge during the time period after the CMS IRF Rule.

The sensitivity analysis results comparing the odds of SNF Rehabilitation versus Home differed from the primary analysis. Within the 0.3% absolute decrease in SNF Rehabilitation discharge after the CMS IRF Rule, the adjusted odds of discharge to SNF Rehabilitation (compared to home) was 2% lower in the primary analysis (OR 0.98, 95% CI 0.96 – 0.99; P<0.0070, Table 2). Among the NIHSS population, this difference increased to 12% in the adjusted analysis (aOR 1.12, 95% CI 1.10–1.14; P<0.0001, Table 4).

Discussion

The provision of timely and intensive post-acute rehabilitation is an important component of stroke recovery[12]. In this evaluation of post-acute care trends, the odds of inpatient rehabilitation facility compared to home discharge decreased 12 percent, with no significant change in skilled nursing facility compared to home discharge, after the CMS 2010 IRF PPS Rule. This decrease was within a 1.1% absolute decline in IRF rehabilitation discharges. The National Institutes of Health Stroke Scale was used both as a stroke severity measure and a validated predictor of acute ischemic stroke outcomes[13,14].

Approximately 795,000 people experience a stroke annually in the United States [15]; for persons with stroke, 81,600 IRF Rehabilitation cases were funded by Medicare fee-for-service in 2018[8]. Given the study findings, this translates to 898 Medicare fee-for-service cases per year. Should clinicians be concerned? One could surmise more persons with stroke went home rather than to IRF, and the regulatory changes identified a population on the threshold of IRF qualification. The utilization of short-stays (5 days or less) is sometimes recommended by rehabilitation clinicians for stroke survivors with higher level coordination or balance deficits, deemed to be at risk of falls. As completion of the IOPOC has to occur within 4 days of IRF admission, and trial admissions were effectively eliminated by the CMS 2010 IRF PPS Rule, a decrease in short-stay admissions likely occurred. Indeed, for IRF stays less than 3 days, Medicare makes payment adjustments that decrease facility reimbursement[16]. Whether health policy changes such as the CMS 2010 IRF PPS Rule improve access to care for populations in need of a two-week IRF stay versus selecting against populations with impairments that warrant a short-stay for safety concerns and fall mitigation strategies is an interesting topic for future study.

In our analyses, the odds of IRF rehabilitation decreased 12% across all age groups after the CMS 2010 IRF PPS Rule. This finding may provide insight into the potential effect of Medicare health policy changes on non-Medicare insured populations. Medicare, Private Insurance and Medicaid plans have indirect associations in the United States. Medicare Advantage plans, such as Health Maintenance Organizations (HMOs) and Preferred Provider Organizations (PPOs), are sponsored by private insurers, paid by the federal

government to provide Medicare-covered services[17]. Over nine and a half million traditional Medicare beneficiaries purchased Medicare supplemental insurance (Medigap) policies from private insurers in 2016, and another 9.6 million Medicare beneficiaries received private, employer or union-sponsored retiree health benefits that year[18]. Two-thirds of all Medicaid enrollees have coverage provided by private managed care plans, under contract with their respective states of residence[17]. Private insurers have been observed to follow regulatory requirements implemented by CMS; the relationship between access to post-acute care and the influence of Medicare legislation on private insurers is another potential research topic.

The Patient Protection and Affordable Care Act (PPACA) of 2010 created Accountable Care Organizations (ACOs)[19], integrated groups of health care providers responsible for providing high quality, cost efficient care. ACOs are incentivized to further increase cost efficiency through the receipt of money from the US government equal to a percentage of estimated cost savings. This incentive potentially decreases IRF resource utilization to what is deemed minimally necessary, in an effort to increase profit margins[20]. The PPACA also initiated bundled payments, based on the average cost of an episode of care[21]. Ideally, use of the case-mix index at IRFs ensures bundled payments are fair and accurate based on medical comorbidities, age and functional status, however, an incentive remains to limit resource utilization.

