Payment Systems, Market Factors and Long-Term Care Hospitals

by

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CHAPTER I

Introduction

Long-Term Care Hospitals (LTCHs) have emerged as an important alternative to traditional settings for post-acute care (PAC), such as skilled nursing facilities (SNFs) and inpatient rehabilitation hospitals (IRFs). LTCHs are accredited acute care hospitals and are designed to provide extensive medical and rehabilitative care to chronic, critically ill patients. Hospitals qualify as LTCHs under the Medicare program if they maintain an average length of stay above 25 days among their Medicare patients. Most LTCH patients are admitted from other health care institutions and often come from intensive care units (ICUs) in acute hospitals. These patients tend to have long acute and post-acute stays and suffer from complex medical conditions. LTCHs have historically played a fairly minor role in the health care system, but in recent years have grown in market share, in share of Medicare outlays, and in the sheer number of facilities. The number of LTCHs nearly doubled between 1996 and 2004, and Medicare outlays to LTCHs grew 18% annually from 1996 to 2005, far outpacing growth in outlays to SNFs and IRFs. In 2004, Medicare paid $3.8 billion to the 353 operating LTCHs for care provided during more than 122,000 episodes [29]. In that year, LTCHs were operating in 42 states.

Like conventional PAC providers, demand for LTCH care has flourished since the introduction of Medicare prospective payment system for acute care hospitals because the site of care has shifted away from acute hospitals. Until 1984, the Medicare program paid all providers, acute and post-acute, on a retrospective cost basis; under this system, payment incentives had little effect on where services were performed. With the introduction of the acute hospital prospective payment system, however, the Medicare program gave acute hospitals the incentive to provide shorter stays and discharge patients either to home or to institutional PAC settings earlier than had been the case under cost-based reimbursement. This change in payment incentives, coupled with changes in medical technology and changes in Medicare coverage of PAC services, enabled and encouraged a shift in the site of care from the inpatient setting to post-acute settings [6]. Whereas demand for conventional PAC grew out a need for cost-effective and less intense alternatives to hospital care in general, LTCHs grew out of demand for specialized post-acute services. The modern LTCH emerged in the 1980s as an alternative provider to ICUs in treating long staying, difficult to wean mechanically ventilated patients. Over time LTCHs became a setting where many different types of chronic, critically ill patients could be treated in lieu of prolonged acute hospital stays. LTCHs expanded their treatment focus to include specialization in rehabilitative and mental care, in addition to respiratory care [22].

The purpose of this dissertation is to investigate the market behavior of LTCHs, to examine payment system incentives in post-acute care, and to study substitution between LTCHs and other PAC providers. This work focuses on three specific questions. First, are LTCHs similar to other PAC providers in the patients they treat and the services they provide, and is regional variation in LTCHs' location related to regional variation in health needs? Second, does the eligibility criterion (that LTCHs maintain at least 25 average length of stay) alter how LTCHs change their practice patterns under prospective payment? Finally, do SNFs, LTCHs and IRFs substitute well for each other in the care of prolonged mechanically ventilated patients? In studying these questions, this dissertation addresses some of the gaps in our current understanding of LTCH patients, operations and outcomes.

Recent work has shown the class of LTCHs to be very heterogeneous in their structural characteristics, practice patterns, and patient caseloads. Patients treated in LTCHs span broad classes of diagnoses [22]. Like other PAC stays, LTCH stays following an acute hospital stay are relatively common among patients with stroke, chronic obstructive pulmonary disease, heart failure and shock, hip replacement, septicemia, and having a tracheotomy with ventilator support [26]. LTCHs are generally the most expensive PAC setting: payment rates for clinically similar patients have been as high as 12 times the rates received by other PAC providers under the Medicare program [27].

In general, LTCHs are believed to treat patients with greater disease severity than would be found in SNFs and IRFs, they are believed to have a narrower treatment focus by specializing in respiratory, rehabilitative and mental health care, and they are believed to provide more medically intense treatment than conventional PAC providers. These beliefs, however, are based on a fairly limited body of research on LTCH patients, operations and outcomes. First, research focusing on LTCHs has been largely limited to the study of ventilator patients [12]. Although ventilator patients are thought of as the quintessential LTCH patient, in fact they made of only 10.6% of all LTCH patients in 2004 [29]. Second, the role of LTCHs in the larger context of PAC has not been addressed in research. Research specific to LTCHs, focusing on the ventilator population, does not generally recognize conventional PAC settings as possible alternatives to LTCH care. Analysis in Chapter 4 suggests that this is not the case for all ventilator dependent patients; it is also unlikely to be true for patients with medical conditions more commonly treated in conventional PAC settings. Moreover, broader studies of PAC generally do not fully account for LTCHs. In studies of PAC utilization, PAC provider operations, patient caseloads and outcomes, LTCHs often comprise the 'other' group if they are considered at all. Indeed, studying LTCHs is difficult simply for the reason there are very few stays compared to conventional PAC settings. For example, in 2004, 13% of hospital stays among Medicare beneficiaries were followed by SNF stays; to contrast, just 1% of hospital stays were followed by LTCH stays [28] [27]. Appropriately studying LTCHs requires an over-sampling of patients. Consequently, how LTCHs compare to conventional PAC settings like SNFs and IRFs is not well understood.

Analysis of means in Chapter 2 quantitatively assesses LTCHs' role in PAC markets by identifying similarity in structural characteristics, patient caseloads, and inputs to patient care among LTCHs, SNFs, and IRFs. In addition, regression analysis identifies local market characteristics associated with LTCHs' regional variation. The analysis reveals that LTCHs are more similar to other PAC providers than previously thought. For example, LTCHs devote more nursing to patient care than other PAC providers, but use of therapy is similar to SNFs' use, and far less than IRFs' use. But, LTCHs appear to provide more medically intense treatment than other providers. The analysis also reveals that substitution occurs primarily among LTCHs and hospital-based SNFs and IRFs, rather than freestanding SNFs and IRFs. For example, areas with LTCHs in operation have more LTCH stays following acute hospital stays and fewer hospital based SNF and IRF stays, compared to the national average. Also, LTCHs tend to be located in areas with lower concentration of some types of hospital-based PAC providers. It is possible that LTCHs address an unmet need for relatively intense PAC services in the communities where they locate.

In Chapter 3, the analysis measures the policy effect of Medicare's prospective payment system for LTCH, and tests whether responses to prospective payment are uniform among LTCHs. Prospective payment reimburses providers for patient care using fixed rates per stay according to patients' characteristics. In general, the expected response by health care providers under prospective payment is to provide fewer services and fewer days of care than if they were reimbursed for each service provided. The intent of prospective payment is to create financial incentives for providers to provide cost-effective treatment. The prospective payment system for LTCHs differs from other prospective systems in that hospitals must quality as LTCHs to be eligible for LTCH-PPS payment rate: they must maintain an average length of stay above 25 days among their Medicare patients. This eligibility criterion alters financial incentives among LTCHs with different facility average lengths of stay. While some LTCHs may be able to shorten patient stays under prospective payment without regard to maintaining eligibility, other LTCHs' interest in maintaining their LTCH status may override the financial incentives of prospective payment. LTCHs with baseline average LOS above 32 days shorten patient stays on average by 5.7 days. LTCHs with baseline averages between 25 and 32 days appear to protect their eligibility to the LTCH-PPS payment rates: these LTCHs shorten patient stays by 1.6 days on average. LTCHs with averages below 25 days, those which are directly at risk for losing eligibility, also appear to protect their LTCH status. These LTCHs provide longer stays under prospective payment by an average of 0.1 day. These policy effects are generally robust to regression to the mean and other natural changes in LOS over time.

Finally, Chapter 4 tests how well SNFs, LTCHs, and IRFs substitute for each other in providing care to prolonged mechanically ventilated patients. This study uses an instrumental variables approach to compare patient health and cost outcomes among SNFs, LTCHs and IRFs. Choice of PAC setting is instrumented with measures of proximity: differential distance to LTCHs and IRFs, and the number of SNFs, LTCHs, and IRFs located within 100 miles of patient residence. The analysis suggests that LTCHs outperform SNFs for some patients, but cannot conclude that LTCHs outperform SNFs for all patients. Among some patients, LTCH patients experience mortality rates that are roughly 50% lower than SNF patients. Other study outcomes include PAC complication rates, readmission to acute hospitals, and 6-month follow up costs. The analysis does not find conclusive results on the comparison of IRF and SNF care. In some cases, it appears that IRFs outperform SNFs, but, in general, results are inconclusive. With respect to the relatively generous payment that LTCHs receive to treat patients with prolonged mechanical ventilation during their acute hospital stay, these results suggest that differential payments across PAC setting are not necessarily undesirable, nor inefficient.

CHAPTER II

Long-Term Care Hospitals in Markets for Post-Acute Care: A Descriptive Analysis

2.1 Introduction

Many observers of health care trends have noted the rising importance of the post-acute care (PAC) sector in the U.S. health care system. The Medicare program has experienced tremendous growth in PAC utilization and expenditure since the 1980s. Most of this growth has been among conventional institutional PAC providers, including skilled nursing facilities (SNFs) and inpatient rehabilitation facilities (IRFs). Though accounting for a small portion of Medicare PAC expenditure, the fastest growth in the number of providers, utilization, and payments per stay has been among Long-Term Care Hospitals (LTCHs) [30].

Accredited acute care hospitals can qualify as Long-Term Hospitals (LTCHs) under the Medicare program if they maintain an average length of stay above 25 days among their Medicare patients. Medicare is the principal payer of LTCH services. LTCHs primarily serve long-staying patients, and provide recuperative and rehabilitative care following short-term acute hospital stays. In 2004 there were 353 LTCHs operating in 42 states and 137 U.S. metropolitan areas. The purpose of this analysis is to assess how similar LTCHs are to other providers of recuperative and rehabilitative care following acute hospital stays, and to identify the local market conditions related to where LTCHs locate.

LTCHs are of particular interest to policymakers for reasons beyond the rapid growth among LTCHs. There are, as yet, some important unanswered questions about LTCHs and their operations. LTCHs are widely believed to have a narrower treatment focus than conventional PAC providers. In particular, LTCHs are believed to specialize in treating patients with high disease severity and acuity, to specialize in providing respiratory, rehabilitative and mental health care, and to provide more medically intense treatment than would be provided by SNFs and IRFs. Nevertheless, there is concern that LTCHs are more similar to these providers than our current understanding would suggest. This is of particular concern for the Medicare program, the primary payer of PAC services in the U.S., because the program reimburses, regulates and covers services from LTCHs, SNFs, and IRFs very differently. The more similar these classes of providers are to each other, the greater the potential there is for substitution of treatment services among them, and the more similarly the Medicare program should treat them.

To test whether LTCHs specialize in treating higher severity patients, specialize in respiratory, rehabilitative and mental health care, and whether LTCH care is more medically intense than care provided by SNFs and IRFs, this analysis examines statistical information on the operations of PAC providers. We examine similarity among these classes of providers by looking at patient caseloads, use of nursing and therapy personnel, use of diagnostic and therapeutic procedures in patient care, and service offerings among LTCHs, SNFs, and IRFs. A strong case can be made that substitution occurs primarily among LTCHs and hospital-based SNFs and IRFs, rather than with freestanding SNFs and IRFs. We also find that that LTCH care is more medically intense than other providers', that LTCHs employ more nurses than other providers, but not more therapists. LTCHs also offer some services not offered by other PAC providers.

Another important policy question surrounding LTCHs is whether they add value to the Medicare program and, whether patients who use LTCHs are better off than comparable patients who do not. Although one could ask the same question of any type of medical care, it is particularly apropos to ask this about LTCHs because with so few LTCHs, most U.S. communities do not have one and it is not clear that those communities are worse off because of it. Growth in LTCHs has followed an uneven path, and currently there are several cities with multiple LTCHs in operation but some states without any. To better understand LTCHs' role in health care markets, it is crucial to understand why LTCHs have chosen to locate where they have.

We provide a comparison of population health characteristics and concentration of health care providers in metropolitan areas with and without LTCHs in operation to identify market characteristics related to LTCHs' location. The analysis tests whether LTCHs tend to be located in areas with particular population health characteristics and patterns of health care provider concentration to discern whether they might address unmet demand for health care services. We find that the health characteristics of Medicare beneficiaries are unrelated to LTCH's location. However, LTCHs do tend to locate in areas with higher concentrations of hospitals, general PAC providers, as well as, specialist physicians. In locating in these areas, LTCHs may address a specific unmet need for PAC services that does not express itself in beneficiaries' health characteristics. On the other hand, LTCHs may choose to locate in areas where there is a greater propensity to use post-acute and specialized services that is unrelated to need.

In the next section, we present background on LTCHs, including the historical reasons why LTCH practices are thought to differ so significantly from other PAC providers, and several reasons why their similarity ought to be reassessed. We then describe our approach to comparing LTCH practices to the practices of hospital-based and freestanding SNFs and IRFs, and our approach to comparing the characteristics of markets with and without LTCHs in operation. Section 2.3 presents the comparison of LTCH, SNF and IRF patient caseloads and inputs to care. Section 2.4 presents findings on market characteristics related to LTCHs location. Finally, Section 2.5 summarizes the findings and discusses policy implications.

2.2 Background

Long-Term Care Hospitals are widely believed to differ from other post-acute care providers in three fundamental ways. First, LTCHs are believed to treat patients with higher acuity and disease severity than would typically be found in SNFs and IRFs. Second, LTCHs are generally thought to have a narrower treatment focus than SNFs and IRFs by specializing in treatment for patients requiring respiratory, rehabilitative and mental health treatment. Finally, LTCHs are widely believed to provide more medically intense post-acute care than SNFs and IRFs. These fundamental differences in patient populations and treatment focus would suggest very limited potential for substitution of treatment among LTCHs, SNFs and IRFs.

However, there are several factors related to LTCHs' current operations that suggest LTCHs, relative to SNFs and IRFs might no longer admit higher acuity patients, have a narrower treatment focus, and no longer provide more medically intense treatment. Consequently, there might be greater similarity in operations and greater interchangeability of care provided than is generally recognized. This section presents background on LTCHs, reasons why LTCH practices are thought to differ significantly from other providers, and reasons why similarity ought to be assessed.

LTCHs' history as a niche provider supports the notion that their practices differ significantly from other providers in patients' disease severity, treatment focus, and the medical intensity of care provided. LTCHs are designed to provide very extensive medical and rehabilitative care to chronic critically ill patients. Whereas conventional PAC settings like SNFs and IRFs benefited from a demand for post-acute services for patients with common medical needs, LTCHs grew out of demand for specialized services. The modern LTCH emerged in the 1980s as an alternative provider to ICUs in treating long staying, difficult to wean, mechanically ventilated patients. New construction of LTCHs accelerated once their success in weaning long-term, ventilator-dependent patients was found to be as good or better than traditional ICUs. The oldest LTCHs, which were former tuberculosis and chronic disease hospitals, also changed their treatment focus to accommodate the needs of these and other chronic critically ill patients [16].

Over time LTCHs became a setting where many different types of chronic critically ill patients could be treated in lieu of prolonged acute hospital stays. LTCHs' exclusion from Medicare's prospective payment system (PPS) for acute care hospitals made LTCHs an attractive discharge destination from the perspective of acute hospitals. Financial losses on extremely costly patients could be limited by discharging to these facilities [12]. LTCHs, being reimbursed on costs under the TEFRA program for their Medicare patients, did not face the same financial risk and would have been willing to treat even the most expensive patients.[1] With these incentives, LTCHs expanded their treatment focus to include specialization in rehabilitative and mental health care, in addition to respiratory care. Indeed, Lui et al.

[1]TEFRA: Tax, Equity, and Fiscal Responsibility Act. Under TEFRA, providers were reimbursed based on their incurred costs with fairly weak limits.[27]

(2001) found that, as of 1997, most of the oldest LTCHs (operating before 1984) had a multispecialty focus, where no one specialty area dominated among patients. In contrast, newer LTCHs were found to more frequently have either respiratory- or rehabilitation-focused treatment[22]. Interestingly, much of the growth in LTCHs has been concentrated among those located on the campuses of other hospitals (the so-called 'hospitals-within-hospitals') and among for-profit LTCHs. For-profit LTCHs are often part of larger hospital chains; two for-profit chains, Kindred Health Care and Select Medical Corporation, dominate the industry, each operating in 24 states.

The characteristics of LTCH patients also suggest a relatively high level of acuity, compared to other PAC patients. One study found that more than one half of LTCH patients had more than five diagnoses upon admission to LTCHs, suggesting multiple comorbid conditions. Patients were also found to be less stable at admission than patients admitted to other PAC settings [35].

LTCHs are believed to devote more skilled nursing and therapy to patient care than would typically be found in other PAC settings, suggesting that LTCHs tend to provide more medically intense care than other providers. Treatment for mechanically ventilated patients, LTCHs' quintessential patient, is ideally rehabilitation focused and multidisciplinary, drawing input from nurses, respiratory therapists, nutritionists, as well as physical, speech and occupational therapists [38] [43]. Anecdotal evidence, collected by MedPAC through interviews of LTCH clinicians, suggests that LTCH care consists of active daily physician time, 6 to 10 hours daily of licensed nurse time, and use multidisciplinary teams of specialty nurses, respiratory therapists, as well as speech, occupational and physical therapy in patient care. Interviewed clinicians insisted that LTCHs devote greater skilled labor to patient care than would be found in other PAC settings [27].

Although LTCHs' history gives credence to the notion that LTCHs admit higher severity patients, have a narrower treatment focus, and provide more medically intense treatment than SNFs and IRFs, these notions have not been systematically evaluated. Moreover, there are several reasons why these notions, even if they were once true, may no longer be representative of LTCH practices. Recent changes in how LTCHs are paid under the Medicare program, their uneven geographical distribution across the U.S., as well as a limited understanding of the true scope of LTCH patient caseloads, call into question just how different LTCHs really are from other PAC providers.

Recent changes in financial incentives under the Medicare program no longer encourage LTCHs to treat patients with high expected treatment costs. Patients with high disease severity are likely to be costlier to treat than low severity patients. Under cost-based reimbursement, LTCHs did not take on financial risk when admitting patients. There was neither an incentive to provide cost-effective care, nor a disincentive to treat costly patients. The LTCH prospective payment system (LTCH-PPS) under the Medicare program (introduced in 2002) is intended to give providers a financial incentive to control costs, but may also discourage LTCHs from treating the costliest patients. The LTCH-PPS established the financial incentive for LTCHs to admit patients with relatively low resource needs, so long as they are relatively long staying.[2] The third chapter of this dissertation is an analysis of LTCHs' response to the introduction of the LTCH-PPS; the analysis shows that the majority of LTCHs experienced shorter stays under PPS than under cost-based reimbursement. Stays were shorter for two reasons: LTCHs admitted patients who were likely to have shorter stays, and LTCHs provided fewer days of care. The effect of PPS on LTCH's

[2] LTCHs must maintain an average length of stay above 25 days to remain eligible for the LTCH-PPS under the Medicare program.

practices may mean that LTCHs are no longer willing to be a provider of last resort for very costly patients.

Uneven geographic distribution of LTCHs and their clustering in some metropolitan areas has two implications for their operations. First, uneven distribution suggests that LTCH care replaces care provided in other settings, and therefore, must be somewhat interchangeable. LTCHs are clustered in several metropolitan areas, while most U.S. communities do not have any LTCHs in operation. In communities where there are no LTCHs in operation, patients who would be good candidates for LTCH treatment must seek care in alternative settings. Recent work has found that these patients have longer acute hospital stays than they would if LTCHs were available, and are more likely to use SNF care [27]. In communities where LTCHs have clustered, and there are several in operation, LTCHs are likely compete with each other for patients. Competition for patients may have caused LTCHs to begin admitting patients with lower average disease severity than was true several years ago as they look for stable streams of patients [27]. LTCHs may also compete with SNFs and IRFs for patients who may not have been considered good candidates for LTCH care several years ago.

Finally, most of what is known about LTCH patient caseloads may actually only be relevant for a subset of their patients. LTCHs' quintessential patient-the mechanically ventilated patient-actually only makes up a minority of their caseloads. This study finds that 22% of all LTCH patients have respiratory system diagnoses. Almost none of the literature on LTCH patients, operations, and outcomes considers patients other than those requiring respiratory care [12]. Hence, the conventional wisdom about how LTCH caseloads differ from other PAC providers' caseloads may not represent actual differences.

For these reasons, there is cause to reevaluate our understanding of how similar LTCHs are to other PAC providers.

2.3 Approach

This analysis draws on several different data sources to identify similarities between LTCHs and other post-acute care settings and to identify market characteristics related to the location of LTCHs. First, the 2004 Provider of Service (POS) file, a licensure file maintained by the Centers for Medicare and Medicaid Services, contains detailed information about health care facilities participating in the Medicare and Medicaid programs. Second, the 2004 Area Resource File is a compendium of county-level data from various sources on population, health resources and facilities, and health professionals. Finally, the Medicare Denominator and Inpatient and SNF claims data contain information on acute hospital and post-acute care use among a sample of Medicare beneficiaries during 2004.

This analysis uses two modes of analysis. First, attributes of LTCHs, SNFs and IRFs are compared using information available about hospitals (LTCHs and IRFs) and SNFs in the POS file. We compare means, 25th and 75th percentile values of facility attributes. We also include a subgroup of LTCHs for comparison: those operating before 1984. This cohort of 'old LTCHs' is included to informally test whether the beliefs about how LTCHs differ from other PAC providers may have been driven by differences between older LTCHs and other PAC providers.

In some cases, the comparison of IRFs is limited to freestanding IRFs, about 16% of all IRFs operating in 2004. Unfortunately, only very basic information is available about hospital-based IRFs in the POS file because they are considered units within larger acute care hospitals and reporting is conducted at the acute care hospital level. Patient claims for services provided within these units are identifiable, but we do not have information about treatment setting characteristics specific to the unit. Comparison of SNFs is restricted to include SNFs that participate only in the Medicare program, about 6% of all SNFs. We exclude Medicare/Medicaid SNFs and Distinct Part SNFs because they do not comprise a good comparison group for LTCHs. These facilities provide custodial care to patients in addition to PAC services and the resources devoted to custodial care cannot be differentiated from those devoted to PAC.

