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Medicare Spending and Outcomes after Post-Acute Care for Stroke and Hip Fracture

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Abstract

Background—Elderly patients who leave an acute care hospital after a stroke or a hip fracture may be discharged home or undergo post-acute rehabilitative care in an inpatient rehabilitation facility (IRF) or skilled nursing facility (SNF). Since 15% of Medicare expenditures are for these types of post-acute care, it is important to understand their relative costs and the health outcomes they produce.

Objective—To assess Medicare payments for and outcomes of patients discharged from acute care to an IRF, a SNF, or home after an inpatient diagnosis of stroke or hip fracture between January 2002 and June 2003.

Research Design—This is an observational study based on Medicare administrative data. We adjust for observable differences in patient severity across post-acute care sites and we use instrumental variables estimation to account for unobserved patient selection.

Study Outcomes—Mortality, return to community residence, and total Medicare post-acute payments by 120 days after acute care discharge.

Results—Relative to discharge home, IRFs improve health outcomes for hip fracture patients. SNFs reduce mortality for hip fracture patients, but increase rates of institutionalization for stroke patients. Both sites of care are far more expensive than discharge to home.

Conclusions—When there is a choice between IRF and SNF care for stroke and hip fracture patients, the marginal patient is better off going to an IRF for post-acute care. However, given the marginal cost of an IRF stay compared to returning home, the gains to these patients should be considered in light of the additional costs.

Keywords

health care financing; post-acute care; Medicare; selection models

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Introduction

Medicare spending on post-acute care has increased 9% per year since 2000 and now constitutes over 15% of Medicare spending.[1] Policymakers mindful of this increase, yet open to the potential of post-acute care to improve health outcomes and smooth transitions between care settings, need research comparing outcomes and costs of different types of post-acute care. However, there is little definitive evidence regarding the best setting and level of intensity for rehabilitative care, even for groups of patients such as those with hip fracture or stroke who can benefit from rehabilitation and regularly use post-acute care. Post-acute care can take place in an inpatient rehabilitation facility (IRF, the most intense rehabilitation setting), a skilled nursing facility (SNF), or in the patient's home, provided by either Medicare-paid home health agencies or informal caregivers.

The available evidence indicates that stroke victims achieve greater functional gain, more frequent return to community, and lower death rates in the more intense IRF setting than in SNFs.[2–12] But while therapy intensity may be beneficial, two studies found that its benefit may depend on specific patient characteristics.[13–14] The evidence on post-acute care for hip fracture patients is less definitive. Some researchers found that patients in IRFs had better functional outcomes[15] and that patients in SNFs were less likely to return to the community,[7] but another study found that there was no significant difference in functional outcomes or discharge disposition between SNFs and IRFs.[12] Some studies found that for sicker or more severely disabled hip fracture patients, SNFs produce comparable rehabilitation functional outcomes to IRFs and similar rates of return to the community at a lowercost.[6,16] Other studies of both hip fracture and stroke have found that home health agencies may provide less expensive care with outcomes comparable to or better than IRFs.[8,17]

The major challenge to research in this area is that patients are generally discharged to the setting judged by their providers to best meet their needs. Thus care settings are selected for patients, often based at least partially on patient attributes that their providers can assess but that are not captured fully in administrative data sets. Prior research has used a variety of methods to attempt to control for differences in observable characteristics across patients using different post-acute care settings, but studies have not controlled for unobservable differences in the types of patients admitted to each setting.

This study seeks to build on prior research by comparing outcomes of and Medicare payments for post-acute care across settings after controlling for differences in both observable and unobservable patient characteristics. Based on the prior research, we hypothesized that IRF care would produce the best outcomes.[18–26] We also hypothesized that even after controlling for observed and unobserved characteristics, IRFs would be the most expensive setting, followed by SNFs, and by patient discharge to their homes. Our study, which is based on national data, provides more generalizable and less biased results than are currently available in the literature.

Data and Methods

Data Sources

We linked multiple patient-level Medicare administrative files to data on the providers they used and the characteristics of the health care markets in which they resided. We used Medicare inpatient claims, as well as the home health, SNF, and IRF standard analytic files to trace the path of care and payments for each patient; the Medicare Denominator file to determine beneficiary death; Medicare cost reports and the Provider of Services data file for

provider characteristics; the Area Resource File; and finally the Minimum Data Set to determine which patients were residents of custodial nursing homes.

