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ABSTRACT

To assess the relative impact of clinical factors versus non-clinical factors – such as post acute care (PAC) supply - in determining whether patients receive care from skilled nursing facilities (SNFs) or inpatient rehabilitation facilities (IRFs) after discharge from acute care. Medicare acute hospital, IRF and SNF claims provided data on PAC choices; predictors of site of PAC chosen were generated from Medicare claims, provider of services, enrollment file, and Area Resource File data. We used multinomial logit models to predict post-acute care use by elderly patients after hospitalizations for stroke, hip fractures, or lower extremity joint replacements. A file was constructed linking Medicare acute and post-acute utilization data for all sample patients hospitalized in 1999. PAC availability is a more powerful predictor of PAC use than the clinical characteristics in many of our models. The effects of distance to providers and supply of providers are particularly clear in the choice between IRF and SNF care. The farther away the nearest IRF is, and the closer the nearest SNF is, the less likely a patient is to go to an IRF. Similarly, the fewer IRFs, and the more SNFs, there are in the patient's area the less likely the patient is to go to an IRF. In addition, if the hospital from which the patient is discharged has a related IRF or a related SNF the patient is more likely to go there. We find that the availability of PAC is a major determinant of whether patients use such care and which type of PAC facility they use. Further research is needed in order to evaluate whether these findings indicate that a greater supply of PAC leads to both higher use of institutional care and better outcomes – or whether it leads to unwarranted expenditures of resources and delays in returning patients to their homes.

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Post-acute care (PAC) was the fastest growing sector of the Medicare program throughout the early to mid 1990s. A number of factors including payment incentives, advances in drug treatments and surgical techniques, and improvements in outpatient care contributed to shorter lengths of stay in acute care hospitals and corresponding increases in PAC use. As increasing numbers of hospitalized patients transfer to PAC, the need to better understand the factors driving such transfers is growing.

Patients can access PAC services in many settings including skilled nursing facilities (SNFs), inpatient rehabilitation facilities (IRFs) and patients' homes with services from home health agencies (HHAs).[1] Each of these settings offers a different level of care. IRFs provide intensive rehabilitation (three or more hours a day of therapy) in an inpatient setting. SNFs can also provide inpatient rehabilitation under the Medicare benefit, although it is generally less intensive than that provided in an IRF (Gage 1999). Home health care agencies provide therapy, nursing care, and assistance from home health aides.

In many instances referrals to these settings are made in the absence of clear clinical criteria that would identify the best PAC setting for maximizing outcomes. Although a limited number of observational studies have explored variations in outcomes across settings for stroke and hip fracture patients, there is a dearth of clinical or health services research that explains which patients are most appropriate for each PAC setting (Kane 2000; Kane 1997; Kramer 1997). Under these circumstances, patients and doctors must weigh a range of clinical and non-clinical factors – such as the perceived quality of care delivered by a PAC provider and its convenience – when making these decisions.

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[1] Services provided in long-term care hospitals, outpatient departments, clinics, or physicians' offices can also be considered post-acute care under some circumstances. Care provided in nursing homes can be provided to patients when they leave the hospital, but it is generally considered long-term care rather than post-acute care.

In addition, admissions to PAC are often guided by a hospital discharge planner and PAC providers play a role in deciding which patients to accept. Although Medicare PAC eligibility criteria are codified in regulations, as a practical matter PAC providers, physicians, and hospitals discharge planners have discretion in interpreting these guidelines. In fact, researchers examining PAC have observed tremendous variation in utilization rates, geographically and by type of discharging hospital (Benjamin 1986; Neu, Harrison and Heilbrunn 1989; Swan and Benjamin 1990; Kenney and Dubay 1992; Schore 1996; Kane et al. 1996; Cohen and Tumlinson 1997; Kane et al. 2002; MedPAC 2003).

All of this suggests that a variety of nonclinical factors are likely to affect where patients go for post-acute care. Previous research has noted the importance of the supply or availability of PAC in an area on rates of use (Swan and Benjamin 1990; Kenney and Dubay 1992; Kane et al. 1996; Cohen and Tumlinson 1997; MedPAC 2003). The objectives of this study are to develop more refined methods of measuring PAC availability and to assess the relative impact of clinical versus non-clinical factors, especially availability, in determining where patients go for PAC services.

Determinants of Post-Acute Care Use

Researchers have found a number of patient-level, provider-specific, and area factors that affect the use of PAC and choice of post-acute care sites. Individual demographic and clinical factors including age, gender, race, marital status, functional status, history of disability, medical condition, and comorbidities influence the sites to which patients are discharged (Neu et al. 1989; Manton et al. 1993; Steiner and Neu 1993; Blewett, Kane and Finch 1995; Kane et al. 1998; Lee et al. 1997; Liu et al. 1998; Gage 1999; Bronskill et al 2002; Finlayson 2002; McCall et al. 2003; MedPAC 2003). The use of PAC is generally positively associated with age and negatively associated with being married, presumably because patients' spouses often serve as informal caregivers (Kane 1994; Liu et al. 1998; Gage 1999; Shatto 2002). Primary and comorbid diagnoses affect decision-making with respect to patient suitability for one site of post-acute care over another. For example, researchers have found that use of post-acute care was highest among people with Alzheimer's and Parkinson's, diseases that require a high level of clinical monitoring and assistance (Liu et al. 1998). Living alone and functional dependency at discharge from inpatient care were also significant predictors of PAC services chosen (Kane et al. 1996; McCall et al. 2003).

Factors beyond patient characteristics also influence use of post-acute care. These include hospital-level predictors such as the volume of Medicare patients served, hospital size, percent low-income patients, ownership, and status as a teaching hospital (Blewett et al. 1995; Neu et al. 1989; Steiner and Neu 1993; Bronskill et al. 2002). Although the effects of these characteristics depend on the condition studied and the patient-level variables included in the analysis, more than one type of study found that discharge from teaching hospitals and hospitals with high Medicare volume was associated with greater use of PAC.

Researchers have also identified a number of area-level predictors of PAC use. For example, researchers have found that higher income communities have higher utilization rates of SNF and home health care (Neu et al. 1989).