To compare patients treated in LTCHs, SNFs, and IRFs we use a 10% sample of Medicare beneficiaries with at least one acute hospital stay during 2004. These beneficiaries' acute hospital stays are matched with subsequent post-acute stays as applicable. By linking these stays, we have detailed information on medical diagnoses and procedures used during both the acute and post-acute stays. We aggregate these data to the facility level and compare the composition of providers' patient base. We characterize patients according to their acute hospital admission diagnosis rather than their post-acute diagnosis in order to help ensure comparing similar sets of patients.

Although many LTCHs are located on the campuses of acute care hospitals ('hospitals-within-hospitals'), we do not separate LTCHs along this dimension for our analyses. The primary reason is that the information is not available in the POS file, and classifying LTCHs as freestanding or hospitals-within-hospitals would be an approximation.

In the second mode of analysis, we conduct regression analysis to estimate the association between patient and market characteristics and LTCH location. For this, we use several different measures of LTCH location. Table 2.1 provides summary statistics on the five measures of LTCH location. First, we calculated the distance from beneficiaries' zip code to the nearest LTCH, and regressed this measure (log transformed) on beneficiary health and hospital stay variables using an OLS model. Second, we counted the number of LTCHs within 100 miles of beneficiaries' residence. We regressed an indicator variable for having any LTCHs within 100 miles on the same set of beneficiary variables using a Logit regression model. Finally, we estimated a Poisson regression model using the number of LTCHs within 100 miles of beneficiary residence and the set of beneficiary variables. With these models, we identify demographic and health characteristics of residents that may attract LTCHs. Beneficiary level data come from the 10% sample of Medicare beneficiaries with at least one hospital stay in 2004.

On the market level, we use two LTCH location measures: LTCHs' share of PAC beds and LTCHs' share of PAC stays. The denominators for these market share measures are the total number of certified beds and total number of stays in LTCHs, Medicare-only SNFs, and IRFs (all stays follow an acute hospital stay). Overall, LTCHs' average share of PAC beds is 10.4% and average share of PAC stays is 11.4%.[3]

For markets we use 'statistical areas' as defined by the Office of Management and Budget. Our markets consist of Metropolitan and Micropolitan Statistical Areas which are part of a larger Combined Statistical Area (CSA), and Metropolitan Statistical Areas which are not part of a larger unit. Metropolitan Areas consist of at least one county and includes the counties comprising the urban core (with populations at least 50,000), as well as the adjacent counties with a high degree of social

[3]Note that the maximum LTCH bed share is 100% (indicating that at least one market has no Medicare-only SNFs or IRFs), but the maximum LTCH share of stays is 95% (indicating that, at most, 95% of PAC stays in any one market occur in LTCHs). The apparent discrepancy between these measures is possible because beneficiaries' use of PAC providers is not limited to the PAC providers in their market. Market definitions do not reflect beneficiaries' PAC use.

Table 2.1: Measures of LTCH Location

Location Measures	Unit of Observation	N	Mean	SD	25th %ile	50th %ile	75th %ile	Max
Distance To Nearest LTCH (miles)	Beneficiary	508,403	40.2	120.3	5.5	12.7	31.1	1,426.4
One or More LTCHs within 100 miles	Beneficiary	508,403	0.9	0.3	1.0	1.0	1.0	1.0
Number of LTCHs within 100 miles	Beneficiary	508,403	8.6	6.0	3	9	14	24
LTCH Share of PAC Beds	Analysis Market	323	10.4%	16.7%	0.0%	0.0%	17.1%	100.0%
LTCH Share of PAC Stays	Analysis Market	323	11.4%	16.6%	0.0%	6.2%	14.6%	94.5%

Source: 2004 Medicare Denominator File, 2004 POS file, 2004 Area Resource File

and economic integration with the urban core. CSAs aggregate adjacent MSAs and Micropolitan Statistical Areas (adjacent and integrated counties with an urban core population 10,000-49,999) when the MSAs and/or Micropolitalan Areas have sufficient social and economic integration. Our analysis markets consist of 323 statistical areas, of which 116 are CSAs and 207 are MSAs. The 323 markets represent 1,326 of the 3,225 U.S. counties. LTCHs operate in 137 of the analysis markets.

The following section presents statistical information on the operations of LTCHs, SNFs, and IRFs. We then move to the analysis of market characteristics and LTCH location.

2.4 Comparison of Facility Operations

This section presents a comparison of patient populations and treatment setting characteristics among LTCHs, SNFs and IRFs. We present comparisons of the patients each PAC setting draws from acute hospitals, patient caseloads treated in each setting, and the inputs to care used in these settings. The purpose is to assess the three stereotypes about LTCHs: that they admit higher severity patients than other PAC providers, that LTCHs have a narrower treatment focus than more conventional PAC settings, and finally, that LTCHs provide more medically intense treatment than other PAC providers.

To begin, Table 2.2 presents basic structural characteristics of LTCHs, SNFs and IRFs operating in 2004 that are used in this analysis. LTCHs are slightly larger institutions than freestanding SNFs and IRFs, on average, and quite a bit bigger than hospital-based SNFs and IRFs. There are a range of control types among PAC providers. Like freestanding SNFs and IRFs, more than half of LTCHs are proprietary, or for-profit, institutions. Hospital-based SNFs and IRFs are primarily non-profit or government operated; these facilities are typically owned and operated together with their host institution. Overall, 8% of LTCHs are government operated. Government-operated LTCHs are concentrated among the oldest LTCHs: nearly half of LTCHs operating before 1984 (and still operating in 2004) continue to be government operated.

LTCHs are not distributed geographically in proportion to the U.S. aged population, the main population served by LTCHs. Table 2.3 shows the distribution of aged persons (2002 population estimate) across Census Divisions, compared to the distribution of PAC providers. One-third of LTCHs are located in the West South Central region, while only 10% of persons over 65 reside in this region. On the other hand, there are disproportionately few LTCHs in Middle and South Atlantic regions, and the Pacific region. IRFs have a geographical distribution that is similar to LTCHs: there are disproportionately many in the West South Central region, and disproportionately few in East and West North Central and Pacific regions (freestanding IRFs), and the New England and South Atlantic regions (hospital-based IRFs). In contrast, the table shows that Medicare-only freestanding and hospital-based SNFs are distributed roughly proportionately to the aged population.

Table 2.2: Structural Characteristics of LTCHs, SNFs, and IRFs

Size and Ownership	All LTCHs	Old LTCHs	FS SNFs	HB SNFs	FS IRFs	HB IRFs
Number of Facilities	353	39	419	463	217	1,111
Number of Beds						
Mean (SD)	69 (87)	198 (185)	56 (42)	24 (17)	64 (40)†	25 (19)
25 & 75%ile	30, 79	96, 215	30, 70	15, 28	38, 82	14, 30
Non-Profit	33%	44% †	46%	70%	33%†	69%
Proprietary	59%	8%	53% †	19%	62%†	16%
Government	8%	49%	1%†	12%†	5%†	15%

Source: 2004 POS File
Note: Old LTCHs include LTCHs operating before 1984.
Note: SNFs are Medicare-only. FS= Freestanding HB= Hospital-Based
Note: † Statistics are not statistically different from All LTCH statistics (5% level).
Other statistics are.

Table 2.3: Aged Population, LTCHs, SNFs, and IRFs by U.S. Census Division

Census Division	Aged Pop	All LTCHs	Old LTCHs	FS SNF	HB SNF	FS IRF	HB IRF
New England	5%	6%	43%	7%	4%	6%	2%*
Middle Atlantic	15%	9%	19%	16%*	14%*	16%*	16%*
East North Central	16%	17%	5%	20%	16%	8%*	21%
West North Central	7%	5%	0%	7%	8%*	4%	7%
South Atlantic	20%	14%	16%	17%	18%	18%	12%
East South Central	6%	6%	0%	5%	6%	8%	5%
West South Central	10%	33%	11%	11%*	9%*	29%	17%*
Mountain	6%	6%	3%	5%	6%	7%	7%
Pacific	14%	5%	3%	13%*	18%*	4%	13%*

Source: 2004 POS file, 2004 Area Resource File
Note: * Statistics are different from All LTCH statistics at the 5% level.
Aged population size is a 2002 estimate.

2.4.1 Patient Base and Caseloads

Nationally, LTCH stays are a relatively rare PAC outcome: only about 1% of hospital stays among all Medicare beneficiaries are followed by an LTCH stay [27]. Owing to the small number of LTCH stays, there is not a very good understanding of what makes patients good candidates for LTCH care. MedPAC (2004) found anecdotal evidence that LTCHs conduct extensive screening and target admissions among patients with high disease severity whose conditions are likely to improve.

This suggests that admission to LTCHs is highly subjective and that LTCHs exercise control over which patients are admitted. MedPAC also found that the strongest predictor of LTCH use is undergoing tracheostomy in an area with a least one LTCH in operation. How the population of patients treated in LTCHs differs from patients using other PAC settings is not well understood, because there are so few predictors of LTCH admission and relatively few LTCH stays.

Therefore, it is useful to consider which patients are likely to use LTCHs for PAC treatment and to compare the characteristics of patients treated in LTCHs to those treated elsewhere. In particular, we are interested in whether LTCHs systematically admit higher severity patients and whether LTCH patient caseloads are more concentrated in their specialty areas than other PAC providers' patient caseloads. Previous work found that many LTCHs serve relatively high proportions of patients with respiratory system or rehabilitation-related medical conditions. A minority of LTCHs also specialize in treating patients with mental health conditions [22]. We use Liu's definitions of these specialty areas. Tables 2.4, 2.5, 2.6 and 2.7 present information to this end.

Tables 2.4 and 2.5 present the use of post-acute care by Medicare beneficiaries following acute hospital stays in 2004 grouped by their acute hospital diagnosis. For each diagnostic category, the tables show the percent of all hospital stays that are followed by a particular PAC outcome (including no PAC). Diagnoses are grouped into the 25 Major Diagnostic Categories. The 'All' columns represent PAC use for each diagnostic category for the total sample of Medicare beneficiaries (a national estimate). The 'LTCH Markets' columns represent PAC use for each diagnostic category in the 137 markets with at least one LTCH in operation.

The first column in Table 2.4 reports the percent of all hospital stays in each diagnostic category which are followed by an LTCH stay. Although only about 1% of all hospital stays are followed by an LTCH stay, LTCH stays occur more frequently among some groups of patients. More than 1% of patients are discharged to LTCHs from acute hospitals among Medicare patients with Burns (MDC 22), Infectious and Parasitic Diseases (MDC 18), Injuries and Toxic Effects of Drugs (MDC 21), HIV/AIDS (MDC 25), Skin and Tissue conditions (MDC 9), as well as Respiratory (MDC 4) and Nervous System conditions (MDC 1).[4]

Interestingly, LTCH stays are not particularly concentrated among patients in the diagnostic categories corresponding to the traditional LTCH specialties: rehabilitation, and respiratory system and mental health conditions. The respiratory care specialty includes only the Respiratory System MDC (MDC 4). Whereas about 1% of all hospital stays are followed by an LTCH stay, only a slightly higher percent, 1.15%, of stays in this MDC are followed by an LTCH stay. The rehabilitative care specialty includes the Nervous System (MDC 1), Musculoskeletal and Connective Tissue MDC (MDC 8), and Factors Influencing Health Status (MDC 23). This last MDC includes screening, aftercare and rehabilitation diagnoses. Only among patients in the Nervous System MDC do LTCH stays occur slightly more frequently than 1% (1.02%). Finally, the mental health specialty includes only the Mental Diseases MDC (MDC 19). Less than 1% of patients in this diagnostic category have LTCH stays after their acute hospital stays. Thus, although recent work found that many LTCHs had patient caseloads concentrated in these diagnostic groups [22], patients in these categories are not relatively likely to use LTCHs over other PAC settings.

[4] It should be noted that, because LTCH stays are overall relatively infrequent events, relatively frequent LTCH stays among beneficiaries in these diagnostic categories does not necessarily imply that having a condition in these diagnostic categories would be predictive of having an LTCH stay in a multivariate regression context.

Table 2.4: Use of Post-Acute Care Following Acute Hospital Stay, by Acute Hospital Major Diagnostic Category

		Post-Acute Care Setting					
		LTCH		FS SNF		HB SNF	
	Acute Admission: MDC	All	LTCH Mkts.	All	LTCH Mkts.	All	LTCH Mkts.
1	Nervous System	1.02%	1.35%	0.74%	1.04%	1.30%	1.27%
2	Eye	0.37%	0.27%	0.37%	0.37%	0.43%	0.27%
3	Ear, Nose, Mouth & Throat	0.74%	1.05%	0.58%	0.81%	0.94%	1.05%
4	Respiratory System	1.15%	1.64%	0.52%	0.73%	1.30%	1.28%
5	Circulatory System	0.47%	0.64%	0.39%	0.55%	0.82%	0.84%
6	Digestive System	0.62%	0.86%	0.48%	0.67%	1.03%	1.02%
7	Hepatobiliary System & Pancreas	0.53%	0.74%	0.28%	0.41%	0.77%	0.74%
8	Musculoskeletal System & Connective Tissue	0.86%	1.24%	1.91%	2.62%	3.90%	3.82%
9	Skin, Subcutaneous Tissue & Breast	1.81%	2.47%	0.60%	0.83%	1.92%	1.89%
10	Endocrine, Nutritional & Metabolic System	0.75%	1.04%	0.63%	0.87%	1.24%	1.30%
11	Kidney and Urinary Tract	0.71%	0.98%	0.55%	0.76%	1.05%	1.03%
12 & 13	Reproductive System	0.19%	0.24%	0.22%	0.28%	0.47%	0.49%
16	Blood & Blood Forming Organs and Immunological Disorders	0.42%	0.58%	0.47%	0.68%	0.81%	0.70%
17	Myeloproliferative & Poorly Differentiated Disorders	0.52%	0.70%	0.21%	0.29%	0.75%	0.65%
18	Infectious & Parasitic Diseases	1.82%	2.39%	0.65%	0.85%	1.57%	1.39%
19	Mental Diseases & Disorders	0.54%	0.73%	0.48%	0.64%	0.75%	0.68%
20	Alcohol/Drug Use or Induced Mental Disorders	0.23%	0.29%	0.15%	0.17%	0.35%	0.25%
21	Injuries, Poison & Toxic Effect of Drugs	1.38%	1.76%	0.69%	0.91%	1.47%	1.43%
22	Burns	2.46%	2.92%	0.98%	1.25%	1.97%	1.67%
23	Factors Influencing Health Status	0.99%	1.32%	1.00%	1.33%	1.70%	1.68%
25	HIV Infection	1.80%	2.15%	0.00%	0.00%	0.23%	0.27%

Source: 2004 Medicare Inpatient and SNF Claims files, 2004 POS file.
Note: 137 statistical areas have at least one LTCH in operation. No cases were found in MDC 14, 15 and 24. MDC 12 and 13 were combined. FS = Freestanding HB = Hospital Based. Note: FS and HB SNFs are Medicare-only SNFs.
Other SNFs include Medicare/Medicaid SNFs and Distinct-Part SNFs.

Table 2.5: Use of Post-Acute Care Following Acute Hospital Stay, Continued

	Post-Acute Care Setting							
	FS IRF		HB IRF		Other SNF		Other/No PAC	
MDC	All	LTCH Mkts.	All	LTCH Mkts.	All	LTCH Mkts.	All	LTCH Mkts.
1	2.68%	3.04%	1.06%	0.92%	16.50%	16.97%	75.53%	74.53%
2	0.61%	0.73%	0.73%	0.64%	8.47%	7.59%	88.12%	89.48%
3	0.33%	0.41%	0.71%	0.67%	8.59%	8.89%	87.19%	86.57%
4	0.53%	0.64%	1.06%	0.81%	13.51%	14.28%	80.55%	79.73%
5	0.57%	0.67%	2.00%	1.71%	8.08%	8.61%	85.68%	85.25%
6	0.41%	0.49%	0.90%	0.62%	10.01%	10.52%	85.60%	85.24%
7	0.29%	0.36%	1.33%	0.90%	7.08%	7.49%	88.21%	88.22%
8	5.99%	7.09%	0.88%	0.80%	26.36%	27.16%	58.42%	56.37%
9	0.58%	0.73%	0.61%	0.49%	15.46%	16.41%	77.89%	76.56%
10	0.54%	0.63%	0.75%	0.61%	17.69%	18.75%	77.37%	76.32%
11	0.47%	0.60%	0.70%	0.50%	16.31%	16.80%	79.22%	78.67%
12 & 13	0.13%	0.20%	0.27%	0.22%	3.57%	4.25%	94.87%	94.15%
16	0.29%	0.35%	0.82%	0.60%	11.64%	12.49%	84.61%	84.00%
17	0.15%	0.17%	0.73%	0.51%	5.14%	5.48%	91.56%	91.65%
18	0.56%	0.68%	1.19%	0.74%	18.72%	19.48%	74.21%	73.68%
19	0.50%	0.53%	0.60%	0.50%	17.33%	16.40%	78.48%	79.30%
20	0.03%	0.00%	0.55%	0.75%	4.89%	4.69%	92.17%	92.33%
21	1.45%	1.73%	0.91%	0.80%	15.16%	15.94%	77.50%	76.47%
22	1.23%	2.08%	1.97%	1.25%	12.04%	11.25%	76.41%	77.08%
23	1.11%	1.31%	0.96%	0.77%	23.99%	24.20%	68.81%	68.48%
25	0.00%	0.00%	0.90%	1.08%	7.66%	7.53%	88.74%	88.71%

Source: 2004 Medicare Inpatient and SNF Claims files, 2004 POS file.
Note: 137 statistical areas have at least one LTCH in operation. No cases were found in MDC 14, 15 and 24. MDC 12 and 13 were combined. FS = Freestanding HB = Hospital Based. Note: FS and HB SNFs are Medicare-only SNFs.
Other SNFs include Medicare/Medicaid SNFs and Distinct-Part SNFs.

The second column of Table 2.4 reports LTCH use among beneficiaries who reside in analysis markets with at least one LTCH in operation. Not surprisingly, LTCH use is higher among beneficiaries who have an LTCH operating in their metropolitan area. Other columns in this table and in Table 2.5, a continuation of Table 2.4, report use of post-acute care in other settings (freestanding and hospital-based SNFs (Medicare-only) and IRFs, other SNFs, and Other or No PAC use) among all patients, and among patients in analysis markets with at least one LTCH. This table shows for which patients LTCH care appears to replace the use of other types of post-acute care.

For most diagnostic categories, greater use of LTCHs in the markets with LTCHs entails lower use of hospital-based SNFs and hospital-based IRFs. For example, in markets with LTCHs, 1.35% of patients in the Nervous System MDC (MDC 1) have an LTCH stay following their acute hospital stay, compared to 1.02% overall. As use of LTCHs increases in markets with LTCHs, the use of hospital-based SNFs and hospital-based IRFs declines from 1.3% (all patients) to 1.27% (markets with LTCHs) and from 1.06% to .92%, respectively. In contrast, the use of freestanding SNFs and IRFs increases among patients in LTCH markets, compared to overall.

The consistency in these trade-offs suggest that substitution primarily occurs between LTCHs and hospital-based providers. For most diagnostic categories, an increased use of LTCH care is matched with a decline in the use of either or both hospital-based SNFs and IRFs. For no set of patients is greater use of LTCH paired with a decreased use of freestanding SNFs, and for only patients with Alcohol-related conditions (MDC 20) does there appear to be a trade-off with freestanding IRFs.

The last two columns in Table 2.5 represent patients with either no PAC following their acute hospital stay, or care provided by other types of providers. Other types of providers include other acute care hospitals and psychiatric hospitals. For many diagnostic classes, fewer patients in the LTCH markets have either no PAC or another type follow-up care, compared to patients overall. This suggests substitution between LTCHs and acute hospitals. The likely story is that having LTCHs available allows acute hospitals to discharge patients who would have otherwise remained in the acute care setting for a prolonged period before eventually returning to the community, with no further institutional PAC treatment. If this is the case, LTCH care may also be similar to care provided in acute hospitals.

To evaluate whether LTCHs admit patients with higher disease acuity and whether their caseloads are concentrated in their specialty areas, relative to other PAC providers, we compare patient caseloads across PAC settings. Tables 2.6 and 2.7 presents the characteristics of patients treated in LTCHs, SNFs and IRFs and suggests two things. First, LTCH patients appear to have somewhat higher disease severity than users of other types of PAC; second, despite differences in disease severity, caseloads appear remarkably similar across PAC settings.

LTCH patients have significantly longer acute hospital stays preceding their LTCH stays than users of other types of PAC. This is true for all LTCHs and for old LTCHs (operating before 1984). One possible explanation is that it takes patients who are ultimately discharged to LTCHs about twice as long for their medical conditions to improve and be stabile enough for transfer to a less intense setting. Longer recovery time suggests greater acuity among LTCH users. LTCH patients also have higher average Charlson Comorbidity Index scores. The Charlson Comorbidity Index is a measure of mortality risk based on a series of conditions that are present along side patients' acute hospital admission diagnosis. Each condition is assigned a score (1, 2, 3, or 6) depending on the mortality risk associated with the condition [36].

LTCH patients, and especially patients treated in old LTCHs, have higher average Charlson scores than other users of PAC. LTCH patients' Charlson scores are most comparable to patients treated in hospital-based SNFs and IRFs, further lending support that these are the primary substitutes for LTCH care. Although averages are higher among LTCH patients, the range of Charlson scores is very similar to these facilities. The 25th and 75th percentile Charlson scores in LTCHs, hospital-based SNFs and IRFs are 1 and 3. Thus, it appears that the types of patients (as measured by their Charlson score) treated in these facilities are quite similar. On the other hand, the table indicates that the distribution of Charlson scores is different in freestanding SNFs and IRFs.