Study Sample

We analyzed data on all elderly Medicare stroke and hip fracture patients enrolled in the fee-for-service Medicare program and discharged from an acute care hospital between January 2002 and June 2003. We defined post-acute care setting as the first care site used after discharge from acute care because many patients use only one site in their post-acute care episode, and this study seeks to inform the discharge planning process. We considered institutional post-acute care use to be IRF use or SNF use that began within 30 days of discharge from acute care and was covered by Medicare; other patients were classified as receiving care at home, with or without formal home health care. We did not analyze use of long-term care hospitals since less than 0.05% of Medicare patients discharged from acute care used these facilities during our study period. We also excluded patients who died in the hospital or within 30 days of discharge, because we did not expect post-acute care to affect their outcomes, and patients residing in a custodial nursing home before or immediately after the hospital stay, because they were not good candidates for rehabilitation (12% of hip fracture and 22% of stroke patients). Finally, we excluded patients for whom we did not have complete claims data, including those receiving rehabilitation in acute hospitals, patients with missing information, and HMO enrollees (5% of the hip fracture and 4% of the stroke populations).

Measures

Return to the community and mortality are key health outcomes after an acute event such as stroke or hip fracture. We developed two measures to assess these outcomes in our study sample of patients who survived at least 30 days after acute care discharge: death within 120 days after acute hospital discharge, and a composite measure capturing death or institutionalization in a custodial nursing home at 120 days after discharge.

Using the home health, skilled nursing, and inpatient rehabilitation standard analytic files and hospital claims, we created summary variables describing the Medicare payments for each site of care for each beneficiary. However, because some IRFs were still transitioning to prospective payment during our study period, we created the IRF payment amounts using the prospective payment rules. We summed home health, skilled nursing, inpatient rehabilitation, long-term care hospital, and acute care hospital readmission payments to create a post-acute payment variable. After wage-adjusting them, we modeled post-acute payments on the natural scale because of the large number of patients with zero payments. Modeling payments on the natural scale yields consistent estimates (i.e., estimates that are unbiased in large samples).[27]

The key independent variables in the analyses were indicator variables for the first post-acute care setting, categorized as IRF, SNF, or home (the omitted category). Covariates in the analyses included patient demographic and clinical characteristics, discharging hospital characteristics, and market factors that might affect post-acute outcomes. Demographic characteristics included the age of the beneficiary and age squared, gender, race and urbanicity of residence (MSA, area adjacent to a MSA, or rural area/not adjacent to an MSA), an indicator for receiving Medicaid, and interactions between gender and age. To capture the clinical severity of patients at the time of hospital discharge, we also included a large set of indicator variables for comorbidities and complications tailored to stroke and hip fracture patients and derived from diagnoses on the hospital discharge records.[28–29] The comorbidities were primary cancer with poor prognosis, metastatic cancer, chronic pulmonary disease, coronary artery disease, congestive heart failure, peripheral vascular

disease, severe chronic liver disease, diabetes mellitus with and without end-organ damage, chronic renal failure, nutritional deficiencies, dementia, and functional impairment. Complications arising during the hospital stay that could influence the outcomes of post-acute care included post-operative pulmonary compromise, post-operative gastrointestinal hemorrhage, cellulitis or decubitus ulcer, septicemia, pneumonia, mechanical complications due to a device, implant, or graft, shock or arrest in the hospital, post-operative acute myocardial infarction (AMI), post-operative cardiac abnormalities other than AMI, procedure-related perforation or laceration, venous thrombosis and pulmonary embolism, acute renal failure, miscellaneous complications, delirium, and dementia. We also created condition-specific measures for stroke and hip fracture patients: indicators for basilar artery infarct; carotid, verterbral, or multiple artery infarct; and hemorrhagic stroke for the stroke population; and indicators for pertrochanteric fracture, total hip replacement, partial hip replacement, hip revision, and stroke for hip fracture patients.

Patterns of care and approaches to discharge planning in the acute care hospital can influence post-acute care. Accordingly, we included the following acute care hospital characteristics as covariates: size (average daily census or ADC), teaching status (resident to ADC ratio), ownership status, Medicare patient percentage, case-mix index of the hospital, and low-income patient percentage. Finally, we included a measure of the county-level HMO penetration rate, which has been shown to be associated with market-level variations in practice patterns and is an important predictor of variation in care even among non-HMO patients.[30–32]

Estimation

Our analyses were based on estimating the following multivariate model:

$$Y=f(\theta+\beta_1 IRF+\beta_2 SNF+\zeta X+\varepsilon_1+\lambda_1\sigma)$$

where Y is any of the three outcome variables (mortality, mortality/institutionalization, Medicare post-acute payments), IRF and SNF indicate the setting of post-acute care used, X denotes the covariates, ε_1 is an independently distributed random error, and σ denotes unobservable patient characteristics that lead to selection bias. Thus ε_1 is assumed to be uncorrelated with choice of post-acute setting (IRF, SNF or home) or with X, whereas σ is assumed to be correlated with both choice of post-acute setting and X. The function f is a binary logit for the health outcomes, and linear for the payment outcomes.