Finally, prior research has noted the influence of the supply of PAC on utilization, a finding consistent with research on use of other types of care (Gatsonis et al. 1995; Kane et al. 1996; Pritchard et al. 1998; Fisher et al. 2000). A positive correlation was found between the initiation and extent of home health use and the number of home health agencies in an area and a negative correlation was found between home health use and the number of nursing home beds per capita was found in some, but not all, studies (Swan and Benjamin 1990; Kenney and Dubay 1992; Liu et al. 1998; MedPAC 2003). Characteristics of discharging hospitals that may affect the ease of referrals to PAC, including ownership of a PAC facility, can boost PAC use (Young 1997; MedPAC, 2003).

Although research has noted the effects of PAC supply on post-acute care use, relatively little attention has been paid to the measurement of PAC supply. Prior studies have relied on simple counts of PAC providers and/or counts of PAC beds within geopolitical boundaries such as counties or MSAs, measures that may not capture the variation in accessibility or availability of PAC for beneficiaries within these areas. In this study, we developed a more detailed and comprehensive approach to measuring PAC supply, and we determined which factors most affected the use of PAC services by Medicare beneficiaries in 1999.

Conceptual Framework

We conceptualized the decision to use PAC as a joint decision made by a hospitalized patient, his/her family, and his/her physician(s), and influenced by discharge planners at the acute care hospital and admission staff at PAC sites. Clinicians involved in the decision consider medical and rehabilitation needs when referring some types of patients to PAC, but clinical evidence is not available for all patient types. For those patients falling into “gray areas” in which there are no clinical norms, patient preferences, local practice patterns, PAC availability, and psychosocial factors play stronger roles. Thus, patient and family preferences and circumstances – such as whether or not patients have caregivers at home or are eligible for Medicaid-covered custodial nursing home care -- are likely to influence the decision. In addition, factors such as the experience of the discharge planning staff and the financial pressure on the hospital to discharge the patient quickly may affect PAC use.

Finally, the overall attractiveness of the PAC options in the area and the availability of facilities willing and able to accept the patient come into play.[2] Some areas have many IRFs competing to admit patients, while others have very few. Similarly, there are areas in which SNF beds are rarely vacant and others in which SNFs actively market the range of services they can offer to discharge planners. Hospitals with IRF and/or SNF subproviders might find it easier to place their patients in those related facilities. Patient preferences for receiving care and family close to home can also affect PAC use. Thus, whether or not a patient is referred to PAC is a function of individual clinical characteristics, individual and family circumstances, hospital characteristics, and the availability of PAC.

Drawing on this framework, our overall analytic approach was to define relatively clinically homogenous populations that had high rates of post-acute care use and then build models using the four types of factors hypothesized to influence whether they used institutional PAC and if so, of what type.

Methods

Data Sources. We linked administrative data from Medicare acute hospital, IRF and SNF claims so we could observe choices of institutional PAC by our sample patients. We then drew on Medicare claims data, provider of services file data, enrollment file data, and data from the Area Resource File in generating predictors of site of PAC chosen.

Population Studied. We examined the use of post-acute care by three groups of Medicare patients discharged from acute care hospitals in 1999. We chose to examine 1999 both because

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[2] This framework emerged from our discussions with experts and practitioners familiar with the acute care discharge planning process and PAC admissions.

of data availability and because it is the only recent year during which no new PAC payment systems were implemented. We focused on the three largest patient groups using post-acute care: stroke patients; hip fracture patients; and lower extremity joint replacement patients. Hip fracture was defined using an acute inpatient principal diagnosis of "fractures of the neck of the femur" (diagnosis codes 820.xx). Hip fracture patients whose fractures could be due to metastases to the bone or who suffered major trauma to a site other than a lower extremity were excluded from the sample. Stroke was defined as intracerebral hemorrhage (431.xx), occlusion and sterosis of precerebral arteries with infarction (433.x1), occlusion of cerebral arteries with infarction (434.x1), and acute but ill-defined cerebrovascular disease (436.xx). Lower extremity joint replacement was defined using the diagnosis related groups for joint replacement procedures (209, 471) excluding those patients classified above as hip fracture and those with reattachment procedures 84.26, 84.27 and 84.28.

We excluded certain groups of patients from our analyses. Patients who died in the hospital or within 30 days of discharge were dropped from the sample since their use of PAC was effectively truncated, as were patients for whom we did not have complete claims data.[3] We restricted our sample of discharges to a beneficiary's first discharge for any given condition during 1999. Finally, we excluded patients who were residents of nursing homes at the time of their admission to acute care, since we hypothesized these patients would most likely return to the nursing home after discharge from acute care without considering other PAC alternatives.[4]

[3] The patients without complete data included patients enrolled in HMOs at the time of their admission or within 4 months of their discharge or for whom Medicare was not the primary payer for their acute stay.

[4] Patients were identified as being nursing home residents prior to admission using place of service and CPT codes on physician claims for services delivered to such residents. This measure was developed and validated using residence histories recorded in the Medicare Current Beneficiary Survey and linked acute care and Part B claims. We found the indicator to have a sensitivity of 86.3 percent and a specificity of 95.2 percent in detecting patients who were in nursing homes immediately prior to their acute admission.

Measures. Our dependent variable was the first post-acute care site used after discharge from an acute care hospital. We considered post-acute care use to be IRF or SNF care that began within 30 days of discharge from acute care and was covered by Medicare.[5] We focused on the use of institutional PAC in these analyses because we were unable to distinguish patients returning to their homes from those sent to receive custodial nursing home care – i.e. we did not have data on nursing home stays not paid for by Medicare. (This limitation is discussed further below.) We grouped care delivered in swing beds with SNF care. Each of these types of care was defined using Medicare provider numbers and/or claim types. Patients who were readmitted to the hospital during the 30-day window were kept in the sample but acute care was not counted as a PAC site. Although Medicare rules allow SNF patients to delay entry for more than 30 days after their acute discharge (in order to gain enough strength to undertake rehabilitation) this did not greatly affect our analyses: 97.3 percent of SNF patients in our sample began SNF care within 30 days of discharge if they used it at all.

We assembled, and included as independent variables in our models, a wide array of indicators of clinical, individual, discharging hospital, and PAC supply factors that might affect PAC choices.