Geographic variations in relation to IRF Rehabilitation access are an important consideration. In our analyses, the odds of IRF rehabilitation significantly decreased in all regions of the United States after the CMS 2010 IRF PPS Rule, with further decreases in the South and West relative to the Midwest and Northeast. The findings of decreased IRF admission in the South, also known as the “Stroke Belt”, are of particular interest. There are over 1,100 IRFs in the United States[22]; an analysis of Provider Enrollment Chain Ownership System (PECOS) data showed the Southern US had the highest number of IRF beds per 100,000 Medicare beneficiaries[23]. Age-adjusted stroke hospitalization rates in persons over age 65[24] and age-adjusted stroke deaths rates in persons age 35 and older are high in this region[25], suggesting the presence of high stroke severity, with substantial stroke related impairments. The paradox of decreased IRF admissions, in a region with high stroke prevalence and stroke mortality can potentially be attributed to known health disparities in the South, namely African-American race, rural location and lower regional and individual-level socioeconomic status[26,27,28]. Decreased access to post-acute IRF rehabilitation, however subtle, in this region has the capacity to further widen the disability gap between minority and non-minority populations.

The effect of hospital type on IRF discharge warrants discussion. Although the facilitation of the academic mission at teaching hospitals has been credited as a contributor to decreased stroke mortality from 1950 to 2015[29,30], better acute stroke treatment and lower 30-day readmissions[31], a recent study found significant variation in IRF versus SNF discharge across all acute care hospital types – teaching and non-teaching[32]. The overall decrease in IRF discharges at both teaching and non-teaching hospitals in this study may result from a lack of education regarding the admission criteria for IRF rehabilitation. This hypothesis is supported by the study findings of a further decrease in the odds of IRF Rehabilitation at non-teaching hospitals compared to teaching hospitals.

In response to the COVID-19 pandemic, the US Congress passed the Coronavirus Aid, Relief, and Economic Security (CARES) Act – waiving the three hour therapy rule and allowing IRF admission criteria flexibility[33]. The waiver is anticipated to last until December 1, 2020[34]. Future studies that evaluate the effect of the CARES Act on both the IRF admission process and the decompression of acute care beds are appropriate next steps.

Study Limitations

The decision to discharge a person with ischemic stroke to post-acute rehabilitation involves a complex set of demographic, socioeconomic and environmental factors, which were controlled in our analyses. We recognize that there may be many other factors that influence changes in access to post-stroke rehabilitation that are not available through the GWTG-Stroke registry; for example, we could not measure inter rater reliability between both physicians and therapists during the “rehabilitation assessment” process. Hospitals that chose to participate in the GWTG-Stroke registry are often large, teaching hospitals, or located in urban centers, which may limit sample generalizability.

The rate of missing NIHSS data for IRF discharges was lower than SNF discharges, potentially introducing selection bias in the sensitivity analyses. Adjustment for NIHSS had oppositive effects – decreasing the odds of IRF discharge compared to home post CMS 2010 IRF Rule, while increasing the odds of SNF discharge compared to home. NIHSS underreporting could have occurred with advancing age, female sex and severe strokes[35], a group for which SNF Rehabilitation is highly likely due to the extent of neurologic impairments. Evidence of a modest bias in NIHSS reporting within the Get with the Guidelines-Stroke registry has improved since 2011[32].

The exclusion of persons at intermediate care and long term acute care facilities may have removed a population receiving intensive rehabilitation therapies. The frequency and intensity of therapy services have not been quantified by CMS at these levels of post-acute care; therefore, we are unable to determine the impact of legislative changes. Some IRFs may have implemented IRF admission documentation in the latter part of 2009, to ensure readiness for a formal transition upon CMS 2010 IRF PPS Rule initiation on January 1, 2010. This may yield a reduced change in the odds of IRF discharge in our analyses. Lastly, we were unable to examine the impact of IRF or SNF Rehabilitation care on disability rates, utilization of outpatient therapy services or the overall cost of post-stroke care.