We estimated the models in two ways. First, we estimated the models using standard methods, which ignore selection bias (i.e., these methods ignore σ). Next, we estimated a two-equation instrumental variables (IV) model which adds to the outcome equation a "choice" equation to predict the probability of use of each post-acute care setting. The process of assigning patients to post-acute discharge destinations is affected by many factors and may be modeled as an optimal choice problem. We conceptualized decisions to use PAC and which type of facility to use as joint decisions made by patients, their families, and their physicians, and influenced by discharge planners at the acute care hospital and staff at PAC facilities. Clinicians consider medical and rehabilitation needs when making their recommendations and choose the setting judged to best meet patients' clinical needs and goals; patients and their families introduce their own concerns about convenience; and discharge planning staff are influenced by the availability of beds in different types of facilities. This approach to the problem nicely fits the random utility framework that has been developed to analyze choices of this type.[33] To apply the framework, we choose return to home after acute care discharge as the base category; then the model can be written as follows:

$$U_{IRF}=f(\alpha+\eta X+\omega Z+\varepsilon_2+\lambda_2\alpha) \quad \text{and} \quad U_{SNF}=f(\gamma+\delta X+\rho Z+\varepsilon_3+\lambda_3\sigma)$$

where U_{IRF} and U_{SNF} are the utilities (relative to going home) that the patient derives from the respective care sites; Z is a vector of IVs that affect the choice of post-acute care setting but have no direct effect on the study outcomes (see below); X and σ are as in the outcome equations; and ε_2 and ε_3 are independently distributed random errors. Of note, by linking the outcome and choice equations, σ allows unobservable patient characteristics to affect both the choice of post-acute care setting and outcomes, which in turn enables the IV estimates to correct for selection bias.

Assuming that ε_2 and ε_3 follow an extreme value distribution (a standard assumption, though seldom explicitly noted), the post-acute care choice model becomes a multinomial logit model. Consequently, it is straightforward to write down the likelihood of jointly observing a particular site of care and outcome given a value of σ. For example, the probability of observing someone in a SNF who died within 180 days of admission is simply the probability of SNF care from the multinomial logit model times the probability of death from the binary logit model. However, the problem for our analysis is that we do not observe the σ; therefore, we need to assume a distribution for σ and integrate over that distribution to compute the likelihood of jointly observing a particular site of care and outcome. We assumed that σ was normally distributed and used quasi-random draws based on Halton sequences to numerically integrate over the distribution of the unobserved characteristics (σ). Halton sequences (compared to random draws) are more efficient for numerical integration as they draw evenly from all parts of the distribution. We used the maximum likelihood routine in the statistical software Stata version 9 to estimate parameter values that maximize the joint simulated likelihood of observing our data. A more detailed description of our methods is available in Deb and Trivedi (2006).[34]

Instrumental Variables

Our choice of IVs (Z) was guided by earlier research on the factors that influence referrals for post-acute care. In many cases, referrals to the various settings are made in the absence of clear clinical criteria that would identify the optimal setting. Thus patients and doctors must weigh a range of clinical and nonclinical factors—such as the perceived quality of care delivered by a provider and its convenience—when making these decisions. Although Medicare eligibility criteria are codified in regulations, as a practical matter, providers, physicians, and hospital discharge planners have discretion in interpreting these guidelines. Researchers examining post-acute care have observed considerable variation in utilization rates and choice of setting, geographically and by type of discharging hospital. This suggests that nonclinical factors, such as location of post-acute care facilities and established referral relationships between facilities, affect where stroke and hip fracture patients go for post-acute care.[35]

We created patient-specific measures of availability and proximity of post-acute care providers to use as IVs in our models. We used patient and provider zip code information to measure the distance traveled from patients' residences to providers. Our first set of IVs captured the distance from the patient to the closest provider of each type. We included both distance and distance squared, since the effects of distance on choice are likely diminishing as distances become large. These variables measure how accessible the provider type is in terms of proximity. The second set included the number of providers of each type within a given radius around the patient's home. We calculated these radii separately for hip fracture and stroke patients by area type, and defined the radii using the 90th percentile of the distance traveled to that type of provider by beneficiaries living in that type of area. The

90th percentile was chosen since it reflected a generous definition of the market area, but was minimally influenced by the care patterns of patients who receive care very far from home. We also created indicators for areas without any of a given type of provider.