<u>Individual Predictors.</u> We identified a number of patient-level characteristics hypothesized to affect use of PAC care and type of PAC used. To allow for non-linear effects of age on PAC use in our models we classified patients into 3-year age bands. We also included gender, race and place of residence (defined as a MSA, an area adjacent to a MSA, or rural area/not adjacent to an MSA) in our analyses. All of these patient-level predictors were created

[5] In addition, care delivered in long term care hospitals (LTCHs) often qualifies as institutional PAC as well. We do not analyze LTCHs here, however, since there are relatively few of them. Less than 0.05% of Medicare patients discharged from acute care use these facilities, and the facilities do not all provide post-acute care. Many LTCHs, for example, serve a primarily psychiatric population (Liu et al. 2001).

using fields on the inpatient claims. In addition, we used the Medicare Denominator file to create indicators for whether patients were receiving Medicaid at the time of their acute admission or within 4 months of discharge. (Those who went on Medicaid soon after discharge were presumed to have been income-eligible for coverage, but not yet enrolled.)

Clinical Predictors. To capture the complexity of patients at the time of hospital discharge we included a large set of comorbidities and complications tailored to our stroke, hip fracture, and joint replacement patients. These were derived from diagnoses on the hospital discharge records. The comorbidities used in our analyses were the chronic conditions identified by Iezzoni et al. (1994) as conditions that are nearly always present prior to hospital admission and hence are extremely unlikely to represent complications arising during the hospitalization. These conditions included 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.

The second type of case mix variable was complications that were likely to have arisen during the hospital. To develop this list, we adapted the list of complications developed by Iezzoni et al. (1994). From that list, we kept only those complications that were likely to have a continued effect after hospital discharge, and therefore to potentially influence the choice of site for post-acute care (e.g., we excluded transient metabolic derangements and side effects of medications). In addition, we augmented the list to include some important complications for the Medicare population that had been omitted from Iezzoni's list. The resulting list of complications 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, dementia, stroke (for hip fracture and joint replacement patients only), and hip fracture (for stroke and joint replacement patients only).

We also created some condition-specific clinical variables . For hip fracture and joint replacement patients we created indicators of the type of replacement the patient received. Hip fracture patients were classified as having no surgery to pin their hip (i.e. hip replacement), a total replacement, a partial replacement, and/or a revision of a previous joint replacement. We also coded the location of the fracture. For joint replacement patients we coded these indicators, whether they were for a hip or knee, and whether multiple replacements were conducted. For stroke patients we created indicators for the type of stroke.

Characteristics of Discharging Hospitals. Patterns of care and approaches to discharge planning in the acute care hospital can influence the PAC use of patients. Accordingly, we included a number of covariates to capture the orientation of acute care hospitals. They include size (average daily census or ADC), teaching status (resident to ADC ratio), ownership status (government, private non-profit, or for-profit), Medicare patient percentage, case-mix index of the hospital, and low-income patient percentage. These measures were created using cost report and provider of service data available from the CMS website. In addition, we created variables that indicate whether the discharging hospital had a related SNF, IRF, or HHA subprovider listed on its cost report, as this could influence the hospital's incentive to discharge to that site.

PAC Availability. We defined availability from a patient-specific perspective based on how close IRFs and SNFs were to patients' homes and how many of each type of facility were within reasonable distances of patients' homes. To construct our measures, we used patient and provider zip code information to measure the distance traveled from patients' residences to IRFs and SNFs. We used geocoding software to calculate distances from the midpoint of each beneficiary's zip code to the midpoint of the closest provider zip code. In addition, we considered the supply of formal substitutes and complements for formal SNF and IRF care. Specifically, we looked at the per elderly supply of nursing home beds and the number of home health agencies in patients' areas of residence. Unfortunately, because our administrative data does not include information on the individual's access to informal or family caregivers, we were restricted to examining the effects of formal PAC supply.

Using the geocoded information, we created two measures of the availability of PAC. The first captures the distance from the patient to the closest provider (separate measures are created for closest IRF and closest SNF.) Both the distance to the closest and the distance squared are included, since the effects of distance on PAC choice are likely diminishing.[6] These variables measure how accessible the provider type is in terms of proximity while also serving as measures of the density of that type of provider in the patient's place of residence. The second measure includes the number of PAC providers of each type within a given radius around the patient's home. We calculated these radii by condition and 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 not biased by the care patterns of patients who might be receiving care far from

[6] We also fit models in which we interacted distance measures with the area type measures in order to allow distances to have different effects across rural versus urban areas. These interaction variables did not appreciably affect the models, so we present the more parsimonious versions.

home due to holidays or other reasons. We also created indicators for areas without any of a given type of provider as the lack of providers would have a strong negative effect on the likelihood of use of that type of PAC.

Our measures of the "supply" of Home Health Agency (HHA) care differed from that used for other PAC locations because HHA markets cannot be defined by patient travel patterns. Instead, we used patient claims data to determine which areas were served by which agencies -- HHAs serving five or more residents within a given county and located in the same state or an adjacent state as those beneficiaries would be counted as serving that county.[7, 8]

Statistical Analysis

We first identified hospitalized hip fracture, stroke, and lower extremity joint replacement patients and then examined how each diagnostic group's sociodemographic and clinical characteristics varied by PAC site used. We also examined how PAC use varied by characteristics of the discharging acute hospital and the area supply of PAC care. We then fit multinomial logistic regression models of the form:

$$\ln \Omega_{m|b}(X) = \ln \frac{\Pr(y = m \mid x)}{\Pr(y = b \mid x)} = x\beta_{m|b}$$

(where *b* was the comparison group, no Medicare-covered institutional care) to see which patient characteristics predicted use of SNF or IRF care after discharge from acute care in a multivariate

[7] These requirements allowed us to correct for a "snowbird effect" that resulted from patients accessing home health services in a geographic location far from their zip code of record due to seasonal residence.
[8] We calculated the correlation between our measures of PAC supply and more typical measures of supply that take into account only the number of providers within patients' counties. As expected, the measures of numbers of providers were positively correlated. However, they were strongly correlated only within MSAs. In addition, our radius-based measures had higher coefficients of variation, suggesting that they are more sensitive to variations in availability.

framework.[9] We also fit "two-level" logistic regression models in which the first level model predicted use of SNF or IRF care vs. no Medicare-paid institutional care and the second level predicted use of IRF vs. SNF care conditional on the use of institutional care. The fit (AIC=170433 for the two-level model and 170543 for the multinomial model) and predictions from these models were virtually identical to those from the multinomial logit models, so for ease of exposition we have presented only the multinomials.