Conclusions

This study identified a small but significant decline in discharge from acute stroke hospitalization to post-stroke inpatient rehabilitation facility care following the CMS 2010 IRF PPS Rule. This raises a concern that access to inpatient rehabilitation facility care may have been impacted. These findings were noted across all age groups, at teaching and non-teaching hospitals, and in regions of the United States where inpatient rehabilitation facility care is readily available. Studies that evaluate the influence of health legislative changes on access to care should continue in order to develop health policies that maximally benefit populations with ischemic stroke.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

ACO	Accountable Care Organization
AMA	Against Medical Advice
aOR	adjusted Odds Ratio
CI	Confidence Interval
CARES	Coronavirus Aid, Relief, and Economic Security
CMS	Centers for Medicare and Medicaid Services
Dec	December
EMS	Emergency Medical Services
GWTG	Get With The Guidelines
IOPOC	Individualized Overall Plan of Care
IQR	Interquartile Range
IRB	Institutional Review Board
IRF	Inpatient Rehabilitation Facility
IS	Ischemic Stroke
IV	Intravenous
MI	Myocardial Infarction
NIHSS	National Institutes of Health Stroke Scale
PAPE	Post-Admission Physician Evaluation
PAS	Pre-Admission Screening

PECOS	Provider Enrollment Chain Ownership System
PPACA	Patient Protection and Affordable Care Act
PPS	Prospective Payment System
Jan	January
SNF	Skilled Nursing Facility
t-PA	Tissue Plasminogen Activator
TIA	Transient Ischemic Attack
UB	Uniform Billing
UTD	Unable to Determine
VA	Veterans' Affairs

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What is Known

The purpose of the CMS 2010 IRF PPS Rule was to select a population expected to receive benefit from IRF treatment through utilization of (1) Pre-Admission Screening, (2) Post-Admission Physician Evaluation, and (3) Individualized Overall Plan of Care. Trial admissions of less than 10 days, a time period previously used to evaluate rehabilitation potential, were eliminated. Some rehabilitation clinicians hypothesize these requirements select against IRF care while increasing SNF admissions for stroke patients.

What is New

In this study, there was a 1.4% absolute increase in home discharge, a 1.1% decline in acute stroke discharge to IRF and a 0.3% decline in acute stroke discharge to SNF during the time period after the CMS 2010 IRF PPS Rule. Within the 1.1% decline in acute stroke discharge to IRF, the odds of IRF admission versus home decreased by 12% with no significant change in SNF versus home. The effect of this small, but significant change may limit access to care for populations on the threshold of IRF admission.