Our IVs are expected to be uncorrelated with beneficiaries' clinical needs, since seniors are unlikely to choose where to live based on proximity and availability of post-acute care facilities. Consequently, they are expected to affect the study outcomes only through the choice of post-acute care setting, and to have no direct effect on outcomes. We conducted several tests of instrumental validity, as described in the Results section.

Interpreting Instrumental Variable Estimates

Before presenting our results, we underscore an important point regarding the nature of IV estimates. IV estimates of treatment effects apply to patients whose decisions regarding the choice of treatment depends on changes in the values of the instruments, usually referred to as "marginal" patients.[36] Therefore, the IV results presented in the next section apply to patients whose decisions regarding which post-acute care setting to use are influenced by the relative proximity and availability of different post-acute care sites, i.e., by our IVs. We expect that these are the patients for whom there is the greatest clinical uncertainty regarding the optimal setting for post-acute care—i.e., for whom the benefit from one type of care versus another is least clear. Conversely, our findings do not apply to patients who are ideal candidates for one setting or another, and whose decisions regarding where to get care are not affected by geographic factors. We return to this point in the Discussion section of the paper.

Results

Descriptive Data

Hip fracture patients used post-acute care at very high rates. About 26% and 64% of these patients used IRF and SNF care, respectively, whereas only 10% returned directly home post-discharge. About 65% of those who returned home used formal home health care, and the remainder returned home without any Medicare-paid post-acute care. Many more stroke patients returned home (45%), while the number using IRF (24%) and SNF (31%) care was more balanced. Of those stroke patients who returned home, 32% used home health care.

SNF patients were older, more likely to have experienced a complication in the hospital and more likely to be white and dually eligible for Medicaid than IRF patients and patients who went home (Table 1). SNF patients were more likely than others to have each complication and most of the comorbidities that we assessed (the table reports only selected complications and comorbidities). SNF patients were also more likely than other patients to be women.

Patients who returned home after their acute discharge had fewer IRFs and SNFs in their travel radius, and lived farther from both the closest IRF and SNF. Patients who used an IRF for post-acute care were more likely to live within a travel radius of more IRFs, and were more likely to have live a shorter distance from the closest IRF.

SNF patients were more likely to die or reside in a custodial nursing home at 120 days after acute care discharge than either IRF patients or patients who went home (Table 2). However, IRF patients had the highest post-acute payments. Hip fracture patients who went to IRF cost on average $6,433 more per episode than those who went to a SNF, and stroke patients cost on average $10,121 more. Hip fracture patients who returned home cost Medicare $17,332 less ($24,219 less for stroke patients) than those who used an IRF. Medicare paid $2,542 for home health services for the average hip fracture patient who returned home, and $1,266 for the average stroke patient. Many patients used multiple sites

of care. For instance, 54% of hip fracture patients used multiple sites of care, mainly home health care after a SNF or IRF discharge. For hip fracture patients who went to an IRF first, however, Medicare paid $3,160 on average for SNF care. Similarly, for stroke patients who went to an IRF first, Medicare paid $4,218 on average for SNF care.

Regression Results

Our regression results highlight the need to correct for selection into post-acute care sites when studying outcomes. Table 3 displays three sets of results. The first set of results (two left-hand columns) is not adjusted for patient characteristics and suggests that the outcomes of going to SNFs or IRFs for post-acute care were much worse than the outcomes of receiving care at home for both conditions. The only exception was that hip fracture patients who accessed an IRF for post-acute care were less likely to die by 120 days post-discharge. The second set of results (two middle columns) is adjusted for observable patient and market characteristics using multivariate regression, but these results are not adjusted for unobserved characteristics. The differences across settings observed in the unadjusted findings are attenuated, but home care still appears to be the best option for hip fracture and stroke patients.