Finally, we assessed the relative importance of clinical factors versus PAC supply factors in the choice of PAC site by simulating how much each set of factors changed the predicted probabilities of using IRF or SNF care. To look at the effect of supply factors on PAC use we computed standardized predictions holding clinical factors constant at their means across all of our observations, and then predicting the odds of using IRF and SNF care for each observation (Lane and Nelder 1982). The resulting distributions of predicted rates of use demonstrate the extent to which supply factors shift patients across PAC sites when clinical factors are held constant. We then computed the same set of predictions holding the supply factors constant at their means but reflecting the effects of the full observed range of values for the set of clinical variables. We compared the predicted distributions of odds of using IRF care, SNF care, or neither under these two scenarios to see which factors most affected the variability in PAC site used.

[9] An alternative analytic strategy would have been to use nested logit models, because of the independence of irrelevant alternatives assumption required with the multinomial logit. We attempted to fit such models, however, we could not estimate them because the only choice-specific attributes of the PAC options available to include in the models were distances from the site to beneficiaries' homes.

Results

Table 1 presents selected descriptive statistics for our three patient groups in 1999 -- overall and by type of PAC accessed. SNF and IRF patients have different personal characteristics. For all 3 conditions, SNF patients tend to be older and are more likely to be female. Patients not using Medicare-paid institutional care are, on average, younger. The hip fracture and stroke SNF patients have greater numbers of comorbidities and complications. In contrast, the hip fracture and stroke IRF patients have fewer comorbidities than the average patient in those groups, including lower rates of coronary artery disease, nutritional deficiencies, and dementia (not shown in tables). Joint replacement patients, however, have similar levels of comorbidities in both IRFs and SNFs. The percentage of dual eligibles in IRFs is lower, and the proportion of Medicaid recipients who do not receive Medicare-paid institutional care is relatively high; these Medicaid patients may, therefore, be using Medicaid-covered nursing home care or home and community-based services rather than their Medicare IRF or SNF benefit. There is a striking relationship between use of PAC and the availability of PAC, which is explored further below.

As seen in the mean distances to nearest provider in Table 1, patients frequently use PAC providers that are far from their homes. Table 2 describes the distribution of distances, in miles, to the nearest IRF provider by condition and area type. The median hip fracture, joint replacement, or stroke patient in a MSA lives approximately five miles from the nearest IRF. Patients must travel further for IRF care when they live outside of a MSA. The median distance from patients' places of residence to the nearest SNF provider, across all areas and all conditions, is always equal to zero.[10] However, the distance to the nearest SNF provider does vary

[10] There are approximately 15,000 SNFs and they are located in over half of the zip codes in the country. Median distance from patient to the nearest SNF provider is, therefore, consistently equal to zero.

considerably: the top ten percent of rural patients not living adjacent to an MSA have to travel over 12 miles to a SNF. The distances that some patients have to travel to reach the closest IRF are significantly greater, exceeding 70 miles for the most remote decile of patients -- and even within MSAs patient regularly receive IRF care more than 20 miles from their homes. Table 3 shows the distribution of the average number of providers within the radii defined by the 90th percentiles of distance traveled.

These relationships generally held when we fit multinominal logistic regressions for choices between PAC sites for the hip, stroke and joint replacement samples -- and additional use patterns emerged. Table 4 presents the results from these logistic regressions. The first column shows the predictors of hip fracture patients using IRF care. The second column shows the factors affecting patients' use of SNFs (versus no Medicare-paid institutional care). A positive coefficient in the IRF column here generally indicates that patients with that characteristic are more likely to be discharged to an IRF than a non- institutional setting, and a positive coefficient in the second column indicates that patients with that characteristic are more likely to go to an SNF. However, because the signs and magnitudes of the effects are difficult to interpret from the multinomial logit regression output, we provide estimates of the marginal effects of these factors in our discussion below. In addition, our simulations results show the combined effects of the supply factors in the models.

The effects of PAC supply factors are strong and similar across conditions. Patients discharged from hospitals with IRF or SNF subproviders are more likely to go to them and less likely to go without institutional care. If all the hip fracture patients in our sample were discharged from a hospital with a related IRF, 34 percent of them would be expected to get IRF care; if none of them were we predict that only 17 percent would get IRF care. (The corresponding figures for stroke patients are 30 and 17, and for joint replacement patients are 41 and 21.) In addition, hip fracture and stroke patients are less likely to seek IRF care if their discharging hospital has a related SNF; for hip fracture patients having a related IRF reduces the probability of using a SNF by 16 percent. Hip fracture and stroke patients are also less likely to get IRF care if they are discharged from a hospital with a related HHA.

The supply of IRFs relative to SNFs and the distance to each type of care are major determinants of which PAC site is used. The greater the number of IRFs in a patient's area, the more likely s/he is to seek IRF care. Conversely, the greater the number of SNFs in a patient's area, the less likely s/he is to go to an IRF. A one standard deviation increase in the number of SNFs in an area increases the probability that a hip fracture patient will use a SNF by 8.8 percent, and reduces the probability of IRF use by 21.4 percent. Interestingly, for all 3 conditions, those patients without IRFs in their area are less likely to use institutional care of either type. Distance to the nearest provider of each type is also important for all three types of patients. As distance to the nearest IRF increases, patients are less likely to seek out IRF services and as the distance to the nearest SNF increases they are more likely to seek IRF care; a one standard deviation increase in the distance to an IRF reduces the predicted probability of IRF use in our hip fracture model by a third and increases the probability of SNF use 11.5 percent. The more nursing home beds in the county, normalized by the number of persons in the county over age 85, the more likely patients were to use IRFs or SNFs, although the significance of this relationship varied across the conditions.

Demographic, clinical, and other hospital and area characteristics remain important in these multivariate analyses. We have summarized the significance of these factors in Table 4. Despite their significance, however, the simulations described below show that these categories of “non-supply” variables in the second part of Table 4 do not always affect discharge destinations as much as the supply factors do.