Table 2.7 characterizes LTCH, SNF, and IRF patient caseloads by patients' acute hospital admission diagnosis, again using the Major Diagnostic Categories. LTCH patient caseloads are comprised of relatively many patients with Respiratory System diagnoses (MDC 4), Skin and Tissue conditions (MDC 9), Infectious and Parasitic conditions (MDC 18), and Injuries and Toxic Effect of Drugs (MDC 21). Interestingly, only for the respiratory care specialty do patients in the corresponding MDCs make up a larger percent of patient caseloads in LTCHs than for SNFs and IRFs. Patients in the rehabilitation specialty (MDCs 1, 8 and 23) comprise 23% of LTCH patients, which is lower than freestanding and hospital-based SNFs (42.7% and 39.9%, respectively) and freestanding IRFs (67%). Mental health patients comprise between 0.4% and 0.7% of caseloads across all PAC settings.

Overall, the caseloads among LTCHs, SNFs and IRFs are surprisingly consistent. The top ten most frequent MDCs among LTCH patients account for 93% of all LTCH

Table 2.6: Patient Caseloads in LTCHs, SNFs, and IRFs: Patient Characteristics

	All LTCHs	Old LTCHs	FS SNF	HB SNF	FS IRF	HB IRF
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Patient Characteristics	25, 75%ile	25, 75%ile	25, 75%ile	25, 75%ile	25, 75%ile	25, 75%ile
Charlson	2.15 (1.88)	2.34 (2.26)	1.65 (1.78)	1.85 (1.93)	1.44 (1.58)	2 (1.76)
Comorbidity Score	1, 3	1, 3	0, 2	1, 3	0, 2	1, 3
Acute	14.64 (13.05)	12.56 (14.07)	7.64 (6.62)	7.82 (6.23)	7.09 (13.41)	4.24 (5.39)
Hospital LOS	6, 19	5, 16	4, 9	4, 9	3, 8	1, 5
PAC LOS	26.86 (19.22)	24.91 (22.41)	20.5 (16.84)	11.55 (8.72)	13.41 (7.55)	12.84 (8.34)
	14, 34	11, 31	9, 27	6, 14	8, 18	5, 13

Source: 2004 Medicare Denominator, Inpatient and SNF Claim files, 2004 POS file.
Note: All statistics are statistically different from All LTCH statistics at the 5% level.

cases. Although there are differences in ranking among the ten, these same diagnostic categories account for between 93% and 96% of cases in other settings. More than anything, similarity in caseload suggests that patients in these ten categories are commonly treated in all PAC settings. Whether the treatment patients receive in LTCHs is similar to treatment provided by SNFs and IRFs is a different question, and is investigated below.

2.4.2 Inputs to Care

This section evaluates whether LTCHs provide more medically intense treatment, and devote more skilled labor inputs to care than other PAC providers. The tables compare use of nursing and therapy per certified bed, use of procedures during PAC stays, and services offered by LTCHs, SNFs and IRFs.

To evaluate whether LTCH care is more medically intense than care provided by SNFs and IRFs, we compare the use diagnostic and therapeutic procedures that are provided during PAC stays at LTCH, SNFs and IRFs. Medical procedures reported on patients' claims are categorized into four groups using the Agency for Healthcare Research and Quality's definitions: Minor Diagnostic, Minor Therapeutic, Major Diagnostic, and Major Therapeutic.[5] Major Diagnostic and Therapeutic procedures include any valid operating procedures, and thus indicate invasive procedures with relatively high resource requirements.

Table 2.8 characterizes the use of these four classes of procedures across PAC setting. Use of any type of procedure is more common in LTCHs overall than in other PAC settings, and much more so compared to SNFs. All LTCH patients receive an average of just under two procedures, while patients treated in old LTCHs receive an

[5]Available at: http://www.hcup-us.ahrq.gov/toolssoftware/procedure/procedure.jsp

Table 2.7: Patient Caseloads in LTCHs, SNFs, and IRFs: Major Diagnostic Categories

		All LTCHs	Old LTCHs	FS SNF	HB SNF	FS IRF	HB IRF
Acute Admission: MDC		Percent	Percent	Percent	Percent	Percent	Percent
1	Nervous System	8.2%	12.0%	7.3%	6.1%	13.8%	5.6%
2	Eye	0.1%	0.1%†	0.1%†	0.0%†	0.1%†	0.1%†
3	Ear,Nose, Mouth & Throat	0.5%	0.9%†	0.4%†	0.3%†	0.1%	0.3%†
4	Respiratory System	22.5%	18.7%	12.4%	14.6%	6.7%	13.1%
5	Circulatory System	16.4%	18.3%†	16.6%†	16.4%†	12.6%	46.9%
6	Digestive System	9.7%	7.7%	9.1%†	9.3%†	4.0%	9.1%†
7	Hepatobiliary System & Pancreas	1.2%	1.1%†	0.8%	1.0%†	0.4%	2.0%
8	Musculoskeletal System & Connective Tissue	11.3%	17.5%	30.8%	29.7%	50.6%	7.3%
9	Skin, Subcutaneous Tissue & Breast	6.4%	3.0%	2.6%	3.9%	1.3%	1.3%
10	Endocrine, Nutritional & Metabolic System	3.6%	3.6%†	3.7%†	3.4%	1.7%	2.2%
11	Kidney & Urinary Tract	4.3%	3.6%†	4%†	3.6%†	1.8%	2.6%
12&13	Reproductive System	0.3%	0.3%†	0.4%†	0.4%†	0.1%	0.3%†
16	Blood, Blood Forming Organs & Immunological Disorders	0.8%	0.5%†	1.1%†	0.9%†	0.3%	1.0%†
17	Myeloproliferative & Poorly Differentiated Disorders	0.4%	0.6%†	0.2%	0.3%†	0.1%	0.3%†
18	Infectious & Parasitic Diseases	6.7%	4.2%	2.9%	3.3%	1.3%	2.8%
19	Mental Diseases & Disorders	0.6%	1.6%	0.7%†	0.5%†	0.4%	0.5%†
20	Alcohol/Drug Use or Induced Mental Disorders	0.1%	0.3%†	0.1%†	0.1%†	0.0%	0.1%†
21	Injuries, Poison, & Toxic Effect of Drugs	1.5%	1.2%	0.9%	0.9%	1.0%	0.7%
22	Burns	0.1%	0.0%	0.1%†	0.1%†	0.0%	0.1%†
23	Factors Influencing Health Status	3.7%	3.2%†	4.6%	3.7%†	2.6%	2.3%
25	HIV Infection	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%†
	Total Percent of Ten Most Frequent MDCs in LTCHs	93%	92%	94%	94%	96%	93%

Source: 2004 Medicare Denominator, Inpatient and SNF Claim files, 2004 POS file.
Note: No cases were found in MDC 14, 15 and 24. MDC 12 and 13 were combined.
FS=Freestanding HB=Hospital Based. Ten most frequent MDCs in LTCHs are (in order) MDCs 4,5,8,6,1,18,9,11,23, and 10. † Statistics are not statistically different from All LTCH statistics (5% level). Other statistics are.

Table 2.8: Use and Type of Medical Procedures in PAC Settings

	All LTCHs	Old LTCHs	FS SNFs	HB SNFs	FS IRFs	HB IRFs
No. of Procedures						
Mean	1.88	1.14	0.02	0.52	0.21	1.23
(SD)	(1.85)	(1.53)	(0.22)	(1.01)	(0.76)	(1.67)
25, 75%ile	0, 3	0, 2	0, 0	0, 1	0, 0	0, 2
Minor Diagnostic	19.2%	21.1% †	0.2%	1.9%	3.4%	25.1%
Minor Therapeutic	62.7%	41.2%	1.1%	24.5%	7.2%	30.5%
Major Diagnostic	0.5%	0.0%	0.0%	0.0%	0.0%	0.9%
Major Therapeutic	10.3%	3.4%	0.0%	0.9%	0.2%	7.1%
Sample Size	8,842	1,096	7,262	15,368	13,872	12,993

Source: 2004 Medicare Inpatient and SNF Claim files, 2004 POS file.
Note: Old LTCHs include LTCHs operating before 1984.
Note: † Statistics are not statistically different from All LTCH statistics (5% level).
Other statistics are.

average of just over one procedure. Only hospital-based IRF patients receive more than one procedure on average, and other patients are provided very few procedures.

This table suggests that LTCHs provide more intense treatment than other PAC providers; however hospital-based IRF care is most similar. About 19% of LTCH and 25% of hospital-based IRFs provided at least one Minor Diagnostic procedure, while only about 1% of SNF patients and 3.4% of freestanding IRF patients receive at least one such procedure. To contrast, about 60% of LTCH patients receive at least one Minor Therapeutic procedure, compared to about 30% among hospital-based SNF and hospital-based IRF patients, 7% of freestanding IRF patients and 1% of freestanding SNF patients. Use of Major Diagnostic and Therapeutic is much lower across all settings, but patterns of use reflect the Minor categories. It does not appear that perceived differences in medical intensity of treatment provided by LTCHs and other PAC providers has been driven by old LTCHs. Old LTCHs have lower intensity compared to LTCHs overall, and are more to other PAC providers than LTCHs overall.

Note that to the extent that SNFs and IRFs are less likely to report the use of medical procedures than LTCHs because of differences in payment systems and reporting requirements, these differences may be inflated.

To compare the labor inputs PAC providers devote to patient care, we consider use of RNs, licensed practical or vocational nurses, physician assistants, as well as Occupational, Physical, Speech and Respiratory therapists. Table 2.9 compares the average, 25th and 75th percentile number of these personnel PAC providers employ, per certified bed in their facilities.[6]

On average, LTCHs employ 0.41 RNs per bed, which translates to about 2.5 patients per nurse (assuming 100% occupancy). Consistent with what MedPAC found through site visits, this is greater than the use of RNs in both freestanding and hospital-based SNFs [27]. This is especially true among old LTCHs, who employ an average of 0.66 RNs per bed. However, use of RNs in LTCHs is not significantly greater than in freestanding IRFs. The 25th and 75th percentiles of RN use are also comparable between LTCHs (all and old), hospital-based SNFs, and freestanding IRFs, suggesting that even where there are differences in means, use of RNs is somewhat similar across PAC types. PAC providers use licensed practical or vocational nurses and physician assistants at similar rates.

LTCHs also employ an average of 0.16 and 0.25 (all and old LTCHs) Respiratory Therapists per certified beds (about 6.25 and 4 patients per therapist, respectively, assuming 100% occupancy). Given LTCHs' specialty in respiratory care, it is no surprise that LTCHs use significantly more of this type of input than other PAC providers. However, it is surprising that LTCH use of Occupational, Physical, and

[6] In Table 2.9 and 2.10, hospital-based IRFs are excluded from the comparison. Information about facility characteristics about hospital-based IRFs is very limited in the POS file and does not include labor or services offered.

Table 2.9: Comparison of Inputs to Care

	All LTCHs	Old LTCHs	FS SNFs	HB SNFs	FS IRFs
	Mean (SD) 25, 75%ile	Mean (SD) 25, 75%ile	Mean (SD) 25, 75%ile	Mean (SD) 25, 75%ile	Mean (SD) 25, 75%ile
Nursing & Medical Staff: Per Bed					
Registered Nurses	0.41 (0.7)	0.66 (1.87)†	0.15 (0.46)	0.33 (0.17)	0.36 (0.21)†
	0.19, 0.47	0.19, 0.5	0.05, 0.17	0.22, 0.42	0.22, 0.45
Licensed Practical/ Vocational Nurses	0.22 (0.37)	0.32 (0.95)†	0.2 (0.22)†	0.24 (0.17)†	0.22 (0.55)†
	0.07, 0.29	0.05, 0.24	0.08, 0.21	0.11, 0.34	0.08, 0.27
Physician Assistants	0.001 (0.01)	0.005 (0.01)	0.002 (0.01)†	0.002 (0.01)†	0.004 (0.02)
	0, 0	0, 0	0, 0	0, 0	0, 0
Therapy Staff: Per Bed					
Occupational Therapists	0.04 (0.15)	0.1 (0.43)†	0.03 (0.06)†	0.05 (0.04)†	0.15 (0.33)
	0, 0.04		0.01, 0.04	0.02, 0.07	0.07, 0.18
Physical Therapists	0.04 (0.11)	0.1 (0.31)†	0.04 (0.11)†	0.06 (0.05)	0.21 (0.54)
	0, 0.04	0.01, 0.09	0.01, 0.05	0.03, 0.08	0.08, 0.24
Speech Therapists	0.02 (0.06)	0.04 (0.16)†	0.01 (0.04)	0.01 (0.02)	0.08 (0.22)
	0, 0.03	0, 0.02	0, 0.01	0, 0.02	0.03, 0.08
Respiratory Therapists	0.16 (0.49)	0.25 (1.18)†	n/a	n/a	0.03 (0.04)
	0.02, 0.19	0, 0.09	n/a	n/a	0, 0.06

Source: 2004 POS file
Note: Old LTCHs include LTCHs operating before 1984.
Note: † Statistics are not statistically different from All LTCH statistics (5% level).
Other statistics are.

Speech Therapists is more in line with SNFs' use, than with IRFs

since LTCH treatment for patients has been touted to be very focused on rehabilitation [27]. LTCHs and SNFs employ about one of each of these types of therapists for every 25 patients, while IRFs assign between 4.75 and 12.5 patients per occupational, physical and speech therapist. Our findings on LTCHs' use of nursing and therapy in patients care are consistent with the literature on LTCHs [40]. (Note that LTCH care may be more or less labor intensive with respect to physicians or other medical personnel who are not measured in the POS file data.)

Finally, the services offered by LTCHs are compared to freestanding and hospital-based SNFs and freestanding IRFs in Table 2.10. LTCHs offer a few services—

hospice and dialysis—that are not typically found in other PAC settings. In general, however, services offered by LTCHs closely resemble those offered by freestanding IRFs. LTCHs in the old cohort, however, diverge in the services they offer: many more old LTCHs, as compared to the overall rate, offer psychiatric services, and many fewer offer dialysis and speech therapy. Here, data on the some services offered by SNFs is limited to the presence of a special care unit. To the extent that SNFs provide rehabilitative and respiratory care, hospice and dialysis outside of special care units, these comparisons underestimate similarity between LTCHs and SNFs.

Overall, the comparison of diagnostic and therapeutic procedures suggests that LTCH treatment is most similar to care provided by hospital-based IRFs, but is more medically intense. LTCHs devote more nursing to patient care than other PAC providers, but do not use more therapy. Treatment appears more medically intense in LTCHs than freestanding and hospital-based SNFs; LTCHs provide more medical procedures during stays, use more nursing in their patient care, but use comparable amounts of therapy. Treatment appears slightly more medically intense in LTCHs than in hospital-based IRFs; LTCHs provide more procedures, use more nursing in their patient care, but care in LTCHs appears less rehabilitation focused than in IRFs.

2.5 Market Comparison

Despite strong growth in the number of LTCHs over the last several years, LTCHs remain unevenly located across the U.S. LTCHs are primarily located in the eastern and southern regions. Regional concentration of LTCHs has left some states without any LTCHs in operation, while several cities have multiple facilities. Recent research

Table 2.10: Services Offered by LTCHs, SNFs, and IRFs

Services Offered	All LTCHs	Old LTCHs	FS SNFs	HB SNFs	FS IRFs
Rehabilitation ‡	83%	79%†	3%	4%	96%
Respiratory Care ‡	97%	90%†	1%	1%	89%
Hospice ‡	13%	21%†	1%	0%	5%
Dialysis ‡	74%	28%	0%	0%	40%
Psychiatric Services	29%	97%	75%	58%	35%†
Physical Therapy	98%	97%†	99%†	100%†	100%†
Speech Therapy	96%	67%	97%†	97%†	99%†

Source: 2004 POS file
Note: For SNFs, providing the ‡ services is limited to the presence of a special care unit.
Note: † Statistics are not statistically different from All LTCH statistics (5% level).
Other statistics are.

on LTCHs has offered a few potential explanations for their uneven geographical distribution. For example, regional variation in states' Certificate of Need laws, which regulate new construction of health care facilities and hospital bed conversion, may make certain areas of the country more attractive for LTCH growth than others. That these laws vary across states may encourage growth in some states and not in others. LTCHs may also tend to cluster in larger metropolitan areas because there is sufficient patient concentration to support LTCHs' specialized services [22]. Indeed, growth in LTCHs has not favored non-metropolitan areas.

This part of the analysis takes a closer look at the characteristics of the communities in which LTCHs are located. Beyond state regulations and population size, LTCHs may choose a particular city over another because there is an underlying health need they are able to address. If this were the case, we would expect LTCHs to tend to locate in areas with either worse health characteristics, or specific health characteristics, and lower concentrations of certain types of providers. We find that LTCHs do not appear to locate in areas with particular patterns in health characteristics. Rather, they appear to locate in areas with greater concentration of hospitals and other PAC providers, but lower concentration of hospital-based PAC.

These findings suggest that LTCHs locate where there is a greater propensity to use certain types of acute and post-acute care, but where there are fewer providers of hospital-based PAC services. LTCHs may address an unmet need for this type of provider that is not expressed in population health characteristics.

Patterns in LTCH location with respect to concentration of health care providers also provides insight into how LTCHs' fit into the continuum of health care providers. LTCHs may choose to locate in a particular city over another because there are many of certain types of providers and few of others. Whereas the former suggests that LTCHs play a complementary role, the latter suggests they are able to substitute for (and compete with) other types of providers. We find that LTCHs locate in areas of greater hospital concentration, which suggests LTCHs are complementary to acute hospital care. Locating where there are many hospitals may also provide a referral base of patients. That LTCHs locate in areas of greater concentration of PAC providers, but fewer hospital-based providers suggests that they locate in areas with greater propensity to use PAC in general, and fewer of providers whose services they are able to replace. LTCHs may choose their locations with the intent of being one of just a few suppliers of relatively intense PAC services. Moreover, hospital-within-hospital LTCHs likely compete with other hospital-based providers for space on acute hospital campuses.

2.5.1 Health Characteristics

If LTCHs tend to be located in areas with an underlying health need, we would expect measures of LTCHs' location to be associated with population markers for health care need.

Table 2.11 presents three models testing the association between LTCHs' location and health and hospital stay characteristics among our sample of Medicare beneficiaries with at least one hospital stay in 2004. We use three different tests of this association. First, Model 1 in Table 2.11 is an OLS model where the dependent variable is log distance from all sample beneficiaries' residence zip codes to the nearest LTCH and the independent variables include beneficiary health and hospital stay characteristics. Hospital stay characteristics reference beneficiaries' first stay in 2004. Additionally, we use the total number of admissions during 2004. There are 507,477 beneficiaries represented in the models. Second, Model 2 is a logistic regression where the dependent variable indicates whether there are any LTCHs located within 100 miles of beneficiaries' residence zip code. The odds ratios for the same set of independent variables are presented. Finally, Model 3 is a Poisson regression model where the number of LTCHs within 100 miles of beneficiary residence is regressed upon the same set of independent variables. These three location measures are intended to capture two interrelated components of LTCHs' location decisions: the proximity of LTCHs to beneficiaries, as well as the clustering of LTCHs near beneficiaries. We are interested in whether LTCHs tend to locate and cluster nearer beneficiaries with particular health and hospital stay characteristics. Table 2.1 presents descriptive statistics on location measures.

Overall, there does not appear to be a strong relationship between population health characteristics and LTCHs' location. Although many regression coefficients are precisely estimated, many coefficients are relatively small. This suggests that there is only a weak practical relationship between LTCHs' location and the health and hospital stay characteristics of Medicare beneficiaries. That is, LTCHs do not appear to locate closer to populations with markers of particular health needs or greater disease severity. Moreover, LTCHs do not appear to locate in areas with higher prevalence of hospital admissions in their areas of specialization.

Table 2.11: Regression Models: Patient Health and Hospital Stay Characteristics and LTCH Location

		Model 1			Model 2			Model 3		
		OLS Model			Logit Model			Poisson Model		
		Log Distance to Nearest LTCH			One/More LTCHs within 100 Miles			No. LTCHs within 100 Miles		
Independent Variables		Coeff.	S.E.		OR	S.E.		Coeff.	S.E.	
	Age	0.00	0.00	***	1.00	0.00		0.00	0.00	***
	Patient Sex: Male	0.03	0.00	***	0.96	0.01	**	-0.01	0.00	***
	Acute LOS	0.00	0.00	**	1.00	0.00		0.00	0.00	***
	Current MCR Ent.: DI	-0.10	0.01	***	1.14	0.02	***	0.03	0.00	***
	Original MCR Ent.: DI	0.12	0.01	***	0.77	0.02	***	-0.04	0.00	***
	Current MCR Ent.: ESRD	-0.04	0.04		0.76	0.12	*	0.00	0.01	
	Original MCR Ent.: ESRD	-0.02	0.04		1.14	0.12		-0.01	0.01	
	Race: Black	-0.61	0.01	***	3.21	0.02	***	0.13	0.00	***
	Race: Hispanic	0.13	0.01	***	0.38	0.02	***	-0.20	0.00	***
	Race: Other	-0.22	0.01	***	0.72	0.03	***	-0.10	0.00	***
	Charlson Score	0.00	0.00	**	1.01	0.00	**	0.00	0.00	***
	No. Acute Admissions (2004)	-0.01	0.00	***	1.06	0.00	***	0.02	0.00	***
Acute Admission: MDC										
1	Nervous System	0.01	0.01		1.00	0.02		-0.01	0.00	***
2	Eye	-0.10	0.04	*	0.96	0.11		0.07	0.01	***
3	Ear, Nose, Mouth & Throat	-0.07	0.02	**	1.07	0.07		0.01	0.01	*
5	Circulatory System	-0.01	0.01	*	1.07	0.01	***	0.01	0.00	***
6	Digestive System	-0.01	0.01		1.00	0.02		-0.02	0.00	***
7	Hepatobiliary Sys. & Pancreas	0.07	0.01	***	0.85	0.03	***	-0.03	0.00	***
8	Musculoskeletal System & Connective Tissue	0.02	0.01	**	0.91	0.02	***	-0.05	0.00	***
9	Skin, Subcut. Tiss. & Brst	-0.02	0.01	*	0.97	0.03		0.03	0.00	***
10	Endocrine, Nutritional & Metabolic System	-0.03	0.01	**	1.01	0.03		0.02	0.00	***
11	Kidney & Urinary Tract	-0.01	0.01		0.98	0.03		0.01	0.00	***
12&13	Reproductive System	0.06	0.01	***	0.87	0.04	***	-0.05	0.00	***
16	Blood, Blood Forming Organs & Immuno. Dis.	-0.01	0.02		0.97	0.04		0.01	0.00	**
17	Myeloproliferative & Poorly Differentiated Dis.	-0.02	0.03		0.89	0.08		0.01	0.01	
18	Infectious & Parasitic Dis.	-0.04	0.01		1.12	0.03	**	0.03	0.00	***
19	Mental Diseases & Dis.	-0.12	0.02	***	1.02	0.05		-0.03	0.01	***
20	Alcohol/Drug/Induced Mental Dis.	-0.17	0.03	***	1.23	0.09	*	0.15	0.01	***
21	Injuries, Poison, & Toxic Effect of Drugs	-0.05	0.02	**	1.16	0.06	**	0.01	0.01	*
22	Burns	-0.07	0.09		1.12	0.24		0.04	0.02	
23	Factors Infl. Health Status	-0.10	0.01	***	1.23	0.03	***	0.00	0.00	
24	Multiple & Sig. Trauma	0.34	0.33		0.70	0.78		-0.13	0.10	
25	HIV Infection	-0.50	0.09	***	1.54	0.33		0.09	0.02	**

Source: 2004 Medicare Inpatient and SNF Claim files, 2004 POS file.
*** p-value <0.0001, ** p-value <0.01, * p-value<0.1

For example, a one-year increase in age is associated with a 0.2% decline in the distance to the nearest LTCH (Model 1), suggesting that LTCHs tend to locate nearer slightly older populations (holding all else constant). Model 2 indicates no significant relationship between age and beneficiaries' likelihood of having any LTCHs within 100 miles. The Poisson model (Model 3) suggests that the number of LTCHs within 100 miles increases slightly with age: for each one-year increase in beneficiary age we would expect to see 0.2% more LTCHs within 100 miles, holding other variables constant. The average number of LTCHs within 100 miles is 8.6; a 0.2% increase in the average number of LTCHs is equal to 0.017 LTCHs.