The third set of results (two right-hand columns) is adjusted for unobservable in addition to observable characteristics using IV estimation. Among “marginal” hip fracture patients (as defined earlier), use of an IRF reduced mortality by 5.1 percentage points ($p<0.001$) at 120 days post-discharge, compared with returning home, and use of a SNF reduced mortality by 6.3 percentage points ($p<0.001$). IRFs also had a protective effect against the joint outcome of death or institutionalization in hip fracture patients, reducing the probability of this outcome by 3.9 percentage points ($p<0.001$), whereas SNFs had no effect on this outcome. However, the improved outcomes of institutional post-acute care in hip fracture patients were associated with higher post-acute costs. Specifically, IRF care was $16,602 ($p<0.001$) more expensive than returning directly home, while SNF care was $8,944 ($p<0.001$) more expensive. Notably, Medicare payments for hip fracture patients who used SNF care were significantly lower than for patients using IRF care.

Among “marginal” stroke patients, use of an IRF reduced mortality by 2.7 percentage points ($p<0.001$) compared with returning home, whereas there was no difference in mortality between using a SNF and returning home. Interestingly, SNFs produced worse results for the joint outcome of death or institutionalization at 120 days than both patients who used an IRF and patients who returned directly home. Specifically, stroke patients who used a SNF were 9.3 percentage points ($p=0.002$) more likely to be dead or institutionalized at 120 days than patients who used an IRF. IRF care for “marginal” stroke patients was $22,765 ($p<0.001$) more expensive than returning home, whereas SNF care was $11,505 ($p<0.001$) more expensive.

Instrument Validity

The validity of our results rests on the validity of our instruments. Valid instruments must be strongly correlated with the choice of post-acute setting, but they should only affect outcomes through their effect on the choice of setting and should be uncorrelated with unobserved factors that affect outcomes.[37] We found evidence for both of these criteria. The availability measures for both post-acute care types were highly significant in multivariate analyses for choice of post-acute care setting that controlled for patient and discharging hospital characteristics (the chi-square of the first stage was 32,266). This finding is consistent with prior research.[35] The other criterion cannot be tested directly, but we found indirect evidence to support it. First, our IVs were uncorrelated with observable patient characteristics—i.e., in regressions of the IVs on the patient-level covariates in our analyses,

the explanatory power was extremely low ($R^2 \leq 0.01$). This makes it more plausible that they were uncorrelated with unobservable patient characteristics as well. Additionally, our results were robust to the inclusion or exclusion of different sets of instruments. For example, when we dropped the availability or proximity measures, the results were virtually identical. This test is in the spirit of the Hausman over-identification test and is based on the principle that if all the instruments are valid then estimates obtained using only a subset of instruments should differ only as a result of sampling error.[38]

Discussion

Our study found that for both hip fracture and stroke patients admission to an IRF, although more expensive than returning directly home, reduced mortality. IRF care also reduced rates of institutionalization for hip fracture patients, but not for stroke patients. Admission to a SNF also reduced mortality for hip fracture patients, compared with returning home, but had no effect on mortality among stroke patients. Our most striking finding was that SNF care increased rates of institutionalization among stroke patients. Unsurprisingly, both IRF and SNF care were considerably more expensive than going home.

Our finding that stroke patients do better in IRFs than in SNFs or at home is consistent with several earlier studies.[6–9,12] However, the finding of lower rates of return to the community among stroke patients who receive SNF care is unprecedented in the literature. In the case of hip fracture, our results are generally consistent with existing studies suggesting that SNFs and IRFs produce similar outcomes,[12] but they differ from other studies that indicate that one or another institutional setting, or even receiving home health care, is better.[7]

As discussed in the Data and Methods section, our IV estimates apply to “marginal” patients whose decisions regarding which post-acute care setting to use are influenced by the relative proximity and availability of different post-acute care sites. We expect that these are the patients for whom there is the greatest clinical uncertainty regarding the optimal setting for post-acute care. Conversely, our findings do not apply to patients who are ideal candidates for one setting or another, and whose decisions regarding where to get care are not affected by geographic factors. Understanding outcomes for these “marginal” patients is important from a policy perspective, however, because these are the patients that Medicare payment or admittance policies are most likely to affect and shift across sites of care. Given the results of prior research, it seems likely that this group of patients is appreciable in size. In an earlier study, we used simulations to estimate that the proportion of patients going to a site for post-acute care vary by approximately 20–35% based on whether the patient resides in an area with availability at the 10^{th} percentile vs. the 90^{th} percentile. This suggests that a substantial number of patients base their post-acute location decision around availability of post-acute care, and therefore will be affected by the values of our IVs.[35]