Our simulations results show the combined effects of the supply factors in the models. Table 5 shows the predicted proportion of patients not using Medicare institutional care, and the predicted proportions using IRFs and SNFs, under three different scenarios. The first sets of rows, labeled “A”, under each condition show the effects of supply factors on the range of predicted probabilities of using each care type. As described above, these were computed fixing all of the non-supply factors, i.e. the sociodemographic, clinical, and hospital characteristics (other than ownership of a PAC provider) at their averages and then re-predicting PAC use for each patient. The range of predicted probabilities in these rows thus reflects only the effects of variation in PAC supply across the country. It shows that a hip fracture patient with average sociodemographic, clinical, and discharging hospital characteristics who lives in an area that puts him/her in the bottom 10th percentile with respect to IRF use – for example an area where there are many SNFs nearby but few IRFs – would have an 8.5 percent chance of going to an IRF, while one living in an area at the 90th percentile would have a 42.3 percent chance of going to an IRF. Holding supply factors fixed, the interquartile range of the probability of getting IRF care is 20.7 percent, of getting SNF care is 18.9 percent, and of getting no institutional PAC is 4.4 percent.

The second sets of rows, labeled “B” under each condition, present virtually the opposite scenarios. In these simulations the clinical complications, comorbidities, and condition-specific covariates vary as they do in the sample, while the other factors in the model (sociodemographic, hospital, and supply) are fixed at their averages. Looking again at the IRF row for hip fracture patients, a patient at the 10th percentile of likelihood of going to an IRF based on his/her complications, comorbidities, and type of fracture would have an 8.8 percent chance of going to an IRF and a 30.4 percent chance at the 90th percentile. (Given the relationships between IRF use and clinical factors described above, hip fracture patients falling at the lower end of the distribution in terms of rates of IRF use include patients with Medicaid coverage and those with complications and/or comorbidities.)

Comparing the interquartile ranges of the predictions holding the non-supply versus the non-clinical factors fixed shows the relative effects of those factors on the odds of use of each PAC location. These comparisons reveal that, for each condition, IRF use is the most affected by variation in factors related to the availability of PAC. Holding clinical factors constant, the odds of IRF use vary more than 20 percent from 12.9 percent at the 25th percentile to 33.6 percent at the 75th for hip fracture patients; the interquartile range for stroke patients is nearly 15 percent. For joint replacement patients variation in supply factors shifts the odds of going to an IRF from 19 percent at the 25th percentile to 43.3 percent at the 75th percentile. This effect is more than three times as large as the 7.4 percent shift for joint replacement patients due to complications, comorbidities, and the type of replacement surgery performed. The probability of not using Medicare-covered IRF or SNF care, on the other hand, is more affected by variation in clinical factors for each condition (e.g. 25 percent versus 5 percent for stroke). SNF utilization shows more variation across conditions, with supply factors affecting the use of SNF care for hip fracture (18.9 percent versus 14.8 percent) and joint replacement (21.7 percent versus 15.3 percent) patients more than the clinical ones.

Discussion

The availability of PAC is a major determinant of whether patients use such care and which type of PAC facility they use. The effects of distance to providers and supply of providers are particularly clear in the choice between IRF and SNF care. The farther away the nearest IRF is, the less likely a patient is to go to an IRF. The farther away the nearest SNF is, the more likely the patient is to go to an IRF. Similarly, the more IRFs there are in the patient's area the more likely the patient is to go to one and the more SNFs there are the less likely the patient goes to an IRF. In addition, if the hospital from which the patient is discharged has a related IRF subprovider the patient is likely to go to an IRF; and if the discharging hospital has a related SNF subprovider the patient is more likely to go to an SNF. In fact, our simulations showed that PAC availability was a more powerful predictor of IRF and SNF use than the clinical characteristics in many of our models.

The major limitation of this study is that there could be other, unmeasured factors that are affecting choice of PAC site. In particular, we are unable to observe whether patients used non-Medicare nursing home care after their acute stay.[11] Thus, we are unable to distinguish those patients going to nursing homes (paid for by Medicaid or the patients themselves) from those patients returning to their homes. In addition, there may be other aspects of PAC supply – for example, the number of unoccupied nursing home beds – that affect PAC use. Unmeasured clinical factors, such as level of functioning, and sociodemographic factors, such as availability of caregivers, also affect PAC choices (Inouye et al. 2003). If it had been possible to include these other characteristics they might well have produced a stronger set of predictors – and perhaps one that was stronger relative to our set of supply factors. In addition, there could be important aspects of patient behavior or demand that affect the use of PAC, and that may even affect the supply of PAC in an area. Our models did, however, include numerous patient and PAC supply factors that affected choice of initial site of post-acute care.

[11] While our indicator of nursing home residence was precise enough to exclude patients likely residing in a nursing home prior to their admission to the hospital, it was not precise enough to pinpoint which patients went to nursing homes for stays not covered by Medicare after discharge from acute care.

While some might conclude that this evidence of higher utilization of services in areas with a greater supply of services is inefficient, there is little evidence-based research about post-acute care from which inferences about the appropriate level of PAC use can be drawn. Research is needed, therefore, to evaluate whether these findings indicate that a greater supply of PAC leads to both greater use of institutional care and better outcomes – or whether it leads to unwarranted expenditures of resources and delays in returning patients to their homes.

References

Benjamin, A.E. 1986. "State variations in home health expenditures and utilization under Medicare and Medicaid." *Home Health Care Services Quarterly* 7 (1):5-28.

Blewett, L.A., R.L. Kane, and M. Finch. 1995. "Hospital Ownership of Post-Acute Care: Does it Increase Access to Post-Acute Care Services?" *Inquiry* 32: 457-467.

Bronskill, S., S. Normand, and B. McNeil. 2002. "Post-Acute Service Use Following Acute Myocardial Infarction in the Elderly." *Health Care Financing Review* 24 (2): 77-90.

Cohen, M.A. and A. Tumlinson. 1997. "Understanding the State Variation in Medicare Home Health Care: The Impact of Medicaid Program Characteristics, State Policy and Provider Attributes." *Medical Care* 35 (6): 618-633.