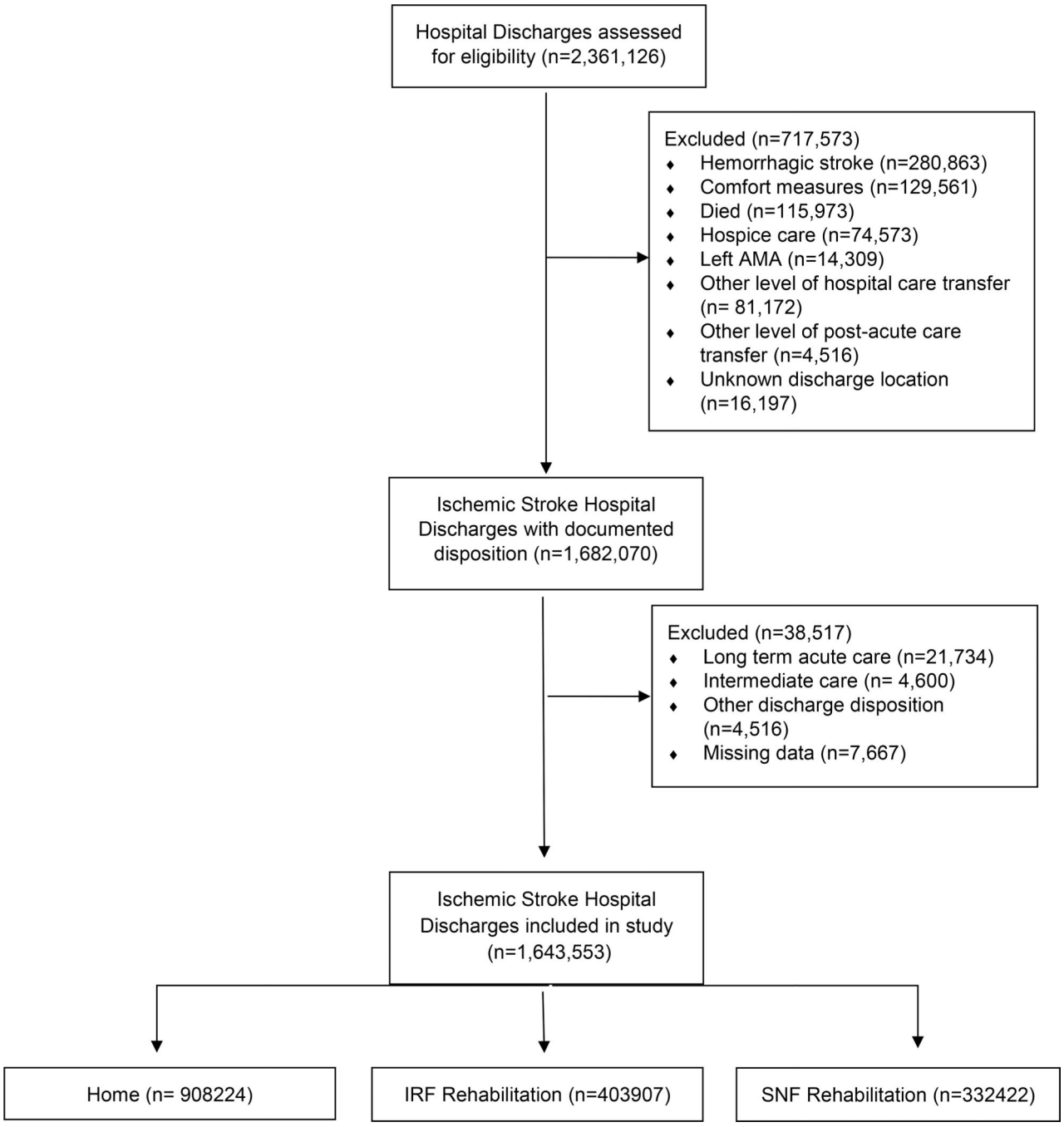

Figure 1.
CONSORT Flow Diagram of Acute Stroke Hospital Discharges

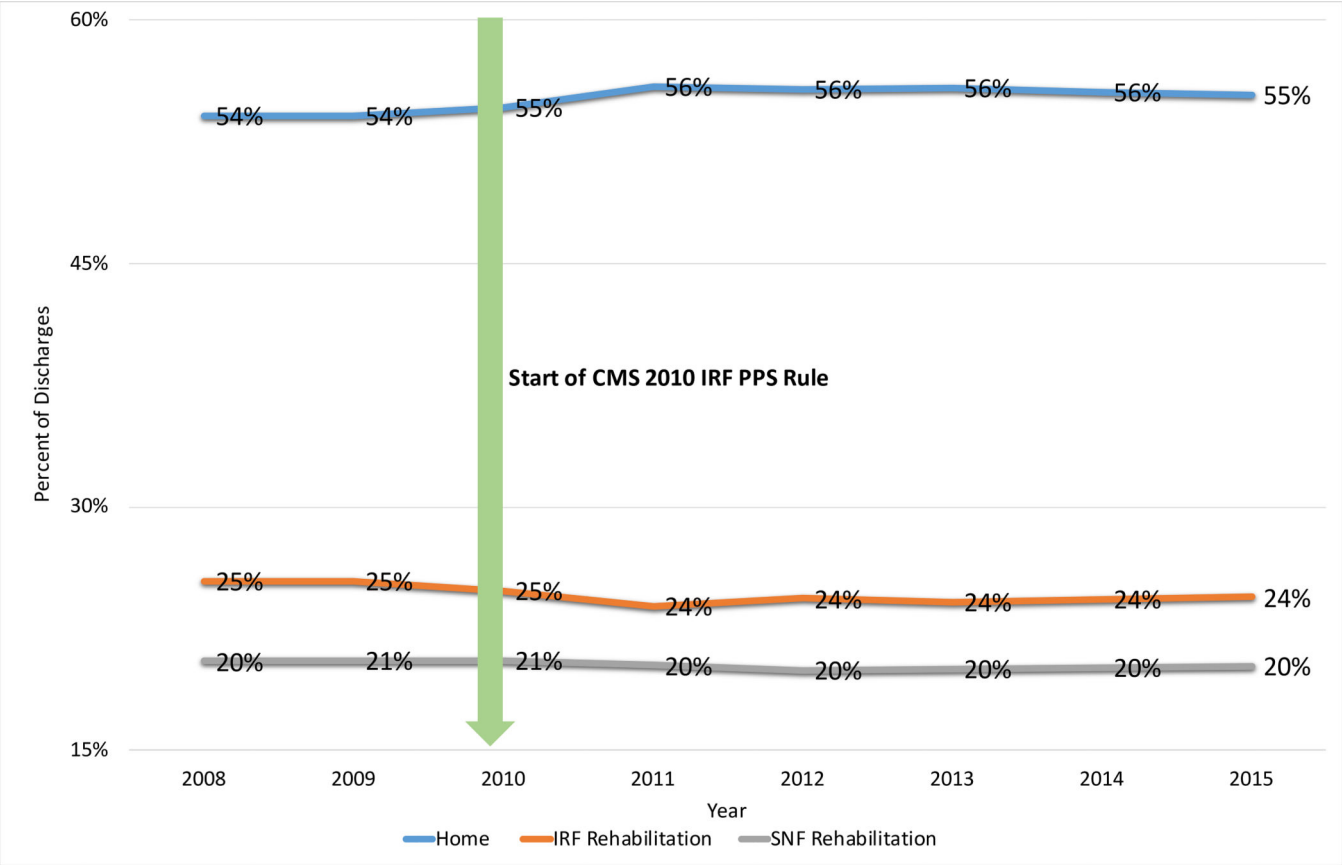

Figure 2.

Percentage of Acute Ischemic Stroke Visits with Discharge Disposition of Home, IRF Rehabilitation and SNF Rehabilitation by Year (2008 to 2015)

Table 1.

Patient and hospital characteristics by discharge disposition – 2008 to 2015 (n=1643553)

	Home	IRF Rehabilitation	SNF Rehabilitation
n of ischemic stroke, %	**908224 (55.3)**	**402907 (24.5)**	**332422 (20.2)**
Age, mean (SD)	66.30 (14.24)	70.37 (13.71)	78.14 (11.91)
Male Sex, %	53.25	49.71	39.49
Ethnicity, %			
African-American	17.23	18.57	15.74
Hispanic	7.55	5.60	5.53
Asian	2.83	2.48	2.58
White	68.01	69.48	72.31
Other, UTD	10.4	9.22	9.47
Missing	0.24	0.19	0.16
Stroke Severity			
NIHSS, median (IQR)	2(1–4)	6(3–11)	7(3–14)
NIHSS mean (SD)	3.49(4.51)	7.71(6.70)	9.09(7.85)
NIHSS Missing, %	28.65	24.23	31.16
Length of Stay, median (IQR)	3 (2–4)	5 (3–7)	5 (4–9)
Insurance, %			
Medicare	36.29	44.74	54.68
Medicaid	8.82	8.47	10.15
Private/VA	39.98	37.82	31.19
No Insurance	7.63	3.98	1.67
Missing	7.29	5.00	2.31
Past Medical History			
Atrial fibrillation, %	12.54	17.21	25.74
Prosthetic Heart Valve, %	1.24	1.30	1.30
Previous Stroke/TIA, %	27.67	30.43	38.06
CAD/Prior MI, %	22.87	25.01	28.85
Carotid Stenosis, %	3.79	3.71	4.19
Diabetes Mellitus, %	32.02	35.22	35.67
Peripheral Vascular Disease, %	3.99	4.51	6.11
Hypertension, %	73.33	77.50	80.79
Tobacco Use, %	22.57	18.69	11.07
Dyslipidemia, %	44.06	44.34	44.83
Heart Failure, %	6.30	8.01	12.98