LTCHs appear to be located in areas where a higher percentage of Medicare beneficiaries are female, minority (Race: Black and Race: Other), and fewer beneficiaries eligible for Medicare through the Disability benefit. Beneficiary race has the strongest relationships with LTCH location: Black beneficiaries and beneficiaries of other races live closer to LTCHs than whites and hispanics; black beneficiaries are more likely to have at least one LTCH within 100 miles; and, LTCHs appear to cluster nearer black beneficiaries. The converse is true of hispanic beneficiaries: they tend to live further from their nearest LTCHs, are less likely to have any LTCHs within 100 miles, and, LTCHs do not appear to cluster in areas with more hispanic beneficiaries. Weaker relationships can be seen between LTCH location and beneficiaries' type of eligibility for Medicare (the reference group are beneficiaries only eligible through the Aged and Survivor benefit). Beneficiaries ever eligible through the Disability benefit tend to live further from the nearest LTCH than Aged and Survivor beneficiaries. Consistent with that, ever Disabled beneficiaries are less likely to have any LTCHs within 100 miles, and LTCHs do not appear to cluster in areas with more disabled beneficiaries.

The negative association between distance to nearest LTCH and having ever been eligible through the ESRD benefit is not statistically significant, but these beneficiaries are less likely to have any LTCHs within 100 miles than Aged and Survivor beneficiaries, and, holding all else constant, have an average of 2.3% fewer LTCHs within 100 miles than the reference group.

Another dimension of population health needs includes markers for disease severity among hospital users. If LTCHs locate where there is an underlying health need they are able to address, they might be expected to locate in areas with greater disease severity. To test this association, we consider the association between LTCH location and beneficiaries' acute hospital length of stay, Charlson Comorbidity Index score, and the number of acute hospital admissions in 2004. We also test whether LTCHs tend to locate near populations with diagnoses matching their specialties (respiratory system conditions, rehabilitation-related conditions, and mental health conditions). We use Liu's classification of Major Diagnostic Categories into LTCH specialty areas, and test whether LTCHs tend to locate near beneficiaries with hospital admission diagnoses (grouped into Major Diagnostic Categories) in these specialty areas.[7] If LTCHs address an underlying health need in the communities where they locate, one might expect LTCHs to choose communities where a relatively high proportion of Medicare-covered acute hospital stays fall into these classes of medical conditions.

Measures of disease severity (acute hospital length of stay, Charlson Comorbidity Score, and number of acute admissions in 2004) display a faint relationship with LTCH location measures. These relationships suggest that LTCHs weakly favor areas where Medicare beneficiaries experience longer, more complex, and more frequent hospital stays. However, the practical significance of these associations is limited in

[7] The full set of MDCs are included in the model for completeness. The reference category is Circulatory System conditions.

that stays are longer only by a fraction of a day on average, only minimally more complex, and occur only slightly more often.

LTCHs also do not appear to systematically locate near patients with acute hospital admissions related to the LTCH specialty areas. They tend to locate in areas with slightly lower rates of respiratory system conditions (MDC 4); beneficiaries with these conditions are slightly less likely to have any LTCHs within 100 miles, and, among those with any LTCHs within 100 miles, there tend to be fewer. The reference group includes beneficiaries with Circulatory System conditions (MDC 5). The same associations can be found in two of the three rehabilitation specialty MDCs (Nervous System conditions (MDC 1) and Musculoskeletal System and Connective Tissue (MDC 8)). Only for Factors Influencing Health Status (MDC 23, in the rehabilitation specialty), and the mental health specialty (MDC 19) do LTCHs tend to be located nearer beneficiaries with these conditions. Holding all else constant, beneficiaries with these conditions live 9% and 11% closer to the nearest LTCH, respectively. Beneficiaries with conditions in MDC 23 are 16% more likely than the reference group to have at least one LTCH within 100 miles, but LTCHs do not appear to cluster near beneficiaries with either condition.

2.5.2 Concentration of Health Care Providers

If LTCHs tend to be located in areas with an underlying health need that LTCHs are able to address, we would expect LTCH location to be negatively associated with other types of health care providers that address those health needs. This section presents the association of LTCH location with concentration of different types of health care providers.

To evaluate whether LTCHs are attracted to areas with higher or lower concentration of other health care providers, we estimated regression models of association between provider concentration and measures of LTCHs' location. LTCHs' presence is measured with the LTCH share of total PAC beds and the LTCH share of PAC stays in a statistical area.[8] Table 2.1 shows descriptive statistics on these measures. Rather than using the raw number of physicians, hospitals, and PAC providers, we use physicians per aged person, hospitals per 1,000 aged persons, and PAC providers per 1,000 aged persons. Population estimates are from 2002. There are 318 statistical areas represented in each model. Models 4 and 5 use the full set of independent variables in regressions with the two market share variables, share of beds and share of stays. Models 6 and 7 use an abbreviated set of independent variables with the two market share variables.

The multivariate models presented in Table 2.12 suggest that LTCHs locate in areas with greater concentration of some types of hospitals, PAC providers, and physicians. These patterns suggest that LTCHs tend to locate in areas with greater propensity to use non-general inpatient services and PAC services. There may be health needs in these communities that LTCHs are able to address (that were not captured in the above analysis). On the other hand, communities with greater propensity to use certain types of services may be financially lucrative.

LTCHs tend to be located in areas with higher concentrations of some types of hospitals. Although there is a negative association (not significant) with short-term general hospitals, LTCHs tend to locate where there are more short-term non-general hospitals, all types of long-term hospitals, and chronic disease hospitals. This relationship can be seen in Models 4 and 5, modeling the two measures of LTCH market share (beds and stays) with provider concentration. The positive association of LTCH location with hospital concentration is not surprising given

[8] Total PAC beds is the sum of SNF (Medicare-only), IRF, and LTCH beds.

a few characteristics of LTCHs. Growth in LTCHs has been concentrated among the hospitals-within-hospitals and it is not surprising that LTCHs would cluster in areas with greater opportunity to locate on hospital campuses. Moreover, LTCHs rely on hospitals in their communities (hosts or otherwise) to provide a referral base of patients. The majority of LTCH admissions come from hospitals and other institutional settings, rather than from the community. LTCHs in areas with lower hospital concentrations may be uncomfortably dependent on a few referral sources.

The relationship between LTCHs' location and other PAC providers appears to be mixed. For many types of providers (SNFs, hospital-based SNFs, IRFs, nursing facilities, and hospice providers), the association with LTCHs' share of PAC beds is positive, while the association with LTCHs' share of PAC stays is negative, or vice-versa. In many cases, the results are not significant at conventional levels. Nevertheless, LTCHs do appear to have the strongest market share in areas with greater concentration of IRFs (Models 5 and 7) and Home Health providers (Model 6). This suggests that LTCHs locate in areas where there is greater propensity to use these kinds of services.

Finally, LTCHs market share appears to be negatively associated with the total number of physicians per elderly person, but positively associated with the number of specialists per elderly person (Models 4 and 6). Again, it appears that LTCHs tend to locate in areas with greater propensity to use specialized services.

2.6 Conclusion

The purpose of this analysis was to assess how similar LTCHs are to other PAC providers and to identify market characteristics related to LTCHs' location. We find that LTCHs are more similar to SNFs and IRFs that the current literature on LTCHs

Table 2.12: Regression Analysis: Concentration of Health Care Providers

	Model 4			Model 5			Model 6			Model 7		
	LTCH Market Share: Beds			LTCH Market Share: PAC Stays			LTCH Market Share: Beds			LTCH Market Share: PAC Stays		
Independent Variables	Coeff.	S.E.		Coeff.	S.E.		Coeff.	S.E.		Coeff.	S.E.	
Intercept	0.052	0.030	*	0.096	0.031	***	0.058	0.032	*	0.092	0.031	***
Short-Term General Hospitals	-0.010	0.017	*	-0.006	0.018							
Short-Term Non-General Hospitals	0.136	0.033	***	0.130	0.035	***						
Long-Term Hospitals	0.087	0.047	*	0.020	0.049							
Veterans Hospitals	0.079	0.067		0.111	0.070							
Psychiatric Hospitals	-0.092	0.057		-0.072	0.060							
Chronic Disease Hospitals	2.241	0.399	***	-0.010	0.417							
Skilled Nursing	0.006	0.006		-0.003	0.006		0.005	0.006		-0.006	0.006	
HB Skilled Nursing	0.000	0.004		-0.003	0.004		0.001	0.004		-0.002	0.004	
Inpatient Rehabilitation	-0.020	0.024		0.023	0.025		-0.007	0.024		0.047	0.024	*
HB Inpatient Rehabilitation	0.001	0.004		0.015	0.005	***	-0.001	0.005		0.014	0.005	***
Nursing	-0.020	0.013		0.009	0.013		-0.013	0.014		0.014	0.013	
Home Health	0.012	0.009		0.001	0.009		0.019	0.009	**	0.008	0.009	
HB Home Health	-0.001	0.006		-0.001	0.007		0.000	0.007		-0.001	0.007	
Hospice	0.009	0.018		-0.024	0.019		0.017	0.019		-0.016	0.018	
HB Hospice	0.005	0.006		-0.009	0.006		0.007	0.006		-0.009	0.006	
Total Active MDs	-0.744	0.349	**	-0.149	0.366		-0.744	0.342	**	0.003	0.337	
Total Specialists	1.824	0.937	*	0.322	0.980		1.919	0.934	**	0.030	0.920	
F-Statistic	5.22			3.05			1.97			2.6		
Pr > F	<.0001			<.0001			0.0312			0.0035		
Adj. R-Squared	0.1845			0.0996			0.0325			0.053		

Source: 2004 POS file, 2004 Area Resource file
*** p-value <0.0001, ** p-value <0.01, * p-value<0.1

would suggest, but do differ in some important ways from more conventional PAC providers. Despite these differences, it appears that LTCHs replace services that would have been delivered by other PAC providers. Finally, our results suggest that LTCHs may address an unmet health need in the communities where they locate.

The comparison of patient caseloads and inputs to care among LTCHs, SNFs and IRFs suggests that patients treated in LTCHs are similar to patients treated in other PAC settings, and treatment is not as different from other providers as the literature on LTCHs would suggest. Patients appear to have higher disease severity than patients using SNFs and IRFs, but caseloads are surprisingly consistent across PAC setting. This consistency suggests that LTCHs, SNFs and IRFs treat patients with similar clinical needs. However, the inputs-to-care analysis suggests that LTCH treatment is more medically intense than care in other settings, but less rehabilitation focused.

Comparison of markets with and without LTCHs in operation indicates that LTCHs may address an unmet need in the communities where they locate. LTCHs tend to be located in areas with greater concentration of hospitals and some types of PAC services. These areas appear to have greater propensity to use acute and post-acute services. Greater propensity to use acute and post-acute services does not appear to be systematically related to the health characteristics among Medicare beneficiaries, but, unmet need may not express itself through the health characteristics measured here.

There is strong evidence that LTCHs substitute for hospital-based SNFs and hospital-based IRFs. Comparison of PAC utilization patterns in markets with LTCHs to all markets indicates that there is a trade-off between LTCH utilization and utilization of hospital-based SNF and IRFs. That LTCHs tend to located in markets with fewer hospital-based PAC providers also supports this notion. LTCHs may choose to locate where markets are not saturated with other providers of relatively intense PAC, where there are fewer competitors for both space in acute hospitals for their operations (for hospitals-within-hospitals) and patients to admit for care.

There are important policy implications of greater similarity and substitution between LTCHs and other PAC services than was previously believed. Fairness dictate that providers, who treat similar types of patients, provide relatively similar treatment and appear to substitute for each other, ought to be reimbursed and regulated in a similar fashion. This study finds the greatest substitution among LTCHs, hospital-based SNFs and hospital-based IRFs. The greatest similarity in treatment was found between LTCHs and hospital-based IRFs. Whereas current policy reimburses and regulates LTCHs separately from all SNFs and all IRFs, this study suggests that it may be more appropriate to consistently reimburse and regulate LTCHs, hospital-based SNFs and hospital-based IRFs together.

In conclusion, this analysis presents a comparison of LTCH, SNF and IRF operations and the local market characteristics of LTCHs' location. The purpose of this analysis is to identify similarities in patients and operations. These similarities can be used to inform future Medicare policy on how PAC providers are regulated and reimbursed.

CHAPTER III

Long-Term Care Hospitals under Prospective Payment: Do Medicare's Payment Rules Affect how Hospitals Respond?

3.1 Introduction

In recent decades, Long-Term Care Hospitals (LTCHs) have emerged as an important alternative provider to short-term hospitals for lengthy inpatient stays. LTCHs have benefited from the growing reliance on post-acute services by Medicare beneficiaries. The number of LTCHs increased from about 80 in the early 1980s to 375 in 2005 and Medicare outlays increased from $1.7 billion in 1999 to $4.6 billion in 2005. [29]. While LTCHs were able to thrive under cost-based reimbursement much longer than most health care providers, rapid growth in Medicare outlays to LTCHs during the 1990s prompted similar payment system reforms used in the Medicare program for other providers. This study considers how LTCHs have changed their practices under prospective payment. The Medicare prospective payment system used to reimburse LTCHs (LTCH-PPS) differs fundamentally from other Medicare payment systems in that hospitals must qualify for the special LTCH payment rates. This eligibility criterion alters the financial incentives facing LTCHs. Of interest in this analysis is whether differing financial incentives among LTCHs drives varying responses to prospective payment. Understanding how practice patterns differ among LTCHs is an important piece of monitoring quality and access to care in the

Medicare program.

Long-Term Care Hospitals are specialty care providers, primarily serving long-staying patients with complex medical conditions. The Medicare program defines them as accredited acute care hospitals with average lengths of stay (LOS) above 25 days. Since the inception of the inpatient prospective payment system (IPPS) for short-term hospitals in the early 1980s, Medicare has maintained a separate payment system for LTCHs and required that hospitals qualify as LTCHs. At the time of IPPS implementation, it was believed that paying these hospitals the same payment rates as short-term hospitals would threaten their financial viability and ability to treat patients with the appropriate treatment intensity [20]. For this reason, qualifying as an LTCH excludes the hospital from the Medicare IPPS.

Because Medicare has used unique mechanisms to govern payment to LTCHs, their payment system offers a good setting with which to study certain nuances of financial incentives. The Medicare payment system for LTCHs consists of two components. The first component is the system's reimbursement methodology. Beginning in October 2002, payment for LTCH services changed from cost-based reimbursement to a prospective system, paying predetermined rates for each hospital stay according to patient and hospital characteristics. The LTCH-PPS uses many of the same Diagnosis-Related Groups as the IPPS to characterize patients, but reimburses at different rates. The second component of LTCHs' payment system is the requirement that hospitals qualify as LTCHs. To qualify, hospitals must maintain an average LOS above 25 days; this threshold is henceforth referred to as the LOS criterion. A hospital may lose its eligibility to the LTCH payment rates if its average LOS falls below 25 days and would be reimbursed for inpatient stays according to the IPPS payment rates. Average LOS is assessed at the end of each LTCH's fiscal year. In 2003, the difference between base payment rates in the IPPS and the LTCH-PPS was about $30,000 [1] [2]. This large difference in payment rates reflects the relative costliness of LTCH care. Moreover, the difference in payment rates provides a strong incentive for LTCHs to remain eligible for the LTCH payment rates.

It is the combination of prospective payment and the LOS criterion which create potentially different responses to the same incentive structure among LTCHs. On one hand, prospective payment breaks the link between reimbursement and incurred costs and gives providers an incentive to provide cost-effective care. Reducing treatment intensity and providing shorter inpatient stays are methods by which hospitals can maximize the difference between patient revenue and treatment costs. On the other hand, the LOS criterion rewards providing longer stays, essentially requiring hospitals to devote a minimum amount of resources to each patient stay. The penalty to not providing long enough stays is significantly lower payment rates in the future. Depending on a facility's average LOS, one of the two payment system components will factor more prominently in decision-making. One LTCH, for example, may have a sufficiently high average LOS to effectively ignore its interest in maintaining its LTCH status. This LTCH could be expected to behave as hospitals have in the past under prospective payment, reducing the resources devoted to patient care. When an LTCH's status is threatened with a low facility average LOS, however, the facility may choose to devote more resources to patient care than would be optimal from its perspective under prospective payment alone. That is, the facility interest of maintaining its LTCH status may override the incentive to minimize costs in treatment decisions.

The incentive effects of this type of payment system structure have only begun to be studied. The facility-level LOS criterion for LTCHs is unique among Medicare payment systems, but it is one of a few threshold parameters currently being used in payment systems. Two salient examples of threshold parameters in payment systems include Medicare's payment system for therapy in the Skilled Nursing Facility PPS and Pay-for-Performance thresholds for quality indicators. Under the first, Medicare reimburses SNFs for therapy in blocks of time (45-149 minutes, 150-324 minutes, etc per week); in the second, many Pay-for-Performance systems reward provider groups with bonuses or higher payment rates for meeting certain performance targets (cervical cancer screening, mammography, and HbA1C levels among diabetics, for example). The common theme among these systems is that there is a financial incentive to meet the threshold, but no financial incentive to go beyond it until there is an additional financial reward. SNFs have very weak financial incentive to provide more therapy than the 'theshold amount', unless the patient can meet the next threshold. Under Pay-for-Performance, provider groups have no financial incentive to improve quality of care after meeting a performance target. In the case of the LTCH payment system, we argue that LTCHs have a strong incentive to provide stays averaging 25 days in order to maintain their LTCH status, but have no incentive to provide additional days of care. Doing so would reduce profits under prospective payment.

To help interpret changes in financial incentives facing LTCHs, we develop a model of hospital behavior in which the hospital administrator chooses a level of treatment intensity to jointly maximize profits and quality of care while operating under a model of the payment system facing LTCHs. Treatment intensity represents the resources LTCHs devote to patient care to maintain a particular average LOS. This model payment system incorporates the IPPS as an alternative set of payment rates by allowing the fixed portion of payment for each stay to vary step-wise with the hospital's overall choice of treatment intensity. The model shows that for different levels of initial treatment intensity, some administrators would choose to increase intensity under prospective payment, while others would decrease intensity.

The empirical analysis uses the implementation of prospective payment to LTCHs and baseline facility average LOS as sources of variation in financial incentives facing providers. LTCHs are grouped according to baseline average LOS to represent groups facing three different incentives. First, LTCHs with a baseline average LOS below 25 days face a binding LOS criterion and are directly at risk for losing access to LTCH payment rates. Second, LTCHs with baseline average LOS between 25 and 32 days form a group which is not directly at risk for losing access to the LTCH payment rates, but is expected to factor long-term access into decision-making. Third, LTCHs with baseline averages above 32 days may have sufficiently high averages that the LOS criterion plays only a minor role in decision-making. The hypothesis is that the three groups, facing different financial incentives, will respond differently under prospective payment. Those at risk of losing eligibility are expected to increase treatment intensity, despite prospective payment. All LTCHs above the LOS criterion are expected to respond to prospective payment by shortening stays, but LTCHs with baseline averages between 25 and 32 days are expected to shorten stays less than LTCHs with baseline averages above 32 days. Descriptive results on the change in average LOS in each of the three LTCH groups are presented. Then, OLS models of patient length of stay are estimated to isolate the policy response from other factors impacting LOS. The primary threat to identification, regression to the mean, is discussed.

LTCHs appear to respond to the change in payment system as hypothesized. Prospective payment is associated with a 5.7 day decline in average LOS among

LTCHs with baseline averages above 32 days. This response is similar to that of short-term hospitals when the IPPS was introduced. LTCHs with baseline averages between 25 and 32 days appear to protect their eligibility to the LTCH-PPS payment rates: in this group, prospective payment is associated with a shortening of patient stays, but to a much smaller extent (1.6 days on average) than LTCHs with higher baseline averages. LTCHs with baseline averages below 25 days, those which are directly at risk for losing eligibility, experience an increase in average LOS over the study period, but this cannot wholely be attributed to prospective payment.