Finlayson, M. 2002. "Changes predicting long-term care use among the oldest-old." *Gerontologist* 42 (4): 443-53.

Fisher, E. S., J.E. Wennberg, T.A. Stukel, J.S. Skinner, S.M. Sharp, J.L. Freeman, & A.M. Gittelsohn. 2000. "Associations among hospital capacity, utilization, and mortality of US Medicare beneficiaries, controlling for sociodemographic factors." *Health Services Research* 34 (6), 1351-1362.

Gage, B. 1999. "Impact of the BBA on Post-Acute Utilization." *Health Care Financing Review* 20 (4): 103-126.

Gatsonis, C. A., A.M Epstein, J.P. Newhouse, S.L. Normand & B.J. McNeil. 1995. "Variations in the utilization of coronary angiography for elderly patients with an acute myocardial infarction. An analysis using hierarchical logistic regression." *Medical Care* 33(6): 625-642.

Iezzoni, L.I., J. Daley, T. Heeren, S.M. Foley, E.S. Fisher, C. Duncan, J.S. Hughes, G.A. Coffman. 1994. "Identifying complications of care using administrative data." *Medical Care* 32 (7): 700-715.

Inouye, S. K., S.T. Bogardus, G. Vitagliano, Jr., M.M. Desai, C.S. Williams, J.N. Grady, & J.D. Scinto. 2003. "Burden of illness score for elderly persons: risk adjustment incorporating the cumulative impact of diseases, physiologic abnormalities, and functional impairments." *Medical Care* 41 (1): 70-83.

Kane, R.L., W.C. Lin, L.A. Blewett. 2002. "Geographic variation in the use of post-acute care." *Health Services Research* 37 (3): 667-682.

Kane, R. L., Q. Chen, M. Finch, L. Blewett, R. Burns, & M. Moskowitz. 2000. "The optimal outcomes of post-hospital care under medicare." *Health Services Research* 35 (3): 615-661.

Kane, R. L., Q. Chen, M. Finch, L. Blewett, R. Burns, & M. Moskowitz. 1998. "Functional outcomes of posthospital care for stroke and hip fracture patients under medicare." *Journal of the American Geriatrics Society* 46 (12): 1525-1533.

Kane, R.L. 1997. "Improving outcomes in rehabilitation. A call to arms (and legs)." *Medical Care* 35 (6 Suppl): JS21-7. Review.

Kane, R.L., M. Finch, L. Blewett, Q. Chen, R. Burns, & M. Moskowitz. 1996. "Use of Post-Hospital Care by Medicare Patients." *Journal of the American Geriatrics Society* 44(3), 242-250.

Kane, R. L., M. Finch, Q. Chen, L. Blewett, R. Burns, & M. Moskowitz. 1994. "Post-hospital home health care for Medicare patients." *Health Care Financing Review*, 16 (1), 131-153.

Kenney, G.M., and L.C. Dubay. 1992. "Explaining Area Variation in the Use of Medicare Home Health Services." *Medical Care* 30 (1): 43-57.

Kramer, A.M., J.F. Steiner, R.E. Schlenker, T.B. Eilersten, C.A. Hrincevich, D.A. Tropea, L.A. Ahmad, D.G. Eckhoff. 1997. "Outcomes and costs after hip fracture and stroke: A comparison of rehabilitation settings." *Journal of the American Medical Association* 277 (5): 396-404.

Lee, A.J., J.H. Huber, and W.B. Stason. 1997. "Factors Contributing to Practice Variation in Post-Stroke Rehabilitation." *Health Services Research* 32 (2): 197-221. (B3, C1, C2, D3)

Liu, K., C. Baseggio, D. Wissoker, S. Maxwell, J. Haley, & S. Long. 2001. "Long-Term Care Hospitals Under Medicare: Facility-Level Characteristics." *Health Care Financing Review* 23 (2): 1-18.

Liu, K., D. Wissoker, and C. Rimes. 1998. "Determinants and Costs of Post-Acute Care Use of Medicare SNFs and HHAs." *Inquiry* 35 (1): 49-61.

Manton, K. G., M.A. Woodbury, J.C. Vertrees, & E. Stallard. 1993. “Use of Medicare services before and after introduction of the prospective payment system.” *Health Services Research* 28 (3): 269-292.

McCall, N., A. Petersons, S. Moore & J. Korb. 2003. “Utilization of home health services before and after the Balanced Budget Act of 1997: what were the initial effects?” *Health Services Research* 38 (1): 85-106.

Medicare Payment Advisory Commission (MedPAC). 2003. *Report to the Congress: Variation and Innovation in Medicare*. Washington, DC: MedPAC.

Neu, C.R., S.C. Harrison, and J.Z. Heilbrunn. 1989. “Medicare Patients and Postacute Care: Who Goes Where?” RAND Report R-3780-MN. Santa Monica, California: RAND.

Pritchard, R. S., E.S. Fisher, J.M. Teno, S.M. Sharp, D.J. Reding, W.A. Knaus, J.E. Wennberg, & J. Lynn. 1998. “Influence of patient preferences and local health system characteristics on the place of death. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Risks and Outcomes of Treatment.” *Journal of the American Geriatrics Society* 46 (10): 1242-1250.

Schore, J.1996.”Regional Variation in Medicare Home Health: Taking a Closer Look”. Report for the Mathematica Policy Research, Inc.

Shatto, A. 2002. “Comparing Medicare Beneficiaries, by Type of Post-Acute Care Received: 1999.” *Health Care Financing Review* 24 (2): 137-146.

Steiner, A. and C.R. Neu. 1993. "Monitoring the Changes in Use of Medicare Posthospital Services." Report prepared for the Health Care Financing Administration. Santa Monica, CA: RAND.

Swan, J., and A. Benjamin. 1990. "Medicare Home Health Utilization as a Function of Nursing Home Market Factors." *Health Services Research* 25 (3): 479-500.

Young, D.A. 1997. "Post-Acute Care." Paper presented at the Princeton Conference on Medicare Reform.