	Home	IRF Rehabilitation	SNF Rehabilitation
n of ischemic stroke, %	**908224 (55.3)**	**402907 (24.5)**	**332422 (20.2)**
Medical History Missing, %	0.86	0.62	0.66
Arrival and Admission			
Arrived off hours, %	44.09	48.38	45.08
Time from onset to arrival in minutes, median (IQR)	644 (130–2105)	620 (161–2000)	680 (160–2034)
EMS arrival, %	34.29	51.19	62.42
Discharge Status			
Able to ambulate independently day 2, %	68.48	19.10	15.05
Dysphagia screening, %	80.23	85.60	82.03
Rehabilitation assessed or received	96.00	100.00	99.29
Hospital Characteristics			
Number of hospital beds, median (IQR)	361 (244–549)	380 (263–579)	349 (235–514)
AIS stroke discharges per year, median (IQR)	230.80 (156.98–353.54)	247.23 (166.67–367.24)	224.57 (148.00–345.02)
Annual IV t-PA cases, mean (SD)	23.42 (17.67)	24.52 (17.56)	22.45 (17.30)
IV t-PA in treating hospital, %	7.66	11.64	7.74
Geographic Region			
West, %	18.91	14.92	20.51
South, %	39.06	35.02	33.69
Midwest, %	18.99	21.33	19.83
Northeast, %	23.04	28.72	25.97
Hospital Type and Location			
Primary Stroke Center, %	44.82	43.51	44.98
Rural location, %	4.94	3.82	5.69
Teaching or Academic Hospital, %	58.98	63.67	57.07

Table 2.

Unadjusted and Adjusted Association of CMS 2010 IRF PPS Rule with IRF Rehabilitation vs. Home and SNF Rehabilitation vs. Home in Ischemic Stroke Discharges

Outcome	Variable	Unadjusted OR (95% CI)	Unadjusted P	Adjusted OR[1] (95% CI)	Adjusted P
IRF vs. Home	After CMS 2010 IRF PPS Rule vs. Before	0.96 (0.95, 0.97)	<0.0001	0.88 (0.87, 0.89)	<0.0001
SNF vs. Home	After CMS 2010 IRF PPS Rule vs. Before	0.99 (0.98, 1.00)	0.1729	0.99 (0.98, 1.00)	0.2225

[1]Variables included in the model were age (per 10 years), female sex, race-ethnicity (Black, Hispanic or Other Race vs Caucasian), insurance type (Medicaid, Medicare or Other Insurance vs None), past medical history of atrial fibrillation/flutter, prosthetic heart valve, previous stroke/transient ischemic attack (TIA), coronary artery disease or prior myocardial infarction, carotid stenosis, diabetes mellitus, peripheral vascular disease, hypertension, dyslipidemia, heart failure or smoking, arrived off-hours, EMS arrival, dysphagia screening, ambulation at day two of hospitalization, rehabilitation assessment, annual number of ischemic stroke/TIA cases (101 – 300 or 301+ vs 0 – 100), IV t-PA use, number of annual t-PA cases (11–20 or 20+ vs 0–10), geographic region (South, West, Midwest vs Northeast; Rural vs Urban), teaching hospital, primary stroke center, and number of hospital beds (per 50).

Table 3.