The analysis proceeds as follows. Section 2 reviews the relevant literature. Section 3 develops the conceptual model of administrator choice of treatment intensity and develops several hypotheses. Section 4 and 5 detail the empirical strategy and present the results. Section 6 discusses the findings and concludes.

3.2 Previous Research

This study builds on three strains of research. First, very little has been published on LTCHs, their role in markets for post-acute care and how Medicare payment rules affect their practices. This study establishes that the mechanism by which Medicare has differentiated LTCHs from other acute care hospitals does affect their practice patterns. Second, this study expands upon traditional models of provider decision-making under supply-side cost sharing to model the payment system facing LTCHs. Finally, this study adds to the established empirical literature on how health care providers alter their resource use under prospective payment. Unlike most studies, this study considers how the response to prospective payment differs among hospitals.

3.2.1 Background on LTCHs

LTCHs provide extensive rehabilitation and medical treatment to a vulnerable patient population. LTCHs can be an appropriate post-acute setting for patients for whom short-term hospitals are no longer a cost-effective option, but require a higher level of care than is generally available in conventional settings. Most LTCH patients are admitted after an acute hospital discharge, and often from intensive care units, rather than from the community.

As with other post-acute settings, LTCH stays following an acute hospital stay are relatively common among patients with stroke with infarction, chronic obstructive pulmonary disease, heart failure and shock, hip replacement, septicemia, and tracheotomy with ventilator support [26]. Unlike patients treated in other post-acute settings, LTCH patients often suffer from complex medical conditions. Many LTCH patients require ventilator care for respiratory failure, have multiple organ failure, neuromuscular damage, infectious disease, or require extended wound care. Liu et al. (2001) showed that among LTCHs in operation in 1997, most had high proportions of cases with respiratory- and/or rehabilitation-related diagnoses. Few LTCHs had significant caseloads outside of these two categories.

The oldest LTCHs have origins as tuberculosis and chronic disease hospitals and were primarily located in the northeastern U.S. The oldest LTCHs still operating tend to be freestanding, government-run or non-profit facilities. Newer LTCHs tend to be affiliated with corporate hospital chains, and are often co-located on another hospital's campus (the so-called 'hospitals-within-hospitals'). Most of the growth in LTCHs has occurred in the Northeast and the South, and among 'hospitals-within-hospitals' [22].

It has been suggested that some LTCHs resemble short stay hospitals in the intensity of care provided and tend to specialize in treating conditions requiring longer term, relatively intense post-acute care. MedPAC found that among likely users of LTCH services, patients with LTCH stays had hospital stays that were an average of 9 days shorter than the stays of patients without subsequent LTCH stays. Other LTCHs, on the other hand, are thought to more closely resemble skilled nursing facilities in patient type and intensity of care provided. Skilled nursing facilities (SNFs) are the principle alternative to LTCH care. MedPAC found that the use of LTCHs was associated with a one-third reduction in the likelihood of having a stay at a freestanding SNF [27].

Chapter 2 of this dissertation found that LTCHs admit patients with somewhat higher average severity than other PAC providers, but appear to treat similar types of patient and substitute for hospital-based skilled nursing facilities (SNFs) and inpatient rehabilitation facilities (IRFs). Treatment intensity appears to be higher in LTCHs, but use of nursing and therapy, with the exception of inhalation therapy, are in line with SNFs' and IRFs'. Unlike other post-acute care providers, LTCHs are said to engage in significant patient screening before admission [27]. Screening and selection of patients may enable LTCHs to target admissions those most appropriately treated in LTCHs, or to alter their patient populations with changing financial incentives.

3.2.2 Models of Provider Decision-Making

The model of provider choice of intensity developed in Section 3 builds on models provider decision-making under supply-side cost sharing developed in the optimal payment system literature. This section briefly outlines two payment system effects developed in optimal payment systems literature: the moral hazard effect and the selection effect.

Until the early-1980s nearly all providers in the U.S. were reimbursed on the basis of incurred costs. Then, beginning with short-term hospitals, the Medicare program began to reimburse on a prospective basis. Most private insurers have followed suit over the last 20 years and Medicare has introduced prospective payment systems to several different types of providers. Under prospective payment, payment is determined according to the Diagnosis-Related Group within which each patient falls and, in general, does not increase with each service provided. By paying only a pre-determined amount, prospective payment requires the provider to bear the marginal costs of treatment. While providers keep any difference between payment and treatment costs, they must also bear any financial loss. This kind of supply-side cost sharing gives a cost-control mechanism to providers: because each additional service provided to patients reduces net revenues, providers have a financial interest in being cost-effective in their treatment decisions. The main issue with this type of payment system is the degree to which the quantity of treatment is affected by supply-side cost sharing, and whether the amount of care provided is more or less than optimal from the social perspective.

The moral hazard effect of prospective payment is the incentive to provide fewer treatment services in order to protect net revenues. Ellis and McGuire argue that, when forced to bear the marginal cost of treatment, providers who put less weight on patient benefits than on profits, will tend to undersupply treatment relative to the social optimum (where the marginal benefit of treatment is equal to its marginal cost). The moral hazard effect gives rise to the hypothesis that hospitals will provide fewer inpatient days to a given patient when reimbursed under a prospective payment system than when reimbursement is based directly on the exact services provided.

A second effect of prospective payment is that of selection. Ma (1994) demonstrates that prospective payment introduces the incentive to hospitals to change the average severity of treated patients by avoiding certain patients. Because providers face non-systematic risk (the risk that a patient will be costlier than the typical patient falling into the same diagnosis group), providers have a strong incentive to attract low-severity patients and avoid relatively severe cases [23]. Providers drawing a favorable selection of patients win at the expense of those left treating high-cost patients [31]. Providers also face systematic risk (the risk that a patient will fall into a diagnosis group for which the provider's average treatment costs exceed the fixed payment). For this reason, providers may do best by avoiding patients with medical conditions for which they lack a cost advantage, and instead target admissions among patients in relatively cost-advantageous groups [8]. Dranove suggests that this force will drive hospitals to specialize in treating certain types of medical conditions. Avoiding certain types of patients, or patient 'dumping', can take on various forms. For example, hospitals may choose not to provide a particular specialized service because doing so would attract a relatively severe and costly patient population [9]. The selection effect of prospective payment gives rise to the hypothesis that access to care among certain types of patients may suffer under prospective payment.

3.2.3 Empirical Work on PPS

LTCHs are one of the last types of providers for which the Medicare program has introduced prospective payment. Many researchers and policy analysts have considered the effects of prospective payment in acute care hospitals and post-acute settings. These studies have documented both the direct and indirect effects of prospective payment, considering the change in resources devoted to patient care, the effects on quality of care and patient outcomes, access to care, as well as changes in the health care industry. Coulam and Gaumer (1991) offer a comprehensive review of the literature on the effects of prospective payment among acute care hospitals after the first several years of implementation. We focus on hospitals' PPS experience, rather than the more recent experience among PAC providers, because there is greater similarity in payment system parameters with acute hospitals.

As the moral hazard effect would predict, prospective payment is associated with a one-time large reduction in the length of acute hospital stays. Studies found prospective payment was associated with a one-day decline in length of stay, a much stronger decline than the trend before implementation [37]. After this initial effect, length of stay moderated. Average patient complexity increased over the first several years of PPS; it is possible that LOS continued to decline among patients with comparable complexity to early-PPS patients. But, because many studies cannot differentiate patient severity within the diagnostic class, this has not been established. These results are consistent across all acute care non-exempt hospitals and across patient groups [7]. Thus, the incentive structure of Medicare's IPPS did not elicit fundamentally different responses to prospective payment across hospitals.

Whether the observed reductions in resource use are desirable from a social perspective depends on how the quality of care, and in turn, health outcomes are affected. If hospitals choose to reduce unnecessary or ineffective treatment, patient outcomes will not suffer as those services would have provided little patient benefit. In reducing the resources devoted to patient care, however, there is no guarantee that beneficial, but costly, services would not go unprovided. Without the provision of these services, patient outcomes are likely to suffer.

On the whole, studies of the first several years after PPS implementation find that the possible negative effects of prospective payment are not sufficiently consistent or large to be detected by commonly used measures of patient outcomes [7]. In particular, with respect to patient mortality, studies found either no change or declines in in-hospital mortality rates, longer-term rates (30-days to 120-days), and population mortality rates. There is some evidence that the location of death shifted from the hospital to post-acute settings and the community. Patient mortality is, admittedly, a crude device for measuring changes in quality of care and may not be sufficiently sensitive to pick up subtle changes. Moreover, it is possible that quality of care is less affected by the form of payment than by the level of payment. Pre-post studies of the effect of prospective payment are not likely to detect this relationship.

3.3 Conceptual Model

In this section, we present a simple one-payer model of hospital behavior, where a decision maker chooses a level of treatment intensity in light of the financial incentives it faces. This model is similar to others developed to illustrate the effect of provider-side cost-sharing on provider behavior [10] and [15], but reflects the payment system facing LTCHs. Payment for each patient stay is modeled as a linear combination of a fixed component, determined by patient characteristics and the facility's choice of treatment intensity, as well as a variable component, reflecting incurred treatment costs. The intensity of patient care is assumed to be under the control of the hospital and represents the resources a hospital devotes to patient care to maintain a particular average LOS. We show that when an eligibility criterion accompanies prospective payment, both aspects of the payment system affect a hospital's choice over resources devoted to patient care.

The administrator's utility is a function of both profits and the quality of care $Q(I)$ provided, with γ representing the weight (between 0 and 1) placed on profits. Quality of care is an increasing function of treatment intensity, I. Profits, measured as the difference between revenue R and costs $C(I)$ across all patients X, are decreasing in treatment intensity for a given α. The hospital administrator maximizes utility by choosing a level of intensity to jointly maximize profits and quality of care, each weighted to reflect the administrator's altruism. Administrator decision making reflects the choices of several different agents including the medical board, board of directors, managers, owners, etc.

The key equations of the model are the following:

$$\max U(I) = U(\pi(I), Q(I), \gamma) \tag{3.1}$$

$$\text{s.t.} \quad U(\pi, Q, \gamma) = X[\gamma\pi + (1-\gamma)Q(I)] \tag{3.2}$$

$$\pi = (R - C(I)) \tag{3.3}$$

$$R = \alpha(I) + \beta C(I) \qquad \textit{where } \alpha > 0 \textit{ and } 0 \leq \beta \leq 1 \tag{3.4}$$

$$C = C(I) \text{ where } C' > 0 \tag{3.5}$$

$$Q = Q(I) \text{ where } Q' > 0 \tag{3.6}$$

$$\alpha_j = \begin{cases} \alpha_H & \text{if } I* > \overline{I}, \\ \alpha_L & \text{if } I* \leq \overline{I}. \end{cases} \tag{3.7}$$

Each Hospital earns revenue per patient stay (R) equal to the sum of the fixed component α and the portion of incurred cost $\beta C(I)$ reimbursed by the system. Because $\alpha > 0$ and $0 \leq \beta \leq 1$, this system is a mixed payment system. In this model, the fixed component of payment α each hospital earns is determined by its choice of treatment intensity: hospitals maintaining an average length of stay above the eligibility threshold $\overline{I}$ earn a high fixed payment α_H while those with choice of treatment intensity below $\overline{I}$ earn the low fixed payment α_L. The threshold $\overline{I}$, α_H and α_L create a step-wise payment system analogous to the payment system facing LTCHs where α_H represents special payment rates available to hospitals qualifying as

LTCHs, and α_L represents payment rates under the alternative IPPS. The treatment intensity-dependent fixed component of payment differentiates this model from other models where all hospitals earn the same fixed payment per discharge for a given patient and diagnosis.

This model considers the decision making of just one hospital, paid under a single payment system for care provided to identical patients. This model does not incorporate a demand response to its choice of treatment intensity, and so does not consider the effect of its choice of treatment intensity on competition with other hospitals. Any possible economies of scale are ignored. The mechanism for altering a hospital's choice of treatment intensity, whether by treating a given set of patients differently or by changing the population of patients treated, is left to the empirical analysis.

3.3.1 Choice of Treatment Intensity

The choice for a provider paid under this payment system will be to reduce, maintain or increase treatment intensity from an initial level in order to maximize hospital administrator utility. We use the the utility maximization problem 3.1 to show how the choice of treatment intensity affects utility when the fixed component of payment depends on the choice of intensity. We then consider specific scenarios and develop several hypotheses for providers' choice of intensity under varying circumstances.

Profits earned by each hospital are given by equation 3.3 where total profits are the difference between revenue and costs across all patients. Substituting equations 3.4 and 3.5 into equation 3.2 yields equation 3.8.

$$U = X[\gamma(\alpha - (1-\beta)C(I)) + (1-\gamma)Q(I)] \tag{3.8}$$

The utility function implies that hospital administrator's choice of intensity depends on the generosity of the payment system, treatment costs, as well as the relative weights given to profits and quality of care. Increasing treatment intensity increases payment through a possible change in α and through the increase in costs, $\beta C(I)$. Hospital profits increase under two conditions. First, profits increase when an increase in intensity brings about an increase in the payment level, α, and this increase more than offsets higher treatment costs borne by the hospital $((1-\beta)C(I))$. Second, profits increase when a decrease in intensity brings about a decrease in fixed payments, and the cost savings from the intensity reduction more than offsets the decrease in the fixed payment. In either case, the change in α less the change in $(1-\beta)C)$ is positive and profits increase. The utility problem requires that the administrators' desire for profits be balanced against preferences for quality of care. Changes to treatment intensity do not necessarily affect quality of care and profits in the same way. The administrator will alter treatment intensity consistent with the joint maximization of profits and quality of care.

Two payment system effects can be derived from the utility function. First, the derivative of equation 3.8 with respect to intensity is $X[(1-\gamma)Q' - (1-\beta)C']$. The moral hazard effect,$(1-\beta)C'$ is common to other models of hospital behavior under supply-side cost sharing and captures the incentive to provide less treatment intensity when the hospital must bear the marginal cost of treatment. Second, the potential for changes in I to change α introduces the payment level effect. Since α depends on the hospital's choice of treatment intensity, there is an incentive to choose a level of intensity which maximizes the fixed component of payment relative to treatment costs.

Possible responses to the payment system can be illustrated by comparing utility under two choices of treatment intensity, I_1 and I_2, for a given number of discharges

X, where $I_2 > I_1$. Recall that $C'(I) > 0$ so $C(I_2) > C(I_1)$. A hospital would choose one level of intensity over another if utility is higher under that choice. We describe the effect of choice of intensity on profits and consider the effect of quality. Equations 3.9 through 3.11 are equivalent.

$$U(I_1) \gtreqless U(I_2) \tag{3.9}$$

$$X[\gamma(\alpha_1 - (1-\beta)C(I_1)) + (1-\gamma)Q(I_1)] \gtreqless X[\gamma(\alpha_2 - (1-\beta)C(I_2)) + (1-\gamma)Q(I_2)] \tag{3.10}$$

$$X[(1-\beta)(C(I_2) - C(I_1))] \gtreqless X[(\alpha_2 - \alpha_1) + \frac{(1-\gamma)}{\gamma}(Q(I_2) - Q(I_1))] \tag{3.11}$$

Case I: $\overline{I} < I_1 < I_2$.

If $\overline{I} < I_1 < I_2$ then $\alpha_1 = \alpha_2 = \alpha_H$. The hospital would not earn a higher fixed payment by providing I_2. The right-hand side of equation 3.11 is equal to the effect on quality from a change in intensity from I_1 to I_2, weighted by the ratio of weights given to quality and profits, while the left hand side is equal to the change in a hospital's treatment cost from I_1 to I_2. Providers would choose to provide the I_1 level of intensity if the reduction in treatment costs over I_2 are greater than the weighted reduction in quality of care. For example, if a hospital gives zero weight to the quality of care provided, then a reduction in intensity from I_2 to I_1 would unambiguously be made because profits are greater under I_1 than I_2.

Case II: $I_1 < \overline{I}$ and $I_2 > \overline{I}$

If $I_1 < \overline{I}$ and $I_2 > \overline{I}$ then $\alpha_1 = \alpha_L$ and $\alpha_2 = \alpha_H$. Again, comparing $U(I_1)$ and $U(I_2)$, it is clear that $C(I_2) - C(I_1) > 0$, $\alpha_2 - \alpha_1 > 0$ and $Q(I_2) - Q(I_1) > 0$ in equation 3.11.

A hospital would choose I_1 if $U(I_1) > U(I_2)$. This is true only when the difference in costs borne by the hospital is greater than the difference in payment and weighted quality. A hospital with initial choice of intensity I_2 would choose to reduce intensity only if the cost savings from the reduction were greater than the resulting decrease in both payments and weighted quality. For a hospital giving zero weight to quality, such a decrease to intensity must increase profits to be worthwhile from the hospital's perspective.

Alternatively, a hospital would choose I_2 over I_1 if $U(I_2) > U(I_1)$. This is true when increases in payment and weighted quality are greater than the necessary increase in treatment costs. In this case, the right-hand side of equation 3.11 must be greater than the left-hand side. For an initial treatment intensity choice I_1, such an increase is likely given that both payment and quality of care would increase under I_2.

The choice of intensity is a facility-level one: the hospital administrator sees that if average LOS is above $\overline{I}$, then the fixed payment earned on each patient stay would be α_H. The hospital administrator may choose to incur greater costs treating patients in order to raise the hospital's fixed payment in the future. Doing so would also improve the quality of care.There is no financial return to providing a level of intensity above $\overline{I}$. The relative weights given to quality and profit will help determine how far above or below $\overline{I}$ an intensity an administrator chooses. The larger the weight given to profit, the larger the reduction in intensity (and quality of care) an administrator will tolerate for a given increase in profit. To increase average LOS, the administrator can alter the hospital's treatment policy by keeping typical patients longer, and alter the admission policy to admit longer-staying patients.

3.3.2 Model Predictions and Hypotheses

This model offers several predictions relevant to the introduction of the prospective payment system for LTCHs. First, a hospital with initial choice of treatment intensity greater than $\overline{I}$, all else equal, has an incentive to reduce intensity toward the point where further reduction would result in an unprofitable change in fixed payments. The main effect of the LOS criterion is to temper reductions in treatment intensity under prospective payment by creating a financial disincentive to providing too few days of care. As in other models, concern for quality moderates the financial incentive to reduce treatment intensity. The first study hypothesis is that while all LTCHs with baseline average LOS above the LOS criterion will reduce treatment intensity and shorten stays, LTCHs relatively close to the LOS criterion will make smaller reductions to intensity. As described in the next section, LTCHs with baseline averages above 25 days are divided into two groups. LTCHs with baseline average LOS above 32 days (the High group) are expected to have a relatively strong policy response to prospective payment with the largest reduction in the average number of days provided. LTCHs with baseline averages between 25 and 32 days (the Middle group) are expected to protect their long-term access to the LTCH-PPS payment rates and make smaller changes to the number of days they provide.

The model suggests different behavior among providers whose initial choice of treatment intensity is below $\overline{I}$. All else equal, a hospital can be expected to increase intensity when doing so will increase profits. Profits would increase if the difference in payments between the two choices exceeds the difference in treatment costs. Administrators' interest in quality of care can amplify this effect; the greater the weight given to quality, the more willing an administrator would be to increase intensity for a given increase in profit.

If profits would not increase under greater intensity, the model suggests the hospital would instead decrease intensity. That is, the hospital would do better by reducing costs to provide lower intensity care under the alternative system. Responding this way would entail opting into the less generous IPPS because the provider will not continue to meet the LOS criterion.

We test the first of these two predictions by focusing on the LTCHs with baseline average LOS below 25 days (the Low group) which operate throughout the study period. The second study hypothesis is that protecting eligibility to relatively generous payment rates will drive LTCHs to increase treatment intensity, despite having to bear the additional costs of treatment under prospective payment. Rather than shorten patient stays, these LTCHs are expected to provide more days of care, on average, under prospective payment.

3.4 Empirical Strategy and Data

This analysis uses the implementation of prospective payment to LTCHs and baseline facility average LOS as sources of variation in financial incentives facing providers. This section describes the sources of information on LTCHs and LTCH patients, this study's empirical strategy, and the analysis plan.

Data for this analysis come from two main sources. The Medicare Provider Analysis and Review (MedPAR) file (2001-2003) and the Medicare claims file (2004) contain 100% of all LTCH stays occurring between 2001 and 2004, as well as any succeeding institutional stays occurring in the same year. These data contain patient stay records with admission and discharge dates, death date, diagnoses (up to ten), age, and sex. Facility information is provided by Medicare's Online Survey Certification and Reporting (OSCAR) data. Facility information includes fiscal year information, size, control type (proprietary, not-for-profit and government run), participation age (age-cohort of facility, determined by the first year of participation in Medicare), and, for institutional stays following LTCH stays, facility type (acute hospital, skilled nursing facility and inpatient rehabilitation facilities). Baseline information is based on 2001 data; 2001 data is then excluded from analysis.

The empirical strategy for this analysis is two-fold. First, the introduction of prospective payment significantly changes the financial incentives facing all LTCHs relative to cost-based reimbursement. LTCHs became eligible for the LTCH-PPS between October 1, 2002 and September 30th, 2003, according to when each hospital began its Fiscal Year 2003. For each hospital, the analysis data contain information on patient stays before and after PPS implementation. Additionally, due to the staggered implementation dates, the pre-PPS and post-PPS periods overlap in time across hospitals. Patient stays are assigned to the post-PPS period if their discharge date occurs on or after the first day that the treating LTCH became eligible for prospective payment.

Second, LTCHs are grouped according to baseline average LOS to represent groups facing three different financial incentives. The first group, is made up of LTCHs with baseline Medicare average LOS below 25 days. This is called the Low LOS group. Although LTCHs have been required to maintain facility average LOS above 25 days for many years, Medicare has calculated this average among all patients, Medicare and non-Medicare (privately-insured, other coverage, and uninsured). With the implementation of prospective payment, LTCHs were newly required to maintain average LOS above 25 days among Medicare patients specifically. Several LTCHs in 2001 (baseline year) were able to qualify as LTCHs despite having Medicare averages below 25 days. These LTCHs face a binding LOS criterion. We hypothesize that this group will provide longer patient stays under prospective payment in order to protect their eligibility to the LTCH-PPS payment rates.