With the qualifications in mind, the results of our study suggest that the more intensive rehabilitation provided in IRFs to marginal stroke and hip fracture patients leads to better outcomes, but at considerably higher cost than rehabilitating these patients at home. Our findings also indicate that providing post-acute care in SNFs to marginal hip fracture patients reduces mortality at 120 days after acute care discharge, again at higher cost. Juxtaposing the mortality and payment results for hip fracture patients implies that the cost to Medicare of preventing a death at 120 days after acute care discharge is roughly $263,000 if patients first receive care in an IRF and $175,000 if patients first receive care in a SNF. A recent study estimates the value of a statistical life year for a 70 year old to be about $250,000.[39] Thus if SNF or IRF care increase life expectancy by about one year, the benefits derived by patients will roughly equal the cost to Medicare. Of note, prior studies suggest that persons in an institutional setting at 70 years of age have a life expectancy of about 5

years, whereas healthy 70 year olds with no functional limitation have a life expectancy of about 14.3 years.[40]

The reasons for higher rates of institutionalization among marginal stroke patients who receive SNF care less clear. One possibility is that these patients experience more deconditioning in SNFs than either in an IRF or at home, and that deconditioning is an obstacle to returning to the community.[41–44] Another possibility is that, since most nursing homes offer both skilled nursing and custodial care, it may be "too easy" to keep SNF patients where they are and simply convert them from Medicare to a different payer—certainly easier than it is to transfer IRF patients to a nursing home—and nursing homes may have incentives to do so. If this is the case, our finding would nonetheless indicate that, all other things being equal, hip fracture and stroke patients discharged to a SNF, rather than to an IRF, are less likely to return to the community. This would surely be a negative outcome for most patients and families. However, a third possibility is that families desiring long-term nursing home placement for a relative after a hospitalization for a stroke prefer to place the relative in the nursing home—first to receive skilled nursing care and subsequently custodial care—directly from the acute care hospital. Our IV estimates cannot correct for this type of decision-making on the part of families. Whether this should be considered a positive or negative outcome depends on the goals and values of patients and their families. Assessing the longer-term outcomes of SNF care for stroke patients is an important area for additional research.

Several limitations of our study deserve mention. First, our best estimates of the effect of post-acute care setting on outcomes are the IVs estimates, but we cannot rule out the possibility that some selection bias remains in these estimates. Outcomes depend on many factors, including patients' physical and cognitive abilities, underlying medical diseases, sensory and emotional factors, willingness to participate in care, and supportive environments, and our IVs may not have fully corrected for all of these. Second, the outcomes we analyzed, although important, are not the only relevant outcomes for stroke and hip fracture patients. Unfortunately, data on functional status, another key outcome, are unavailable. Death and institutionalization at 120 days are imperfect proxies for functional decline and may be less closely related than functional status to the effectiveness of rehabilitation.

Third, we were unable to assess the contribution of formal home health care to outcomes, or to account for confounding due to availability of informal caregivers in the home. Fourth, our study focused on the elderly, so our findings may not generalize to younger patients. Finally, excluded nursing home residents are not randomly distributed across the nation because states have varying endowments of nursing home beds per capita. Thus, the exclusion of the nursing home population could mean that a more disabled population is being observed in states with fewer nursing home beds than in states with a higher availability of nursing home beds. In a related vein, although post-acute care seems unlikely to affect the outcomes of patients who died within 30 days of hospital discharge—another of our exclusion criteria—future analyses should assess whether outcomes in these patients differ from outcomes in our study sample.

Despite these limitations, our study calls attention to the need to consider the costs and outcomes of the full range of post-acute settings when setting clinical and payment policies. Our findings indicate that although costs are higher, marginal stroke patients admitted to IRFs do better than those sent to SNFs. In fact, providing post-acute care at home may be an attractive and less costly option for these patients than IRF or SNF care. Marginal hip fracture patients are best off receiving post-acute care in an institutional setting, but the differences between IRFs and SNFs are not marked. More research is needed on the content

of care received by patients in each setting – especially the home setting – to determine not only which setting but what course of treatment best achieves the goal of returning patients safely to life in their communities after an acute event.