Table 1. Sample Means by Condition, First Site of PAC

	Hip Fracture				Stroke				Lower Extremity Joint Replacment			
	Overall Mean (std. dev.)	No Medicare Institutional Care	SNF	IRF	Overall Mean (std. dev.)	No Medicare Institutional Care	SNF	IRF	Overall Mean (std. dev.)	No Medicare Institutional Care	SNF	IRF
Supply Measures												
Discharging acute has IRF subprovider	37.9%	35.5%	32.1%	58.7%	37.5%	35.6%	28.5%	55.8%	43.4%	42.8%	28.8%	62.0%
	(48.5)	*(48.8)*	*(46.2)*	*(49.2)*	*(48.4)*	*(48.3)*	*(44.8)*	*(49.7)*	*(49.6)*	*(49.8)*	*(45.1)*	*(48.6)*
Discharging acute has SNF subprovider	55.7%	50.9%	57.5%	53.2%	54.0%	52.2%	56.3%	54.6%	56.0%	49.9%	64.5%	53.7%
	(49.7)	*(49.8)*	*(49.4)*	*(49.9)*	*(49.8)*	*(49.9)*	*(49.5)*	*(49.8)*	*(49.7)*	*(49.9)*	*(47.8)*	*(49.9)*
Discharging acute has HHA subprovider	55.1%	56.4%	55.3%	53.5%	54.5%	54.8%	54.8%	53.6%	53.5%	51.9%	56.2%	52.3%
	(49.6)	*(49.4)*	*(49.6)*	*(49.8)*	*(49.7)*	*(49.8)*	*(49.7)*	*(49.9)*	*(49.9)*	*(50.0)*	*(49.6)*	*(49.9)*
Number of IRFs in radius around residence	9.0	8.2	8.7	10.2	10.1	10.0	10.1	10.3	10.9	10.2	10.8	11.8
	(9.7)	*(9.2)*	*(9.6)*	*(10.1)*	*(10.5)*	*(10.5)*	*(10.6)*	*(10.6)*	*(12.0)*	*(11.7)*	*(12.3)*	*(12.0)*
Number of SNFs in radius around residence	35.0	31.0	35.0	38.0	32.6	31.9	32.9	33.7	43.2	40.6	45.8	43.6
	(39.1)	*(36.6)*	*(38.4)*	*(42.8)*	*(38.4)*	*(38.2)*	*(38.0)*	*(39.7)*	*(46.0)*	*(44.8)*	*(47.7)*	*(45.3)*
Number of HHAs serving county of residence	56.8	45.5	55.1	71.0	60.2	58.6	57.6	67.6	52.2	42.6	53.1	63.8
	(80.5)	*(69.9)*	*(78.9)*	*(90.7)*	*(87.1)*	*(85.9)*	*(83.3)*	*(94.8)*	*(77.9)*	*(68.7)*	*(81.0)*	*(83.8)*
Nearest rehab (miles)	15.4	18.3	16.4	9.9	15.5	16.2	16.9	11.6	16.7	18.6	18.7	11.7
	(24.3)	*(28.5)*	*(23.6)*	*(22.3)*	*(27.0)*	*(28.6)*	*26.6*	*(23.4)*	*(24.0)*	*(24.8)*	*(22.9)*	*(23.7)*
Nearest SNF (miles)	2.0	2.6	1.8	1.8	2.1	2.2	1.9	2.0	2.3	2.7	2.1	1.9
	(5.2)	*(7.5)*	*(4.8)*	*(4.5)*	*(5.4)*	*(6.2)*	*(4.3)*	*(5.0)*	*(5.3)*	*(6.2)*	*(4.8)*	*(4.6)*
Selected Patient Characteristics												
Age (years)	82.4	79.7	83.6	80.7	77.7	76.1	80.8	76.5	73.8	71.6	75.8	74.3
	(8.7)	*(10.9)*	*(8.0)*	*(8.4)*	*(9.4)*	*(9.6)*	*(8.6)*	*(8.8)*	*(8.2)*	*(8.2)*	*(7.7)*	*(7.9)*
Female	0.8	0.7	0.8	0.8	0.6	0.6	0.7	0.6	0.6	0.5	0.7	0.7
Medicaid Coverage	0.2	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.1
Any complications	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
Any comorbidities	0.7	0.7	0.7	0.6	0.8	0.7	0.8	0.8	0.4	0.3	0.4	0.4
Selected Other Characteristics												
Discharged from For-profit Hospital	13.3%	11.7%	12.2%	18.2%	13.5%	13.5%	13.1%	14.3%	12.5%	10.5%	11.6%	16.2%
Nursing Home Beds per resident 85+ in County	0.5	0.5	0.5	0.5	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Number of Observations	185608	27026	121893	36689	226849	104664	72841	49344	233652	87351	80396	66786

Table 2: Distribution of Distance to Nearest IRF or SNF Provider in Miles, By Condition and Area Type

	Hip Fracture				Joint Replacement				Stroke			
	Mean	Median	75th percentile	90th percentile	Mean	Median	75th percentile	90th percentile	Mean	Median	75th percentile	90th percentile
IRF												
MSA	7.9	4.5	10.2	19.3	8.3	5.0	11.0	20.3	8.2	4.4	10.2	19.6
MSA Adjacent	26.3	25.9	34.0	43.8	26.8	25.9	34.4	44.8	26.4	26.0	34.3	43.8
Non MSA	41.0	37.2	54.0	75.1	42.6	38.9	56.2	77.8	39.6	36.1	51.6	71.6
SNF												
MSA	1.2	0.0	1.4	4.5	1.5	0.0	1.9	5.2	1.3	0.0	1.5	4.7
MSA Adjacent	3.1	0.0	5.7	10.4	3.4	0.0	6.4	10.6	3.3	0.0	6.3	10.5
Non MSA	4.3	0.0	5.9	12.9	4.7	0.0	7.1	13.9	4.2	0.0	6.3	12.6

Table 3: Numbers of Providers within Radii around Patients' Residences

	MSA			MSA Adjacent			Non MSA		
	Hip	Joint	Stroke	Hip	Joint	Stroke	Hip	Joint	Stroke
IRF									
mean	6.4	7.0	6.5	6.9	10.2	8.6	15.4	27.6	18.7
standard deviation	(8.7)	(9.1)	(8.7)	(6.8)	(8.8)	(7.8)	(16.4)	(23.6)	(18.3)
SNF									
mean	28.8	28.3	26.3	23.3	40.4	21.2	42.6	108.0	34.1
standard deviation	(37.5)	(37.1)	(35.2)	(23.0)	(32.7)	(21.7)	(51.6)	(97.3)	(45.7)