The second group of LTCHs are those with baseline average LOS between 25 and 32 days. This is called the Middle LOS group. These LTCHs are not directly at risk for losing access to the LTCH payment rates, but their long-term access to LTCH-PPS payment rates is expected to factor into decision-making. We hypothesize that this group will provide shorter patient stays under prospective payment than under cost-based reimbursement, but the reduction in days provided will be significantly smaller than reductions made by LTCHs with baseline average LOS above 32 days.

The third group is made up of LTCHs with baseline averages above 32 days. This is called the High LOS group. This group faces the least pressure from the LOS criterion, and therefore, is hypothesized to shorten stays by more than the Middle LOS group.

Tables 3.1 describes the distribution of facility average LOS during the baseline year 2001. About 14% of LTCHs, or 32 LTCHs, fall into the Low LOS group. Table 3.2 shows the number of LTCHs in each of the three LTCH groups. Among the 235 LTCHs used in the analysis, the average LOS over the entire study period is 32.2 days. Accordingly, we use 32 days as a dividing point between the Middle and High LTCH groups. As discussed below, one potential threat to identification is regression to the mean. Dividing LTCHs at the population average creates groups with homogenous regression to the mean effects. All LTCHs in the Low LOS group would experience natural increases in their average LOS (towards the mean), while all LTCHs in the Middle and High LOS groups would experience natural declines in average LOS.

Several LTCHs were excluded from analysis. The largest group of LTCHs excluded from analysis those not operating in each year 2001-2004. There are 56 newly operating or closing LTCHs between 2001 and 2004. Second, 20 LTCHs were excluded because of missing or inconsistent fiscal year information. Finally, in order to avoid using 2001 (baseline year) data in the analysis, We excluded 16 LTCHs which became eligible for PPS before January 1, 2003. The remaining 235 LTCHs offer 154,555 patient stays during the study period.

We estimate Ordinary Least Squares regression models using patient-level data. Patient length of stay, the dependent variable, is assumed to be a function of the financial incentives facing LTCHs, the patient characteristics, hospital characteristics, and time. We assign patient stays to the post-PPS period if the stay discharge occurs on or after the treating LTCH became eligible for the LTCH-PPS. We also assign patient stays to LTCH groups (Low, Middle, and High) according to the baseline average LOS of each patient's treating LTCH. Patient control factors include sex, age, patient diagnoses. Major Diagnostic Categories are used to control for patient diagnosis. Each diagnosis is assigned to one of 25 groups, and (non-exclusive) dummy variables are included in each regression model. Facility-level control factors include type of control, number of beds, and participation age cohort. Finally, we control for the natural trend in LOS over time using fiscal month.

Table 3.3 show selected baseline statistics of the 235 LTCHs and their patients used in the analysis. The most common MDCs are Diseases of the Circulatory System and conditions related to Health Status and Other Contacts with Health Services. Health Status and Other Contacts with Health Services includes rehabilitation, aftercare, and screening. The other MDCs shown in Table 3.3 vary in their prevalence rates across the three LTCH groups.

Table 3.1: Facility Average LOS at Baseline

	2001
Mean	37.5
10%ile	24.2
20%ile	25.9
25%ile	26.1
50%ile	29.3
75%ile	32.5
90%ile	41.3
Maximum	708.8
No. of LTCHs	235

Source: 2001 MedPAR 2001 POS file.
Note: Facility averages are not weighted to reflect the number of discharges.

Table 3.2: LTCH Study Groups

		Facilities	Patients
HIGH Group	LTCHs Baseline ALOS > 32 Days	67	44,776
MIDDLE Group	LTCHs Baseline ALOS 25-32 Days	136	94,919
LOW Group	LTCHs Baseline ALOS ≤ 25 Days	32	14,860
	Total	235	154,555

Source: 2001-2003 MedPAR, 2004 Medicare Claims, 2001 POS file.

Table 3.3: LTCH Baseline Statistics

	High Group	Middle Group	Low Group
Averages over Providers			
Began Operation after 1993	49%	76%	63%
Began Operation 1983-1993	30%	16%	13%
Began Operation before 1983	21%	7%	25%
For-Profit	60%	59%	44%
No. of Beds	134	67	81
Number of LTCHs	67	136	33
Averages over Patients			
Age of Patients	73	74	74
% Male Patients	46%	44%	43%
No. of Major Diagnostic Categories	4.8	4.7	4.1
Circulatory System	68.3%	67.2%	61.1%
Health Status and Other Contacts with Health Services	53.8%	49.1%	48.3%
Respiratory System	56.3%	48.2%	41.1%
Musculoskeletal and Connective Tissue	26.9%	32.0%	33.1%
Kidney and Urinary Tract	36.1%	35.8%	27.3%
Infectious and Parasitic Diseases	23.5%	21.9%	14.5%

Source: 2001-2003 MedPAR, 2004 Medicare Claims, and 2001-2004 POS file.

3.5 Results

This analysis suggests that the combination of prospective payment and the LOS criterion in Medicare's payment system for LTCHs elicits different actions among LTCHs. LTCHs with baseline averages above 32 days, the High LOS group, respond to the change in payment system as other hospitals have done in the past, shortening the stays they provide. LTCHs with baseline averages between 25 and 32, the Middle LOS group, have a smaller policy response, appearing to protect their eligibility to LTCH payment rates and reduce treatment costs. LTCHs with baseline averages below 25 days, the Low LOS group, experience an increase in their average LOS after PPS implementation, but this change cannot be statistically attributed to prospective payment. The primary threat to identification, regression to the mean, is discussed.

3.5.1 Descriptive Changes in Length of Stay

Table 3.4 presents a decomposition of the change in the average length of patient stays before and after PPS implementation. The first column presents average LOS during the baseline period (2001), which is excluded from the regression analysis. The next two columns present the observed average LOS in each LTCH group before and after PPS is implemented. The pre-PPS period spans years 2002 and 2003. The post-PPS period spans 2003 and 2004 (excluding LTCHs eligible for PPS before January 2003). The third column is the predicted average LOS in the post-PPS period using an OLS regression model described below. This predicted post-PPS average LOS is used to decompose the change in average LOS into a selection and treatment effect, shown in columns 5 and 6.

Changes in the average LOS before and after PPS implementation are notable for each LTCH group. LTCHs in the High group experience a strong 12.1 day decline in average stay lengths after implementation. LTCHs in the Middle group experience a 2.0 day decline in average stay length. Meanwhile, LTCHs in the Low group experience an increase in stay length in the post-PPS period by 0.3 day on average. The two groups have strikingly similar averages in the post-PPS period. All of these results are of the expected sign and relative magnitude (the decrease in average LOS in the Middle group is smaller than that of the High group).

The decomposition of the changes in average LOS in the three LTCH groups reveals the forces driving average LOS. There are two dimensions along which average LOS can change from one period to the next. First, the selection effect is the change in average LOS due to a changing patient population (or set of treated patients). Hospitals may admit patients likely to have shorter or longer lengths of stay from one period to the next. Second, the treatment effect is the change in average LOS due to changes in treatment intensity provided by hospitals. Changes in treatment intensity might include changing number of services or procedures provided to patients or changes to the amount of labor devoted to each patient stay, as reflected, in this case, by how many LTCH days are provided to patients.

An OLS regression model estimates the relationship between patient length of stay, patient and facility characteristics, and calender time before prospective payment (i.e. "treatment" in the pre-PPS period). The predicted post-PPS average LOS preserves this relationship and applies it to the post-PPS population.

The selection effect is the difference between the observed pre-period average LOS and the predicted post-PPS average LOS. Thus, the selection effect measures how average LOS would change if "treatment" were unchanged from the pre-PPS to post-

Table 3.4: Decomposition of Change in Average Length of Stay

	1	2	3	4	5	6
	Baseline Avg. LOS	Pre-PPS Avg. LOS	Post-PPS Avg. LOS	Predicted Post-PPS Avg. LOS	Selection Effect	Treatment Effect
High Group	51.5	43.2	31.2	32.5	-10.8	-1.3
Middle Group	28.2	28.1	26.1	28.1	0.0	-2.0
Low Group	23.9	25.8	26.1	27.6	1.8	-1.5

Source:2001-2003 MedPAR, 2004 Claims,2001-2004 POS file
Note: Averages are weighted by the number of patients.
Baseline period is 2001.

PPS period and only the population of treated patients were allowed to vary. By contrast, calculation of the treatment effect holds constant the population of treated patients, but allows "treatment" to vary. Here, we calculate the treatment effect as the difference between the observed post-period average LOS and the predicted post-period average. The selection and treatment effects are not necessarily intentional changes in the set of treated patients or treatment intensity. Rather, these changes are due to a mixture of intentional actions and the randomness of patient populations and treatment needs.

As Table 3.4 indicates, LTCHs in the High group experience sizable, and compounding, selection and treatment effects. These hospitals experience an 12.1 day decline in average LOS under the new payment system. Nearly 11 days of this decline can be attributed to changes in the set of patients treated; patients admitted in the post-PPS period are likely to stay significantly fewer days than before implementation. In addition, 1.3 days of this decline can be attributed to changes in treatment. These LTCHs are able to shorten stays significantly and remain eligible for the LTCH payment rates.

The Middle group experiences a 2.0 day decline in average LOS. This change is due to changing "treatment", rather than changing patient populations. These LTCHs admit patients likely to stay as long after PPS implementation as patients treated in the pre-PPS period (the selection effect is zero). With baseline averages above the LOS criterion, these hospitals have some ability to shorten stay lengths and remain eligible for the relatively generous LTCH-PPS payment rates. Changing treatment accounts for a 2.0 day reduction in the average LOS.

Finally, changes in LOS in the Low group are also notable. Table 3.4 shows that average LOS increases from the baseline period (23.9 days), to the Pre-PPS period (25.8 days), and to the Post-PPS (26.1 days). Note that already by the Pre-PPS period, average LOS is above 25 days, the LOS criterion.[1] From there, the Low group experiences a 0.3 day increase in average LOS. This change is primarily due to a positive selection effect. Holding "treatment" constant, the average LOS among these LTCHs would increase by 1.8 days due to the change in the set of treated patients. Patients treated in the post-PPS period, thus, appear to be longer-staying patients than those treated in the pre-PPS period. With 'average' LOS above the 25 day LOS criterion, LTCHs have the incentive to shorten stays by changing treatment. Changing treatment reduces the average LOS by 1.5 days.

3.5.2 Models of Length of Stay

The decomposition results are consistent with the hypothesized responses to the change in payment system for each LTCH group. However, the decomposition describes the total changes in average LOS after implementation. In order to isolate the policy effect of prospective payment for each LTCH group, it is necessary to control for the impact of patient characteristics, facility characteristics and a secular trend on length of stay. Table 3.5 presents two OLS policy model results which adjust for these factors. The main hypothesis is that variation in financial incentives across the LTCH groups will drive different actions under prospective payment: Low LOS

[1] Recall that study groups are defined during the baseline period, rather than the Pre-PPS period.

LTCHs are expected to provide longer stays, Middle LOS LTCHs are expected to shorten stays only slightly, while High LOS LTCHs are expected to shorten stays significantly.

Table 3.5 presents regression results for the main policy variables. Control variables are not presented here but can be found in the appendix, Table A. Controlling for the secular trend in stay lengths is possible because of the staggered implementation dates across LTCHs. Between January and September 2003, there are LTCHs in both pre-PPS and post-PPS periods. As more LTCHs become eligible for prospective payment, the pre-PPS group shrinks. The time trend can be separated from PPS eligibility, but the two are highly correlated. The correlation coefficient is 0.69 (p-value < 0.000). Except for the secular trend, output for the control variables is not presented.

Model 1 in Table 3.5 is used to estimate the change in patient length of stay associated with the change in payment system. Testing whether the PPS effect differs by LTCH group (using interaction terms) allows us to test whether the Low and Middle LTCH groups respond differently to PPS than LTCHs in the High group (the reference group). The results from Model 1 suggest this is so. While patients treated in LTCHs in the High group experience a 9 day decline in length of stay on average, there are offsetting responses in the two other LTCH groups. The point estimates suggest a much smaller day reduction in the number of LTCH days provided among Middle group LTCHs, and an increase in the number of LTCH days provided by Low group LTCHs. Middle group LTCHs decrease stay lengths by an average 0.21 days under prospective payment, but this effect is much smaller than the response by LTCHs with relatively high baseline averages. LTCHs in the Low group appear to keep patients 2 days longer on average than they did under cost-based reimbursement.

Table 3.5: Length of Stay Models

	Model 1		Model 2	
	Coeff	Std Err	Coeff	Std Err
PPS	-9.10	2.99 **	-5.69	2.05 **
Middle Group	-13.07	3.76 **	-10.71	3.02 ***
Middle Group x PPS	8.89	3.51 *	4.14	2.22 *
Low Group	-16.03	4.62 **	-13.33	3.81 **
Low Group x PPS	11.15	3.91 **	5.78	2.72 *
Fiscal Month	-0.13	0.05 **	-0.44	-0.17 **
Middle Group x Fiscal Month			0.43	0.19 *
Low Group x Fiscal Month			0.49	0.25 *
Constant	40.68	5.69 ***	39.01	5.32 ***
No. Observations	154,555		154,555	
R-Squared	0.03		0.03	

	Full PPS Effects	90% C.I.	Full PPS Effects	90% C.I.
High Group	-9.10	(-4.19, -14)	-5.69	(-2.33, -9.05)
Middle Group	-0.21	(-1.56, 1.14)	-1.55	(-0.62, -2.47)
Low Group	2.06	(-0.69, 4.8)	0.09	(-2.98, 3.16)

Source:2001-2003 MedPAR, 2004 Claims, 2001-2004 POS file
Note: Full models with control variables are presented in the appendix.
*** p-value < 0.000, ** p-value < 0.01, * p-value < 0.10

That confidence intervals for these two LTCH groups each cross zero could be interpreted as either no policy response, or that protecting LTCH status leads these two LTCH groups to keep patients as long under prospective payment as under cost-based reimbursement. In either case, the offsetting effects are statistically separable from the policy response by LTCHs in the High group.

The primary threat to identification in this pre-post study design is regression to the mean. The regression to the mean phenomenon predicts that LTCHs with baseline averages below and above the population mean (32.2 days during the study period) will experience subsequent averages closer to the population mean without intentionally altering admission or treatment policies. Model 1 in Table 3.5 does not control for this threat, and regression to the mean may be an important component of the selection and treatment effects presented in Table 3.4.

Regression to the mean potentially confounds the hypothesized responses to changes

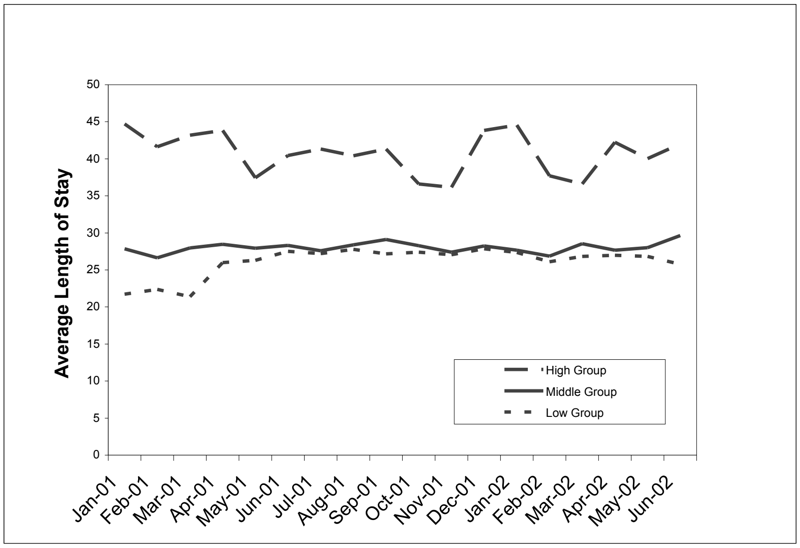

Figure 3.1: Trend in Length of Stay by LTCH Group

in the LTCH payment system in two of the three LTCH groups. Namely, both regression to the mean and a protective response to prospective payment would result in longer patient stays among LTCHs in the Low group. Likewise, both regression to the mean and a reduction in resources devoted to patient care under PPS would result in shorter patient stays among LTCHs in the High group. Regression to the mean is not expected confound the PPS effect among LTCHs with baseline averages between 25 and 32 days because they have opposite predictions. Regression to the mean predicts longer stays (this group having facility averages below the population mean), while the hypothesized PPS effect is a shortening of stays.

Figure 3.1 presents trends in monthly average LOS in each LTCH group before PPS implementation, and offers a glimpse of how strong the regression to the mean effect may be for each group. For this figure, LTCHs are assigned to each of the three groups based on the facility average LOS in the first three months of the baseline period: January 2001 through March 2001. As the figure shows, the greatest confounding may occur with the set of LTCHs in the Low group. For this group there is a clear upward jump in averages after the third month. A weaker downward trend is observable among LTCHs in the High group. These trend lines are only suggestive of each group's regression to the mean effect, however, because other forces may be at play during this period. In particular, Low group LTCHs may have lengthened stays before PPS implementation in anticipation of their facility averages being assessed under the tighter criterion. Such an action would have been in keeping with the financial incentives of cost-based reimbursement. Nevertheless, in order for LTCHs' identifiable responses to prospective payment to be robust, there must be a PPS effect for each of the three groups over and above these changes in length of stay.

A way to over-correct for the regression to the mean bias is to include group-specific time trends in LOS in the model. The time trend variable, Fiscal Month, measures the average monthly change in discharge rates among all LTCHs throughout the study period. Using fiscal time, rather than calendar time, centers time around PPS eligibility. The first month of PPS eligibility, regardless of the calendar time it occurs, has a fiscal month value of 1. Interacting this variable with the LTCH groups captures each group's monthly changes in length of stay. The regression to the mean effects are included in each of these trends. The imperfection of this method is that including these terms separates the instantaneous policy effects (now represented in the PPS and PPS-group interaction terms) from the policy responses which play out over time (now captured in the group-specific time trends). While providers can be expected to make changes to treatment and admission decisions as soon as the new payment system is in place, further adjustments can certainly be expected to take place. Unfortunately, the group-specific time trends capture not only the regression to the mean effects, but also the policy responses played out over time.

The results of this model are presented in Model 2 of Table 3.5. This model shows that the PPS effect among LTCHs in the High group is primarily an instantaneous effect. This effect remains robust after controlling for this group-specific time trend, and shows that LTCHs provider an average of 5.7 fewer days under prospective payment than under cost-based reimbursement. PPS-group interaction terms remain significant at the 10% level after controlling for group-specific time trends, suggesting that the instantaneous policy effect among LTCHs in the Middle and Low groups are different from the reference group. Middle group LTCHs have a smaller policy response than the High group LTCHs, providing 1.6 fewer days on average under prospective payment. The instantaneous policy response in this group is differentiable from a null response: the confidence interval does not cross zero, but there is a slight overlap with that of the High group.

The policy response by LTCHs in the Low group is less robust. This group's instantaneous PPS effect again cannot be differentiated from a null response, or a perfectly offsetting response. Overall, it appears that after controlling for group-specific trends in length of stay, Low group LTCHs keep patients as long under prospective payment as under cost-based reimbursement.

Model 2 can be viewed as offering conservative estimates of the PPS effect for each LTCH group because it offers only the instantaneous PPS effects for each LTCH group and over-corrects for the regression to the mean effect. With this in mind, the 'true' PPS effect for each group can be bound by estimates from Models 1 and 2. The decomposition shows that High group LTCHs experienced an 12.1 day decline in average LOS in the post-PPS period, both by changing treatment and through selection of patients. Controlling for patient and facility characteristics, and the secular trends in LOS, the PPS effect appears to be a shortening of stays by providing between 5.7 and 9 fewer days of care, on average. LTCHs in the Middle group also experienced a decline in average LOS by changing treatment. These LTCHs exhibit a much smaller response to PPS, as hypothesized, and reduce treatment intensity by shortening stays by 0.2 to 1.6 days. Although Low group LTCHs experience an increase in average LOS in the post-PPS period, their policy response is unclear as it is not statistically separable from a null response.

3.6 Discussion

This analysis considers how the presence of the LOS criterion in Medicare's payment system for LTCHs alters behavior under prospective payment. It appears that maintaining eligibility is an important factor in decision making for LTCHs, and hospitals relatively close to the LOS criterion respond to prospective payment differently than hospitals relatively far above it. Given the differing responses to prospective payment among LTCHs, appropriate monitoring of access to care and quality of care under Medicare's LTCH benefit requires not just the consideration of vulnerable patient populations, but also consideration of how access and quality may be differentially affected across LTCHs.

High group LTCHs exhibit a strong response to prospective payment. This group shortens stays by 5.7 to 9.1 days on average. This reduction is robust to the regression to the mean effect and other natural changes in length of stay over time. This response is also much stronger than the response by short-term hospitals when the Inpatient PPS was introduced in the early 1980s. These hospitals shortened stays by about one day under prospective payment, after experiencing a very weak downward trend (average LOS 13.8 in 1968 and 10.1 in 1982) [37]. As shown in the decomposition (Table 3.4), most of the decline in average LOS among these hospitals is due to changing patient populations; that is, these LTCHs select significantly shorter-staying patients after PPS was introduced than before.

Although it is not possible to determine how much of this change is intentional and how much of it is caused by the natural randomness in patients' needs over time, the significant selection effect is a signal that access to LTCH services may be at risk under prospective payment. Patients who require exceptionally long stays may lose access to LTCH care under PPS. If the LTCH was the most appropriate treatment setting for these patients under cost-based reimbursement, then health outcomes are likely to suffer when this population is treated elsewhere.

LTCHs in the Middle group exhibit a smaller policy response to prospective payment, as hypothesized. These LTCHs appear to protect their LTCH status by shortening stays by between 0.2 and 1.6 days after PPS implementation. Though smaller that response by High group LTCHs, the magnitude of the Middle group's response could be considered large compared to previous experience with PPS in hospitals. The decomposition shows that the change in average LOS after PPS implementation was due to changing treatment intensity. While providing fewer services is certainly the intent of prospective payment, it is too soon to tell if these changes are desirable. Patient outcomes, like mortality and health status at discharge, must be monitored to determine whether this reduction in treatment intensity has improved the value of LTCH care, or whether quality has suffered.