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Table 1

Mean Patient Characteristics by Post-Acute Site January 2002 to June 2003

First Site of Post-Acute Care	Hip Fracture			Stroke		
	Home	IRF	SNF	Home	IRF	SNF
Number of Observations	23,451	61,173	149,362	130,365	68,906	87,844
Demographics						
Female	71.0%	76.2%	78.0%	55.2%	57.3%	66.0%
White	91.4%	92.6%	94.1%	83.3%	82.3%	84.6%
Black	4.7%	3.8%	3.1%	12.1%	12.7%	11.4%
Hispanic	1.3%	1.4%	0.9%	1.6%	1.6%	1.4%
Age (+/− SD)	79.5 (+/− 8.1)	80.9 (+/− 7.1)	83.4 (+/− 7.1)	77.1 (+/−7.3)	77.7 (+/−7.1)	81.1 (+/− 7.4)
Beneficiary is covered by Medicaid	16.7%	13.8%	18.5%	16.7%	17.5%	25.6%
Lives in an MSA	66.6%	77.2%	71.6%	72.1%	77.6%	70.8%
Lives adjacent to an MSA	17.8%	12.6%	16.0%	15.8%	12.9%	16.5%
Select Complications						
Post-operative pulmonary compromise	1.2%	1.1%	1.5%	0.7%	1.7%	2.5%
Cellulitis or decubitus ulcer	2.1%	1.6%	2.5%	1.0%	1.2%	3.1%
Pneumonia	3.6%	2.7%	4.7%	2.4%	4.5%	8.7%
Acute renal failure	1.0%	1.1%	1.6%	0.9%	1.2%	1.9%
Delirium	1.6%	2.4%	3.1%	1.1%	1.2%	2.2%
Select Comorbidities						
Coronary Artery Disease	19.2%	22.9%	21.9%	26.5%	24.2%	23.2%
Congestive Heart Failure	12.5%	14.5%	18.5%	13.2%	14.4%	19.6%
Dementia	20.0%	7.7%	23.5%	9.0%	6.6%	19.4%
Diabetes without End Organ Damage	13.1%	15.7%	14.5%	23.1%	24.9%	22.7%
Condition Specific Factors						
Total Hip Replacement	2.2%	3.9%	2.5%	--	--	--
Partial Hip Replacement	26.7%	37.8%	34.0%	--	--	--
Hip Revision	0.2%	0.2%	0.2%	--	--	--
Pertrof Fracture	41.5%	46.2%	51.0%	--	--	--
Hemoraghic Stroke	--	--	--	5.6%	9.6%	9.2%
Basilar Artery Infarct	--	--	--	0.3%	0.5%	0.3%

First Site of Post-Acute Care	Hip Fracture			Stroke		
	Home	IRF	SNF	Home	IRF	SNF
Carotid, verterbral, or multiple artery	--	--	--	6.3%	5.9%	4.6%
Instrumental Variables						
IRFs within travel radius	8.8 (+/−9.7)	10.7 (+/−10.6)	9.3 (+/−10.1)	10.6 (+/−11.0)	11.0 (+/−11.1)	10.8 (+/−11.3)
SNFs within travel radius	30.9 (+/−36.2)	36.8 (+/−41.4)	35.8 (+/−38.8)	31.9 (+/−36.8)	33.6 (+/−38.7)	33.6 (+/−38.1)
Distance to nearest SNF (miles)	2.5 (+/−5.5)	1.8 (+/− 4.5)	1.8 (+/−4.6)	2.1 (+/−4.4)	1.8 (+/−4.3)	1.8 (+/−4.2)
Distance to nearest IRF (miles)	16.7 (+/−24.7)	9.7 (+/− 23.9)	15.2 (+/−22.2)	14.0 (+/−23.0)	10.3 (+/−21.3)	15.3 (+/−25.7)