Table 4: Multinomial Regressions, First PAC Site Accessed After Discharge from Acute Care

	Hip Fracture		Stroke		Lower Extremity Joint Replacement	
	IRF	SNF	IRF	SNF	IRF	SNF
	Multinomial Logit Coefficient *(p-value)*	Multinomial Logit Coefficient *(p-value)*	Multinomial Logit Coefficient *(p-value)*	Multinomial Logit Coefficient *(p-value)*	Multinomial Logit Coefficient *(p-value)*	Multinomial Logit Coefficient *(p-value)*
Discharging acute has IRF subprovider	0.85	-0.22	0.6	-0.4	0.7	-0.7
	0.00	*0.00*	*0.00*	*0.00*	*0.01*	*0.01*
Discharging acute has SNF subprovider	-0.06	0.44	-0.1	0.3	0.01	0.8
	0.01	*0.00*	*0.00*	*0.00*	*0.01*	*0.01*
Discharging acute has HHA subprovider	-0.06	-0.02	-0.04	0.01	0.09	0.10
	0.01	*0.25*	*0.00*	*0.4*	*0.01*	*0.01*
Number of IRFs in radius around residence	0.03	-0.01	0.004	-0.01	0.03	-0.01
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
No IRFs in radius around residence	-0.12	-0.21	-0.03	-0.1	-0.2	-0.3
	0.09	*0.00*	*0.6*	*0.0*	*0.1*	*0.04*
Number of SNFs in radius around residence	-0.01	0.004	-0.001	0.004	-0.003	0.005
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
No SNFs in radius around residence	-0.26	-0.23	0.3	0.02	0.2	-0.06
	0.47	*0.42*	*0.2*	*0.9*	*0.2*	*0.2*
Number of HHAs serving county of residence	0.001	0.001	-0.00001	-0.001	0.0009	0.002
	0.00	*0.00*	*0.9*	*0.0*	*0.00*	*0.00*
NH beds per county resident age 85+	0.41	0.06	0.3	0.2	0.2	0.4
	0.00	*0.29*	*0.00*	*0.00*	*0.04*	*0.04*
Nearest rehab (miles)	-0.02	0.005	-0.01	0.005	-0.01	0.009
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Nearest rehab (miles^2)	0.00004	-0.00001	0.00002	-0.00001	0.00002	-0.00001
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Nearest SNF (miles)	0.01	-0.21	0.01	-0.01	0.001	-0.01
	0.07	*0.000*	*0.00*	*0.00*	*0.00*	*0.00*
Nearest SNF (miles^2)	0.0002	0.0002	-0.00003	-0.00001	0.0002	-0.00001
	0.02	*0.05*	*0.61*	*0.01*	*0.00*	*0.00*
Chi-Sq. tests for joint significance of groups of predictors: All significant at the .0001 level						
Sociodemographic Variables (age, female, race)	3552.3		6651.86		10805.56	
Condition specific clinical attributes	1712.5		592.09		2711.59	
Comorbidities	2295.1		10182.43		1220.03	
Complications	314.8		2210.55		213.78	
Medicaid	84.4		570.61		315.19	
Other Hospital Characteristics	1022.6		850.03		2529.63	
Area and Supply Characteristics	8487.2		6065.14		16791.01	
Number of Cases this Outcome	25,407	67,476	33,059	46,998	44,650	51,650
Total Number of Cases		106,570		149,091		151,168
Pseudo R-squared		0.11		0.10		0.12

Table 5: Simulated Rates of PAC Use By Site

Hip Fracture	Mean	10th percentile	25th percentile	Median	75th percentile	90th percentile	Interquartile Range
A. Predictions allowing only supply factors to vary							
No Medicare-Paid Institutional PAC	11.9%	8.2%	9.4%	11.4%	13.8%	16.6%	4.4%
IRF	23.0%	8.5%	12.9%	19.4%	33.6%	42.3%	20.7%
SNF	65.1%	46.6%	56.2%	67.5%	75.0%	79.6%	18.9%
B. Predictions allowing only clinical factors to vary							
No Medicare-Paid Institutional PAC	13.1%	7.1%	8.2%	10.4%	16.1%	23.2%	7.9%
IRF	21.3%	8.8%	16.7%	22.7%	27.1%	30.4%	10.4%
SNF	65.6%	51.0%	59.0%	66.7%	73.8%	79.3%	14.8%

Stroke	Mean	10th percentile	25th percentile	Median	75th percentile	90th percentile	Interquartile Range
A. Predictions allowing only supply factors to vary							
No Medicare-Paid Institutional PAC	47.4%	43.4%	44.8%	46.9%	49.8%	52.0%	5.0%
IRF	21.9%	12.9%	15.6%	18.8%	30.3%	33.9%	14.7%
SNF	30.7%	20.3%	25.2%	30.8%	36.7%	40.6%	11.5%
B. Predictions allowing only clinical factors to vary							
No Medicare-Paid Institutional PAC	47.7%	25.8%	35.3%	49.7%	60.5%	67.9%	25.2%
IRF	20.9%	11.0%	16.3%	18.6%	23.9%	35.6%	7.5%
SNF	31.4%	14.3%	19.7%	28.5%	39.7%	52.7%	20.0%

Lower Extremity Joint Replacement	Mean	10th percentile	25th percentile	Median	75th percentile	90th percentile	Interquartile Range
A. Predictions allowing only supply factors to vary							
No Medicare-Paid Institutional PAC	34.9%	25.4%	28.9%	33.5%	40.6%	46.5%	11.7%
IRF	30.5%	13.5%	19.0%	27.1%	43.3%	50.4%	24.3%
SNF	34.6%	15.2%	25.6%	32.4%	47.2%	54.6%	21.7%
B. Predictions allowing only clinical factors to vary							
No Medicare-Paid Institutional PAC	38.1%	17.6%	25.9%	37.8%	49.5%	60.0%	23.6%
IRF	28.0%	19.3%	24.1%	28.4%	31.5%	34.1%	7.4%
SNF	33.9%	19.9%	26.1%	33.6%	41.4%	47.8%	15.3%