The PPS effect among LTCHs in the Low group is not statistically robust to regression to the mean effect and other natural changes in LOS. It may be the case that this LTCH group had low baseline averages simply due to the randomness in patient populations from year to year. If this is the case, then we can expect this set of LTCHs to behave under PPS comparably with LTCHs in the Middle group. For this group, special attention should be given to patient outcomes and quality of care.

Finally, the question of whether 25 days is an appropriate LOS criterion remains. When the LOS criterion is set too low, the Medicare program may inappropriately encourage LTCH stays when patients could be treated in far less costly settings with no detriment in the quality of care provided. When set too high, however, the program discourages providing appropriately long stays if they are not 'long enough' from the program's perspective. This analysis suggests that the 25-day LOS criterion is probably not too strict (i.e. not too high). If set higher, Middle group LTCHs could be expected to admit longer-staying patients (as Low group LTCH did), and a weaker downward selection effect could be expected among LTCHs in the HIGH Group (because long staying patients would not be as unattractive). Moreover, as LTCHs grow in number, the forces of prospective payment and greater competition among LTCHs will likely drive increases in admissions among relatively low-severity patients. Raising the LOS criterion may be an appropriate refinement to the Medicare LTCH benefit to keep LTCH financial interests aligned with program interests.

CHAPTER IV

Comparing Value in Post-Acute Care: Do Medicare Payments Reflect Quality

4.1 Introduction

Medicare beneficiaries often face multiple options for care following an inpatient stay, including care provided in skilled nursing facilities (SNFs), inpatient rehabilitation facilities (IRFs), long-term care hospitals (LTCHs), as well as the home care option. It is often not clear which option is better. Many factors have been shown to influence provider choice. Post-acute care providers appear to treat similar sets of patients and therefore may provide similar services. Recent work has found that extensive substitution of care across PAC settings occurs among Medicare beneficiaries [13].

Substitution of care is an important issue for the Medicare program. Medicare currently maintains distinct prospective payment systems for SNFs, IRFs, LTCHs and home health agencies. These systems vary widely in their design parameters, patient eligibility, coverage, and terms of provider participation. Payment rate generosity also varies across post-acute care payment systems. Although each payment system may be internally consistent—i.e., appropriately set payment rates to the average treatment costs of patients in each classification category—payment rates may not be externally consistent, i.e., consistent from one type of provider to another. By maintaining parallel payment systems for post-acute care, in principle the Medicare program may pay providers very differently for providing very similar care to very similar patients. Hence, it is of interest to uncover evidence as to whether this occurs in practice.

Appropriate payment for services across PAC types is particularly salient for LTCHs. Long-Term Care Hospitals are designed to provide extensive medical and rehabilitative care to chronic, critically ill patients. Chapter 2 of this dissertation found evidence that despite LTCHs' apparent narrow treatment focus, substitution between LTCHs and other PAC providers occurs. In markets with LTCHs in operation, fewer Medicare beneficiaries use hospital-based SNFs and IRFs. LTCHs by far are the most expensive PAC setting under the Medicare program, and can earn as much as 12 times as much as SNFs and IRFs for treating comparable patients [27].

Externally inconsistent payment for medical care is not necessarily inefficient, nor is it necessarily undesirable. To the extent that some providers are paid more than other providers for treating a similar set of patients, and are able to achieve commensurately better health and cost outcomes among patients, the difference in payments may be neither inefficient nor undesirable. But, with respect to PAC, how health and cost outcomes vary among clinically similar patients across settings has not received sufficient attention and is not well understood.

The objective of this chapter is to measure differences in health and cost outcomes in one set of patients treated in SNFs, IRFs and LTCHs. This chapter focuses specifically on patients who receive prolonged mechanical ventilation in acute hospitals and are discharged to SNFs, IRFs and LTCHs for post-acute treatment. Comparing health and cost outcomes among these patients provides a test of how well these post-acute modalities substitute for one another. The results of this study

Table 4.1: Average Payment to PAC providers for Mechanically Ventilated Patients

	Respiratory Failure Present		Respiratory Failure Absent	
PAC Setting	Mean	Std Dev	Mean	Std Dev
SNF	$7,555	$7,528	$6,826	$6,795
LTCH	$52,860	$36,604	$37,666	$28,718
IRF	$16,593	$11,016	$16,310	$10,466

Source: 2004 Medicare Denominator, Inpatient and SNF claim files, 2004 POS file

shed light on how interchangeable care provided by SNFs, LTCHs, and IRFs is for patients who are or have received prolonged mechanical ventilation.

Patients who receive prolonged mechanical ventilation comprise an appropriate group with which to study substitutability in post-acute care. Treating long-term ventilator dependent patients is an area of specialization among LTCHs. Since they comprise a relatively small group of providers and only about 1% of all Medicare-covered hospital stays are followed by an LTCH stay, it is important to study a sizeable population within LTCHs. An estimated 10.7% of Medicare-covered hospital stays are followed by an LTCH stay among patients receiving prolonged mechanical ventilation in acute hospitals,[1] and these patients make up about 15.2% of all LTCH patients. Providing post-acute care to prolonged mechanically ventilated patients is fairly common in all three settings. In 2004, there were 15,259 cases in LTCHs, 5,028 cases in IRFs, and an estimated 25,500 cases in SNFs. LTCHs are also paid substantially more to provide post-acute care to patients who received prolonged mechanical ventilation in the acute setting than are SNFs and IRFs. See Table 4.1 for average Medicare payments in 2004 to LTCHs, SNFs and IRFs.

This study contributes to three strains of research. First, there is an extensive literature to build upon regarding substitutability of care across PAC setting. Rather than focus on the extent that different PAC providers are used in place of each

[1]Based on a 10% sample of Medicare beneficiaries with at least one hospital stay in 2004.

other, the focus here is on how well LTCHs, SNFs and IRFs actually substitute for one another. That is, many studies of post-acute site-of-care substitution focus on the relationship between patients' characteristics and where they are placed; in this study, we instrument for where patients are placed, and consider the outcomes of care provided by SNFs, LTCHs and IRFs. Second, the literature on LTCHs and their role in health care markets is small but growing. This study adds to this literature by measuring the clinical benefits to LTCH care. Third, studies of treatment and outcomes of prolonged mechanically ventilated patients are typically limited to the medical literature. Economic studies are often from the perspective of hospital finances. But, a growing frequency of these cases and their expense make them a policy-relevant group for the Medicare program. This study adds to our understanding of the economic burden, from the Medicare program's perspective, of prolonged mechanical ventilation.

This study uses an instrumental variables approach to compare health and cost outcomes of SNF, LTCH and IRF treatment for long-term ventilator dependent patients. The two instruments for choice of PAC setting are: differential distance to the nearest LTCH and IRF, and the number of LTCHs and IRFs located within 100 miles of patients' home zip code. These instruments are predictive of patients' use of PAC.

Study patients—i.e. patients who have received prolonged mechanical ventilation and received post-acute care after their acute-care hospital stay—are identified in the acute hospital setting with DRG values equal to 475 (Respiratory Diagnosis with 96+ Ventilator Support) or 483 (Tracheostomy with 96+ hours of ventilator support, for diagnoses other than face, mouth and neck). Patients' acute hospital stays are matched with their post-acute stays in SNFs, LTCHs or IRFs. (These PAC provider stays follow directly.) Patients are divided into two groups: patients with and without respiratory failure present during the PAC stay. If the diagnosis ICD-9 codes 518.81-518.84 are present in the PAC claim record, we assign the patient to the respiratory failure group.[2]

This study compares rates of mortality, medical complications, readmission to acute hospitals, and 6-month follow up Medicare expenditure among treatment groups. We find that LTCHs achieve lower mortality rates among patients without respiratory failure than comparable SNF patients, and have higher mortality rates among patients with respiratory failure. For both sets of patients, rates of many complications are higher among LTCH patients than SNF patients. However, across the board, LTCHs achieve lower rates of readmission to acute hospitals. Results for IRF patients are mixed. In some cases, IRFs out perform SNFs, but for the most part the results are inconclusive as to how IRF care compares to SNF care.

This analysis proceeds as follows. Section 4.2 presents a review of the literature on prolonged mechanical ventilation and use of PAC, as well as the extent of substitution across PAC settings. Section 4.3 explains the research methods and estimation strategy used in this analysis. This section includes tests of the validity of differential distance as an instrument for choice of PAC setting. Section 4.4 presents the results. Section 4.5 concludes with a discussion of the results.

4.2 Literature Review

The push towards using cost-effective alternative settings to the acute hospital has probably no better case study than among patients requiring prolonged mechanical

[2]Note that patients included in this study do not necessarily receive mechanical ventilation in the post-acute care setting. All these patients receive mechanical ventilation in the acute setting, but there is great variance across PAC setting. About two-thirds of the study group, who use LTCHs are ventilated, but very few SNF and IRF patients are. We found that just 0.4% of SNF patients and about 1% of IRF patients in this group appear to be ventilated during the PAC stay. These patients appear to have been weaned from the ventilator in the acute care setting.

ventilation. ICU utilization has increased over the last several years, especially among Medicare beneficiaries, and utilization is expected to continue increasing. Care for patients requiring mechanical ventilation has been an important part of managing scarce ICU resources. Mechanically ventilated patients have been shown to disproportionately consume resources within ICUs, and it appears that long-staying, difficult to wean patients drive the disproportionate resource use: patients with at least 96 hours of ventilation comprise 39% of all patients undergoing mechanical ventilation, but account for 64% of annual inpatient costs [45]. Moreover, the need for cost effective alternatives to the ICU for mechanically ventilated and other chronic, critically ill patients has been attributed to the expansion of treatment focus of early-operating LTCHs to include care for these patients, new construction of LTCHs, as well as growth in hospital-based SNFs (subacute units) and similar freestanding SNFs [16]. Now, prolonged mechanical ventilation is recognized as a critical care modality that goes beyond the ICU setting to include other settings including step-down units, respiratory care units, and LTCHs [40].

In this section, a brief background on treatment for mechanical ventilation is presented and findings from studies of weaning and mortality outcomes of mechanically ventilated patients are summarized. No studies on mortality and weaning outcomes of patients treated in SNFs were located, so the studies discussed here cover LTCHs, respiratory care units, and IRFs. There were no studies found that directly compared patient outcomes across types of PAC settings for mechanically ventilated patients. Although not directly addressed in research, there is potential for appropriate substitution among PAC providers in the treatment of mechanically ventilated patients. First, the general similarity of patient outcomes across LTCHs, IRFs, and respiratory care units, at least superficially, suggests substitution is possible among patients with prolonged mechanical ventilation. Second, there is an extensive literature measuring the extent of substitution among PAC providers for other patient populations. This literature is useful in that it finds evidence that site of care substitution is extensive among patients with common conditions. Substitution may also be extensive among patients with less common conditions.

There are several different causes of ventilator dependence among patients. Mechanical ventilation is necessary when the respiratory system fails; that is, failure of the ventilatory and/or gas exchange capabilities. Use of ventilator support may be very brief, or it may go beyond 24 hours. Treatment for individuals requiring ventilation for more than 24 hours is focused on not only ventilator management, but also addressing the underlying causes of ventilator dependence [24]. The ability to wean from the ventilator depends on respiratory muscle strength, the load applied to those muscles, and the respiratory drive to breathe [11]. In general, the sooner a patient can be weaned from a ventilator, the better. Unnecessary delays in discontinuation can result in ventilator-related complications. On the other hand, premature extubation carries its own risks. Patients who must be re-intubated have a higher risk of death (6 to 12 times higher), and a higher risk of nosocomial pneumonia (8 times higher). Indeed, treatment guidelines for weaning emphasize the need to balance these risks [24].

While there is a very rich literature on mechanical ventilation, studies focusing on care delivered outside acute hospital ICUs are fairly limited in number and scope. A handful of studies compare mortality and weaning outcomes within LTCHs or respiratory care units within acute hospitals. One multi-center study of LTCHs was recently published. In contrast, just one study of mortality and weaning outcomes in an IRF was found, and no studies of care provided in SNFs were found.

Comparability in mortality and weaning success suggests that care may be interchangeable across these settings. A multi-center study of LTCHs found that 25% of patients treated in 23 different LTCHs died in the facility [40]. This 75% survival rate is somewhat better than what previous studies of single LTCHs found; survival at discharge ranged from 50% to 71% in these studies [33] [5] [3] [39]. One study on patient outcomes at an IRF found that 66% were alive at discharge [32]. Studies of respiratory care units inside acute hospitals report discharge survival between 50% and 94% [18] [21] [14].

Despite differences in study inclusion criteria and definitions of weaning success across studies, weaning success is also fairly comparable. Scheinhorn et al. (2007) found that LTCHs were able to wean 54% of patients. Other studies of single LTCHs found that between 38% and 56% of patients were successfully weaned [33] [5] [3] [39]. The IRF successfully weaned 50% of patients [32]. And, respiratory care units weaned between 34% and 60% of patients [18] [21] [14].

The current study builds on previous work considering patient outcomes in two ways. First, the current study is large, using administrative data for a large sample of patients using SNF care after prolonged mechanical ventilation in an acute hospital, and the universe of such patients who use LTCHs and IRFs for PAC. Second, the current study considers how patient outcomes compare across PAC types. Up to this point, only limited comparison of outcomes across settings has occurred. The main trade-off in this study is that weaning success is not measured in administrative data. Instead, we focus on mortality, PAC complications that make weaning more difficult, PAC complications related to long-term ventilation, length of stay, readmission to acute hospitals (for any reason, and for surgery), and 6-month follow up costs.

In addition to mortality, this study considers differences in PAC complication rates that either impede the weaning process, or are common side-effects of long-term ventilation. Several conditions have been documented with these effects. Urinary Tract Infections (UTI) and clostridium difficile colitis have been found to delay the onset of the weaning process in LTCHs [40]. Renal failure has also been shown to complicate the weaning process; patients receiving hemodialysis have lower weaning success rates [4] [41]. Differences in these complication rates across setting are indicative of how well providers are able to avoid complications to the weaning process.

Complications of long-term ventilation are also well documented. Ventilator-acquired pneumonia is a common ventilator-related complication, occurring, in a large international study of 360 ICUs, among 15% of patients ventilated for more than 48 hours. Patients with ventilator-associated pneumonia experience longer periods of ventilation, but risk of death was not found to be higher among those with pneumonia [42]. Gastrointestinal complications are also related to both the underlying disease process and therapeutic interventions. Mortality is quite high among patients who develop gastrointestinal complications, including GI hemorrhage (which we measure) and being mechanically ventilated for more than 24 hours is one predictive factor of this kind of complication [25]. Finally, deep vein thrombosis has been found to be a fairly common complication among mechanically ventilated patients. One study that 23% of ICU patients who were ventilated for more than 7 days; patients with deep vein thrombosis have a higher risk of pulmonary embolism than those without. In this study, mortality was not found to be higher [17]. By comparing the rates of these types of PAC complications, we measure providers' ability to prevent avoidable types of infections and complications.

In the more general literature on post-acute care, measurement of site of care substitution has typically focused on the extent of substitution, and less so on the appropriateness of substitution. Measuring substitutability in the health industry is notoriously difficult because of the nature of health as a commodity. The unit of care, or the product, is difficult to define; the inputs to care may not be comparable between services or across settings; and the outcomes of care are difficult to measure. Many studies on the substitutability of care across post-acute care setting get around these difficulties by instead comparing clinically similar patients' placement in particular post-acute settings. Rather than measure directly the inputs to care, this patient-placement approach posits that if care among post-acute settings is interchangeable then we should observe clinically similar patients using services across settings with comparable likelihood.

There are issues with this approach. Comparing the likelihood of placement in particular settings among comparable patients measures the extent to which care delivered in post-acute settings are being substituted or are used in place of each other, but does not measure how well one type of care substitutes for another. The patient placement approach implicitly assumes that patients are placed appropriately and does not account for differences in the quality of care. Indeed, very few studies consider differences in the quality and health outcomes of care delivered across settings. Studies of this nature in health services research are somewhat uncommon: randomized controlled studies are exceedingly expensive and have ethical issues, while non-experimental design requires a good method of controlling for unobserved factors related to health outcomes and choice of provider. Lack of patient function and health status data that is comparable across PAC setting has also made comparison of health outcomes particularly difficult in post-acute care.

Measuring the extent that modalities of post-acute care are being substituted for one another is important to policy. The extent of substitution appears to vary over time. Several studies in the early 1990s found that the characteristics of patients differed significantly across post-acute settings. This differentiation suggests that different types of patients seek care from each post-acute modality. More recent findings, however, suggest that SNFs, IRFs, and LTCHs treat similar populations. For example, Gage (1999) used a propensity score technique to test whether the probability of using types of post-acute care varied with patients' inpatient hospital diagnosis after controlling for other health-related factors (e.g. prior disability, hospital readmission, death in current year). This study found that among patients with stroke, respiratory infection, or inflammation, the likelihood of being placed in a SNF, IRF or of receiving home health care differed significantly, suggesting that there is less potential for site of care substitution. But, among patients with one of many other medical conditions commonly requiring post-acute care after a hospital stay (including pneumonia, heart failure and shock, joint/limb reattachment and hip/femur procedures), the likelihood of being placed in various post-acute settings were quite comparable after controlling for disease severity-related factors. Thus, in many cases, the particular health needs of patients do not appear to influence the decision of which type of post-acute modality to use, thereby leaving open the possibility for site of care substitution.

Other studies support Gage's finding of comparable use of different types of post-acute care among clinically similar patients. In a study decomposing the differences in treatment costs between hospital-based and freestanding SNFs, the authors found that higher costs in hospital-based SNFs were primarily due to treatment setting characteristics, rather than selection of patients with disproportionately acute health needs [34]. That is, this study suggests that freestanding and hospital-based SNFs treat on-the-whole comparable populations and that care is costlier on average at hospital-based SNF because of differences setting characteristics (such as higher overhead costs, wage rates, number of beds, chain affiliation, and so on) and not due to differences in patient acuity. Another study of the late 1990s used hospital-based SNFs closures to identify those providers' substitutes. The authors found that among comparable hospitals (likely to have a hospital-based SNF closure), hospitals with a closure between 1997 and 2002 experienced increases in their discharge rates to freestanding SNFs, IRFs and LTCHs (IRFs and LTCHs were pooled). Patients in these hospitals were 2.4% more likely to be discharged to a freestanding SNF, and 2.3% more likely to be discharged to an IRF or LTCH than patients at comparable hospitals not experiencing a closure. This study did not find an association between SNF closure and patient health outcomes at the hospital level [44].

Generally speaking, the studies on post-acute care substitution, patient and non-patient factors related to post-acute care utilization, and geographic variation in use suggest that SNFs, IRFs and LTCHs treat generally comparable populations. The overlap in patient populations suggests that, for better or worse, services across these modalities are being interchanged. These findings suggest that Medicare program costs could be better managed if patients were redirected to the least costly appropriate post-acute care setting. However, the effect on patient outcomes by such management has not been extensively explored by the current literature. The current study adds to the substitution literature by estimating differences in patient outcomes across settings for a set of conditions where treatment is relatively stable across setting. This work sheds light on which post-acute modalities are good substitutes for others.

4.3 Methods

This analysis uses an instrumental variables approach to compare patient outcomes among skilled nursing facilities (SNFs), long-term care hospitals (LTCHs) and inpatient rehabilitation facilities (IRFs) for mechanically ventilated patients. The purpose of comparing patient outcomes of these post-acute care (PAC) providers is to test whether care delivered by SNFs, LTCHs and IRFs is interchangeable, producing similar patient health and cost outcomes.

The primary difficulty in comparing patient outcomes in any observational study is that patients are not randomly assigned to particular providers or treatments. There is a natural endogeneity of provider choice with respect to patient outcomes. The concern in this study is that simply relating patients' observed choice of PAC type (SNF, LTCH or IRF) to their health outcomes would assume that choice of provider is not related to patients' characteristics and health needs (which are, in turn, related to health outcomes). To the contrary, patients should be expected to choose a particular setting specifically because they are likely to benefit from that mode of care. This study uses two instruments for choice of PAC type: differential distance to PAC providers and the number of PAC providers (of each type) within 100 miles of patients' home zip code of residence. These variables were chosen as instruments because these are observable factors that are likely to influence treatment decisions, i.e. choice of PAC type, but it is unlikely to directly affect patient outcomes. Use of differential distance as an instrument is intended to mimic randomization of patients into treatment and control groups [19].

This section presents evidence suggesting that differential distance is, indeed, a valid instrument for choice of PAC type. In addition, I describe the sources of data used in this analysis and the estimation strategy.

4.3.1 Data Sources

The analysis relies on Medicare claims data from 2004 for a sample of beneficiaries using SNFs, LTCHs or IRFs following an acute hospital stay. Patient and institutional stay information comes from the 2004 Medicare Denominator file and Inpatient and SNF Standard Analytic Claim files. Information about health care providers is collected from Medicare's 2004 Provider of Service file. Distances between zip codes centers (definitions as of April 2005[3]) are calculated with the Great Circle Distance Formula.[4]

Patient and institutional stay information are used to construct variables of patient characteristics, disease severity measures, and patient health and cost outcomes. Patients are identified as being mechanically ventilated if they fall into DRG 475 or 483 during their acute hospital stay, and are then followed into their PAC stay (directly following the acute hospital stay). Acute hospital claims for a 10% sample of Medicare beneficiaries with acute hospital stays in 2004 are aggregated to the stay level and matched to SNF follow-up care. Acute hospital claims are likewise aggregated and matched to LTCH and IRF follow-up care for the universe of LTCH users and IRF users. Observations for LTCH and IRF users are weighted to reflect this over-sampling.

Acute hospital stays with either no follow-up care, or care provided by other types of facilities are excluded from analysis. In addition, patients living in rural areas (areas not part of a metropolitan statistical area) are excluded from the analysis.