Table 2

Mean Outcomes by Post-Acute Site January 2002 to June 2003

	Hip Fracture Patients		
First Site of Post-Acute Care	**Home**	**IRF**	**SNF**
Health Outcomes			
Mortality Within 120 Days	7.3%	4.8%	10.2%
Dead or Custodial Nursing Home at 120 Days	8.9%	9.1%	28.4%
Payments--120 Day Episodes			
Total Post-Acute Payments	**$6,012 (+/− 10,756)**	**$23,344 (+/−17,539)**	**$16,911(+/−1,327)**
IRF Payments-Simulated 100% PPS	$208 (+/− 2,383)	$14,560(+/−12,723)	$363(+/−3,156)
SNF Payments	$507 (+/−2,525)	$3,160 (+/−6,191)	$11,547(+/−7,128)
HHC Payments	$2,542 (+/−2,497)	$2,577(+/−2,378)	$1,794(+/−2,208)
LTCH Payments	$77 (+/− 1,477)	$178(+/−2,242)	$89(+/−1,662)
Acute Readmission Payments	$2,678 (+/−8,542)	$2,869(+/−7,684)	$3,119(+/−7,617)
	Stroke Patients		
First Site of Post-Acute Care	**Home**	**IRF**	**SNF**
Health Outcomes			
Mortality Within 120 Days	4.4%	6.2%	14.7%
Dead or Custodial Nursing Home at 120 Days	5.4%	12.4%	39.9%
Payments--120 Day Episodes			
Total Post-Acute Payments	**$4,941(+/−10,290)**	**$29,160(+/−23,630)**	**$19,039(+/−14,383)**
IRF Payments-Simulated 100% PPS	$335(+/−3,134)	$19,265(+/−18,750)	$1,119(+/−6,728)
SNF Payments	$386(+/−2,222)	$4,218(+/−7,930)	$12,353(+/−8,692)
HHC Payments	$1,266(+/−2,100)	$2,078(+/−2,510)	$1,414(+/−2,214)
LTCH Payments	$46(+/−1,077)	$157(+/−1,990)	$123(+/−1,845)
Acute Readmission Payments	$2,908(+/−7,909)	$3,443(+/−8,560)	$4,030(+−8,935)

Table 3

Regression Results Hip Fracture and Stroke Patients January 2002 to June 2003

	Unadjusted estimates		Adjusted for exogenous characteristics			
			IRF/SNF status assumed exogenous		IRF/SNF status assumed endogenous	
Hip Fracture	Effect	Std. Error	Effect	Std. Error	Effect	Std. Error
Dead at post-discharge day 120	(% Point)		(% Point)		(% Point)	
IRF vs. no Medicare-paid institutional care	−3.099	0.196 **	−2.144	0.177 **	−5.114	0.354 **
SNF vs. no Medicare-paid institutional care	2.629	0.183 **	1.144	0.169 **	−6.296	0.559 **
IRF vs. SNF	−5.728	0.146 **	−3.288	0.130 **	1.182	1.782
Dead or institutionalized at post-discharge day 120	(% Point)		(% Point)		(% Point)	
IRF vs. no Medicare-paid institutional care	0.384	0.423	3.996	0.440 **	−3.860	0.981 *
SNF vs. no Medicare-paid institutional care	19.554	0.289 **	16.533	0.285 **	−0.461	0.832
IRF vs. SNF	−19.170	0.212 **	−12.537	0.194 **	−3.399	1.403 *
Post-Acute Payments to post-discharge day 120	($)		($)		($)	
IRF vs. no Medicare-paid institutional care	17,332	101.286 **	17,006	100.1 **	16,602	140.4 **
SNF vs. no Medicare-paid institutional care	10,899	92.630 **	9,946	79.6 **	8,944	146.2 **
IRF vs. SNF	6,433	63.3 **	7,060	80.0 **	7,658	165.6 **
Stroke	Effect	Std. Error	Effect	Std. Error	Effect	Std. Error
Dead at post-discharge day 120	(% Point)		(% Point)		(% Point)	
IRF vs. no Medicare-paid institutional care	2.513	0.158 **	1.818	0.141 **	−2.676	0.420 **
SNF vs. no Medicare-paid institutional care	11.001	0.159 **	6.676	0.147 **	−0.093	0.469
IRF vs. SNF	−8.488	0.163 **	−4.858	0.143 **	−2.583	−0.829 **
Dead or institutionalized at post-discharge day 120	(% Point)		(% Point)		(% Point)	
IRF vs. no Medicare-paid institutional care	12.251	0.254 **	10.448	0.244 **	0.999	0.831
SNF vs. no Medicare-paid institutional care	38.585	0.221 **	29.842	0.234 **	10.341	0.682 **
IRF vs. SNF	−26.334	0.229 **	−19.394	0.223 **	−9.342	−1.448 **
Post-Acute Payments to post-discharge day 120	($)		($)		($)	
IRF vs. no Medicare-paid institutional care	24,219	73.8 **	23,084	94.4 **	22,765	133.5 **
SNF vs. no Medicare-paid institutional care	14,098	68.4 **	12,717	62.9 **	11,505	107.3 **
IRF vs. SNF	10,121	79.7 **	10,368	104.1 **	11,261	167.6 **

Notes: A double asterisk (**) indicates significance at the 0.001 level.

A single asterisk (*) indicates significance at the 0.05 level.