Subgroup Analysis: Association of CMS 2010 IRF PPS Rule with IRF Rehabilitation vs. Home and SNF Rehabilitation vs. Home in Ischemic Stroke Discharges

Outcome	Variable	Adjusted OR[2] (95% CI)	Adjusted P
Age			
IRF vs. Home	After vs. Before CMS 2010 IRF PPS Rule - Age < 65	0.88 (0.87, 0.90)	<0.0001
	After vs. Before CMS 2010 IRF PPS Rule - Age>=65	0.88 (0.87, 0.90)	<0.0001
Geographic Region			
IRF vs. Home	After vs. Before CMS 2010 IRF PPS Rule - Northeast	0.92 (0.90, 0.94)	<0.0001
	After vs. Before CMS 2010 IRF PPS Rule - South	0.85 (0.84, 0.87)	<0.0001
	After vs. Before CMS 2010 IRF PPS Rule - West	0.83 (0.81, 0.85)	<0.0001
	After vs. Before CMS 2010 IRF PPS Rule - Midwest	0.93 (0.91, 0.95)	<0.0001
Teaching and Non-Teaching Hospitals			
IRF vs. Home	After vs. Before CMS 2010 IRF PPS Rule - Non-Teaching	0.85 (0.83, 0.86)	<0.0001
	After vs. Before CMS 2010 IRF PPS Rule - Teaching	0.90 (0.89, 0.92)	<0.0001

[2]Variables included in the model were female sex, race-ethnicity (Black, Hispanic or Other Race vs Caucasian), insurance type (Medicaid, Medicare or Other Insurance vs None), past medical history of atrial fibrillation/flutter, prosthetic heart valve, previous stroke/transient ischemic attack (TIA), coronary artery disease or prior myocardial infarction, carotid stenosis, diabetes mellitus, peripheral vascular disease, hypertension, dyslipidemia, heart failure or smoking, arrived off-hours, EMS arrival, dysphagia screening, ambulation at day two of hospitalization, rehabilitation assessment, annual number of ischemic stroke/TIA cases (101 – 300 or 301+ vs 0 – 100), IV t-PA use, number of annual t-PA cases (11–20 or 20+ vs 0–10), Rural vs Urban location, primary stroke center, and number of hospital beds (per 50).

Table 4.

Sensitivity Analysis: Unadjusted and Adjusted Association of CMS 2010 IRF PPS Rule with IRF Rehabilitation vs. Home and SNF Rehabilitation vs. Home in Ischemic Stroke Discharges

Outcome	Variable	Unadjusted OR (95% CI)	Unadjusted P	Adjusted OR[3] (95% CI)	Adjusted P
IRF vs. Home	After CMS 2010 IRF PPS Rule vs. before	0.88 (0.87, 0.89)	<0.0001	0.94 (0.92, 0.95)	<0.0001
SNF vs. Home	After CMS 2010 IRF PPS Rule vs. before	0.98 (0.96, 0.99)	0.0070	1.12 (1.10, 1.14)	<0.0001

[3]Sensitivity analysis used hospital discharges with NIHSS complete data. Variables included in the model were age (per 10 years), female sex, race-ethnicity (Black, Hispanic or Other Race vs Caucasian), insurance type (Medicaid, Medicare or Other Insurance vs None), past medical history of atrial fibrillation/flutter, prosthetic heart valve, previous stroke/transient ischemic attack (TIA), coronary artery disease or prior myocardial infarction, carotid stenosis, diabetes mellitus, peripheral vascular disease, hypertension, dyslipidemia, heart failure or smoking, arrived off-hours, EMS arrival, dysphagia screening, ambulation at day two of hospitalization, rehabilitation assessment, annual number of ischemic stroke/TIA cases (101 – 300 or 301+ vs 0 – 100), IV t-PA use, number of annual t-PA cases (11–20 or 20+ vs 0–10), geographic region (South, West, Midwest vs Northeast; Rural vs Urban), teaching hospital, primary stroke center, and number of hospital beds (per 50).