Tables 4.2 and 4.3 present descriptive statistics of mechanically ventilated pa-

[3]Available online: http://support.sas.com/rnd/datavisualization/mapsonline/html/misc.html
[4]http://support.sas.com/kb/5/325.html

Table 4.2: Characteristics of LTCH, SNF and IRF Patients

	SNF Users	LTCH Users	IRF Users
N	2,026	12,383	3,875
Patient Characteristics			
Age (Mean, Std. Dev.)	74 (11)	71 (3)	70 (2)
Patient Sex: Male	47%	49%	49%
Race: White	78%	75%	83%
Race: Black	17%	20%	13%
Race: Hispanic	2%	3%	2%
Race: Other	3%	3%	2%
Current Medicare Eligibility			
Old Age & Survivors	85%	80%	79%
Disability	14%	18%	19%
ESRD	1%	2%	2%
Original Medicare Eligibility			
Old Age & Survivors	69%	67%	68%
Disability	30%	31%	29%
ESRD	1%	2%	2%
Discharging Hospital Characteristics			
Hospital has LTC Unit	30%	31%	29%
Hospital has Rehab Unit	39%	49%	55%
Hospital has Swing Bed Designation	2%	1%	1%
Hospital has SNF Unit	32%	29%	24%
Hospital: # Beds			
Mean (Std. Dev)	435 (293)	489 (82)	495 (54)
Hospital: # Residents (FTE)			
Mean (Std. Dev)	61 (141)	63 (37)	79 (27)

Source: 2004 Medicare Denominator, Inpatient and SNF claims, 2004 POS file.

tients, stratified by their choice of PAC type (SNF, LTCH and IRF). SNF users tend to be older than LTCH and IRF users and more slightly more likely to be female. SNF users have shorter acute hospital stays, but have higher Charlson Comorbidity Index scores. The Charlson Comorbidity Index ranks patients according to the number and seriousness of co-morbid conditions, and is predictive of risk of death and treatment costs (not specific to post-acute care) [36]. Higher prevalent Congestive Heart Failure, Chronic Obstructive Pulmonary Disease, and Diabetes (without complication) contribute to the higher average Charlson score among SNF users.

SNF, LTCH and IRF users also have different rates of co-morbid conditions significant for ventilator dependent patients. Comorbidity is defined by presence in

Table 4.3: Characteristics of LTCH, SNF and IRF Patients, Cont'd

		SNF Users	LTCH Users	IRF Users
	N	2,026	12,383	3,875
Hospital Stay Information				
	Acute Length of Stay Mean (Std. Dev)	22 (25)	27 (5)	26 (4)
	Charlson Cormorbidity Index: Mean (Std. Dev)	2 (1.6)	2 (0.4)	2 (0.3)
Admitting Diagnosis: MDC				
1	Dis of Nervous System	5.9%	10.1%	9.8%
4	Dis of the Respiratory System	70.1%	47.7%	59.7%
5	Dis of the Circulatory System	8.7%	17.3%	12.3%
6	Dis of the Digestive System	2.9%	7.5%	4.5%
7	Dis of the Hepatobilary Sys & Pancreas	0.3%	0.9%	0.6%
8	Dis of the Musculoskeletal & Conn Tissue	1.0%	2.9%	2.9%
9	Dis of the Skin, Subcutaneous Tiss & Breast	0.3%	0.7%	0.3%
18	Infectious & Parasitic Dis	4.0%	3.7%	2.3%
Acute Hospital Comorbidities				
	Cardiac Arrest	2.9%	5%	4.0%
	C. Difficile Colitis	4.1%	5%	3.5%
	Stroke/Intercrannial Hemorrhage	5.0%	9%	8.1%
	Deep Vein Thrombosis	4.0%	5%	4.9%
	Ileus Gastoparesis	0.1%	0%	0.1%
	GI Hemorrhage	5.5%	6%	5.3%
	Hypotension	4.2%	6%	6.8%
	Acute Pulmonary Embolism	1.2%	2%	2.2%
	Pleural Effusion	6.8%	10%	9.4%
	Pneumothorax	2.1%	4%	4.4%
	Pneumonia	52.8%	49%	50.3%
	Renal Failure	19.3%	26%	21.0%
	Sepsis	6.3%	7%	6.5%
	Urinary Tract Infection	21.2%	18%	13.3%

Source: 2004 Medicare Denominator, Inpatient and SNF claims, 2004 POS file.

the acute hospital stay (in one of the ten diagnosis fields for each inpatient claim; stay records may consist of multiple claims). Mechanically ventilated SNF patients have higher rates of Pneumonia (53%) and Urinary Tract Infections (21%). LTCH patients experience higher rates of renal failure and insufficiency (26%) and pleural effusion (10%). IRF patients experience comorbidity rates in line with SNF and LTCH patients.

Admitting diagnoses were categorized into the 25 Major Diagnostic Categories (MDC). Not surprisingly for mechanically ventilated patients, admitting diagnoses most commonly fell into Diseases of the Respiratory System (70%, 48% and 60% for SNF, LTCH and IRF users, respectively). Admitting diagnoses also commonly fell into Diseases of the Circulatory system, Nervous System, Digestive System, and Infectious & Parasitic Diseases.

4.3.2 Instrumentation for choice of PAC setting

Differential distance appears to be a good instrument for provider choice. It is predictive of provider choice, but it is unlikely to have an independent effect on health and cost outcomes. Evidence presented in this section suggests that patients are more or less randomly located near or far from SNFs, LTCHs and IRFs with respect to their characteristics and measures of disease severity. As the argument goes, if observable characteristics appear balanced across study groups, unobservable factors (which cannot be directly controlled for) are also likely to be balanced across the study groups.

Table 4.4 shows that choice of PAC type is correlated with differential distance among non-rural mechanically ventilated patients and non-rural PAC providers. Differential distances measures how much farther than the closest PAC provider a patient must travel in order to choose a particular type of PAC provider. The farther

Table 4.4: First-Stage Regression Models

Respiratory Failure Absent

	Dependent Variables					
	Use LTCH			Use IRF		
Independent Variables	Coeff.	SE		Coeff.	SE	
Intercept	0.46	0.06	***	0.22	0.02	***
Log DD to LTCH	-0.05	0.01	***	0.01	0.00	**
Log DD to IRF	0.02	0.00	**	0.00	0.00	*
No. SNFs/100 miles	0.00	0.00	***	0.00	0.00	
No. LTCHs/100 miles	0.01	0.00	***	0.00	0.00	***
No. IRFs/100 miles	0.00	0.00	***	0.00	0.00	***
F-Stat	45.04			4.50		
Pr>F	0.00			0.00		
N	7,612			7,612		

Respiratory Failure Present

	Use LTCH			Use IRF		
Independent Variables	Coeff.	SE		Coeff.	SE	
Intercept	0.88	0.10	***	0.07	0.01	***
Log DD to LTCH	-0.08	0.01	***	0.00	0.00	***
Log DD to IRF	0.03	0.01	**	-0.01	0.00	***
No. SNFs/100 miles	0.00	0.00	**	0.00	0.00	***
No. LTCHs/100 miles	0.01	0.00	***	0.00	0.00	
No. IRFs/100 miles	0.00	0.00	***	0.00	0.00	***
F-Stat	45.04			4.55		
Pr>F	0.00			0.00		
N	10,168			10,168		

Source: 2004 Denominator File, Claims files, 2004 POS file.
Note: *** p-value < 0.001; ** p-value < 0.01; * p-value< 0.05

patients must travel in order to choose a SNF, LTCH or IRF, the less likely patients are to choose any provider of that type. For example, 68% of patients whose closest PAC provider is a SNF (meaning the differential distance to a SNF is zero) choose to use a SNF for care following their acute hospital stay. Among patients whose closest PAC provider is not a SNF (for whom differential distance is greater than zero), the proportion of SNF users drops off to 56%. As the proportion choosing SNFs falls, the proportion of mechanically ventilated patients who choose LTCHs and IRFs increases. This relationship is also apparent with respect to differential distance to LTCHs. It is weaker for IRFs.

Rural patients and providers are excluded from the analysis; they are defined as those patients and providers located in a zip code not part of a metropolitan statistical area. Patients are excluded because they tend to have different health characteristics than urban patients and reside further from all types of providers.

SNFs are the most common type of PAC provider, with about 15,000 operating in 2004, compared to 353 LTCHs and about 1500 IRFs. Only about 1% of mechanically ventilated patients reside nearest to a PAC provider other than a SNF (the 99th %ile is 2.4 miles). The median differential distance to LTCHs is 6.7 miles. The median differential distance to IRFs is 3.0 miles. In most cases, if the differential distance to SNFs is zero, patients must travel farther in order to choose a LTCH or IRF (and the differential distance is positive). There is not complete trade-off between differential distances between SNFs, LTCHs and IRFs, however. Because the distance calculation uses the center of the zip code, rather than patients' and providers' addresses, differential distance is the same across PAC types where the nearest of multiple types are located in the same zip code. SNFs serve as the reference group for the analysis.

The second criterion that an instrument must meet to be valid is to be distributed more or less randomly with respect to the unobserved characteristics influencing treatment outcome. Differential distance would not be a good instrument for choice of PAC type if it were associated with patient characteristics predictive of the health and cost outcomes of interest. If this were the case, differential distance would

Table 4.5: Instrument Validation

	Differential Distance to LTCH			Differential Distance to IRF		
Patient Characteristics	≤ 16 Miles	> 16 Miles		≤ 5 Miles	> 5 Miles	
Age (Mean, (SD))	72.91, (4.4)	72.94, (5)		73.02, (4.6)	72.73, (4.4)	**
Patient Sex: Male	48%	47%	*	48%	47%	*
Race: White	72%	88%	**	73%	86%	**
Race: Black	22%	8%	**	21%	10%	**
Race: Hispanic	3%	2%	**	3%	1%	**
Race: Other	3%	2%	**	3%	2%	**
Current MCR Ent.: OASI	83%	85%	**	83%	84%	**
Current MCR Ent.: DI	15%	14%	**	15%	15%	
Current MCR Ent.: ESRD	2%	1%	**	1%	1%	**
Discharging Hospital Characteristics						
Has LTC Unit	32%	27%	**	34%	23%	**
Has Rehab Unit	44%	39%	**	50%	27%	**
Has Swing Bed	1%	2%	**	1%	2%	**
Has SNF Unit	30%	32%	**	33%	27%	**
No. Beds (Mean, (SD))	73, (58)	40, (52)	**	74, (62)	40, (45)	**
No. Residents (Mean, (SD))	483, (121)	388, (121)	**	478, (120)	401, (123)	**
Hospital Stay Information						
LOS (Mean, (SD))	23.24, (9.2)	24.37, (9.9)	**	24.14, (10)	22.47, (7.8)	**
Charlson Score (Mean, (SD))	1.99, (0.6)	2.05, (0.8)	**	2, (0.6)	2.03, (0.7)	**
Nervous System	8%	6%	**	7%	7%	**
Respiratory System	63%	65%	**	62%	66%	**
Digestive System	5%	4%	**	5%	4%	**
Hepatobiliary Sys & Pancreas	1%	0%	**	1%	0%	**
Musc. Sys & Conn. Tiss	2%	2%		2%	1%	*
Skin, Subcut. Tissue & Brst	1%	0%	**	1%	0%	**
Infectious & Parasitic Dis	4%	4%	*	5%	2%	**
Acute Hospital Comorbidities						
Cardiac Arrest	3%	4%		4%	3%	**
C. Difficile Colitis	4%	4%	**	5%	3%	**
Stroke/Intrcrnl. Hemorrhage	7%	5%	**	7%	5%	**
Deep Vein Thrombosis	5%	4%	**	5%	4%	**
GI Hemorrhage	6%	5%	**	6%	5%	**
Hypotension	5%	5%	**	5%	4%	**
Acute Pulmonary Embolism	1%	1%		1%	1%	
Pleural Effusion	8%	8%		8%	8%	*
Pneumothorax	3%	3%	**	3%	3%	**
Pneumonia	51%	52%		51%	53%	**
Renal Failure	22%	20%	**	21%	21%	
Sepsis	7%	6%	**	7%	6%	**
Urinary Tract Infection	21%	18%	**	21%	18%	**

Source: 2004 Denom. & Claims files, 2004 POS file. Differences sig. at the ** 1% and * 5% level.

Table 4.6: Instrument Validation, Continued

	No. of SNFs w/in 100 Miles			No. of LTCHs w/in 100 Miles		
Patient Characteristics	≤ 240	> 240		≤ 20	> 20	
Age (Mean, (SD))	72, (4)	74, (5)	**	72, (5)	74, (4)	**
Patient Sex: Male	47%	49%	**	47%	49%	**
Race: White	78%	76%	**	78%	77%	**
Race: Black	18%	17%	*	15%	20%	**
Race: Hispanic	2%	3%	**	3%	2%	**
Race: Other	2%	4%	**	4%	2%	**
Current MCR Ent.: OASI	82%	86%	**	82%	85%	**
Current MCR Ent.: DI	16%	13%	**	16%	13%	**
Current MCR Ent.: ESRD	2%	1%	**	1%	1%	
Discharging Hospital Characteristics						
Has LTC Unit	34%	26%	**	33%	27%	**
Has Rehab Unit	47%	37%	**	41%	44%	**
Has Swing Bed	1%	1%	**	2%	1%	**
Has SNF Unit	30%	32%	**	33%	29%	**
No. Beds (Mean, (SD))	45, (44)	84, (74)	**	40, (46)	86, (66)	**
No. Residents (Mean, (SD))	462, (125)	442, (117)	**	443, (127)	463, (117)	**
Hospital Stay Information						
LOS (Mean, (SD))	22.8, (7.1)	24.6, (12.5)	**	23.4, (8.2)	23.6, (10.6)	
Charlson Score (Mean, (SD))	2.02, (0.6)	2, (0.7)		1.99, (0.7)	2.02, (0.7)	
Nervous System	7%	7%		7%	7%	**
Respiratory System	63%	63%		64%	63%	*
Digestive System	4%	4%		4%	4%	**
Hepatobilary Sys & Pancreas	1%	0%	*	0%	0%	
Musc. Sys & Conn. Tiss	2%	2%		2%	2%	**
Skin, Subcut. Tissue & Brst	0%	1%		0%	0%	
Infectious & Parasitic Dis	4%	4%	**	4%	4%	**
Acute Hospital Comorbidities						
Cardiac Arrest	3%	4%		4%	3%	**
C. Difficile Colitis	3%	5%	**	3%	6%	**
Stroke/Intrcrnl. Hemorrhage	7%	6%	**	7%	6%	**
Deep Vein Thrombosis	4%	5%	**	4%	5%	**
GI Hemorrhage	6%	6%	*	6%	6%	**
Hypotension	5%	5%		5%	5%	
Acute Pulmonary Embolism	2%	1%	**	2%	1%	**
Pleural Effusion	8%	8%		7%	8%	**
Pneumothorax	3%	2%	**	3%	2%	**
Pneumonia	51%	52%	**	53%	50%	**
Renal Failure	22%	20%	**	22%	20%	**
Sepsis	7%	7%		7%	6%	**
Urinary Tract Infection	19%	21%	**	19%	21%	**

Source: 2004 Denom. & Claims files, 2004 POS file. Differences sig. at the ** 1% and * 5% level.

Table 4.7: Instrument Validation, Continued

	Number of IRFs w/in 100 Miles		
Patient Characteristics	≤ 70	> 70	
Age (Mean, (SD))	71.91, (4.3)	74.07, (4.9)	**
Patient Sex: Male	47%	49%	**
Race: White	80%	74%	**
Race: Black	15%	20%	**
Race: Hispanic	3%	2%	*
Race: Other	3%	3%	**
Current MCR Ent.: OASI	82%	86%	**
Current MCR Ent.: DI	17%	12%	**
Current MCR Ent.: ESRD	1%	1%	
Discharging Hospital Characteristics			
Has LTC Unit	32%	29%	**
Has Rehab Unit	42%	43%	*
Has Swing Bed	2%	1%	**
Has SNF Unit	32%	30%	**
No. Beds, (Mean, (SD))	42, (43)	86, (73)	**
No. Residents (Mean, (SD))	459, (126)	447, (116)	**
Hospital Stay Information			
LOS (Mean, (SD))	22.8, (7.2)	24.5, (11.9)	**
Charlson Score (Mean, (SD))	2.01, (0.6)	2.01, (0.7)	
Nervous System	7%	7%	
Respiratory System	64%	62%	**
Digestive System	4%	4%	
Hepatobilary Sys & Pancreas	1%	0%	**
Musc. Sys & Conn. Tiss	2%	2%	
Skin, Subcut. Tissue & Brst	0%	0%	
Infectious & Parasitic Dis	4%	4%	**
Acute Hospital Comorbidities			
Cardiac Arrest	3%	4%	**
C. Difficile Colitis	3%	6%	**
Stroke/Intrcrnl. Hemorrhage	6%	7%	**
Deep Vein Thrombosis	4%	5%	**
GI Hemorrhage	6%	5%	**
Hypotension	5%	5%	
Acute Pulmonary Embolism	2%	1%	**
Pleural Effusion	8%	7%	**
Pneumothorax	3%	2%	**
Pneumonia	52%	52%	
Renal Failure	22%	20%	**
Sepsis	6%	7%	
Urinary Tract Infection	18%	22%	**

Source: 2004 Denom. & Claims files, 2004 POS file.
Differences are significant at the ** 1% and * 5% level.

not mimic randomization into study groups. Of course, how differential distance is distributed with respect to unobserved patient characteristics cannot be assessed. But, information from the Medicare inpatient claims and Denominator files suggests that, to the extent that it can be assessed, differential distance is a good instrument for choice of PAC type.

There are no major differences in patient characteristics and acute hospital stay information across groups above and below mean values of differential distance to LTCHs, IRFs, and number of SNFs, LTCHs and IRFs within 100 miles (Tables 4.5, 4.6, and 4.7). Mechanically ventilated patients residing nearest to LTCHs tend to be slightly younger, slightly more likely to be non-white, and slightly more likely to be disabled (current Medicare entitlement category). These patients have a slightly lower Charlson comorbidity score. Among the conditions that contribute to the Charlson score, these patients have slightly lower prevalence rates of Acute Myocardial Infarction, cancer and diabetes without complication. Patients are overall similar in terms of admitting diagnoses and rates of comorbid conditions. Dummy variables for the Major Diagnostic Categories are mutually exclusive. Dummy variables for comorbid conditions significant for ventilator dependent patients are not mutually exclusive. Patients nearest to LTCHs experience renal failure and urinary tract infections at slightly higher rates than patients further away from LTCHs. Similar patterns are present above and below mean value of differential distance to IRFs.

The greatest differences across LTCH and IRF groups are in the characteristics of the discharging acute care hospitals. Patients nearer LTCHs tend to be treated in hospitals offering long-term care (not necessarily a Long-Term Care Hospital), and housing an IRF and SNF (hospital-based providers). Patients located nearer LTCHs tend also to be treated in larger hospitals, with more total beds and more physicians.

These differences are present even after removing rural patients. Differences in discharging hospital characteristics over quartiles of distance to IRFs are similar, but patients between the 25th and 50th %ile of differential distance (located between 0.5 and 3.0 miles from IRFs) appear to be treated in the larger hospitals.

Overall, information from the Medicare claim and Denominator files for mechanically ventilated patients suggests that differential distance can be used as an instrument for choice of PAC type. Differential distance is correlated with choice of PAC type, and patients appear to be more or less randomly distributed in differential distance with respect to their observable characteristics. Of course, it cannot be verified with absolute certainty that differential distance is not correlated with unobserved factors influencing treatment choices, but with the information available, it appears that differential distance can mimic randomization into study groups.

4.3.3 Estimation Strategy

This analysis will follow a typical two-stage least squares estimation strategy. Differential distances to LTCHs and IRFs are log-transformed, and linear models are estimated.

The first stage models are:

$$\text{LTCH user} = \beta + \beta_1 DD_{LTCH} + \beta_2 DD_{IRF} + \beta_3 S100 + \beta_4 L100 + \beta_5 I100 + \beta_6 X + \beta_4 H$$

$$\text{IRF user} = \beta + \beta_1 DD_{LTCH} + \beta_2 DD_{IRF} + \beta_3 S100 + \beta_4 L100 + \beta_5 I100 + \beta_6 X + \beta_4 H$$

where LTCH user and IRF user are the observed choices of PAC type. DD_{LTCH} and DD_{IRF} represent the log-transformed differential distances to LTCHs and IRFs; differential distance to SNFs is the exclude category. The variables S100, L100 and

Table 4.8: Study Outcome Variables

Outcome Measure	Notes
1 Year Mortality	
90 Day Mortality	
60 Day Mortality	
30 Day Mortality	From acute hospital discharge
C. Difficile Colitis	
Deep Vein Thrombosis	
GI Hemorrhage	
Pneumonia	
Acute Renal Failure	Condition is absent in acute hospital stay,
Urinary Tract Infection	but present during PAC stay
Acute Readmission	Admission for any reason, following directly from PAC discharge
Acute Readmission: Surgery	Surgery DRG listed in acute hospital claim, following PAC discharge
6- month follow up costs	Study population limited to stays occurring in January to June 2004; Medicare expenditure.

I100 are the number of SNFs, LTCHs and IRFs within 100 miles of beneficiary residence, respectively. X is a matrix of patient characteristics; H is a matrix of discharging hospital characteristics. Selected results from the first-stage model are shown in Table 4.4; the full models are in appendix Tables B through B.

The second stage is:

$$\text{Outcome} = \gamma + \gamma_1 \widehat{LTCH} + \gamma_2 \widehat{IRF} + \gamma_3 X + \gamma_4 H$$

where outcomes include patient health and cost outcomes listed in Table 4.8. The predicted values for using an LTCH and IRF, rather than the observed choice of PAC type, are used in the second stage. The same set of patient and discharging hospital characteristics used in the first stage are used in the second stage. Mortality measures begin counting days at the discharge from the acute care hospital. Conditions must be newly present in the PAC stay (rather than the acute hospital stay) in order to be considered a PAC complication.

Next we proceed with the results.

4.4 Results

This section presents the regression results of patients outcomes among patients with prolonged mechanical ventilation during their acute hospital stay, followed by PAC stays at SNFs, LTCHs and IRFs. We find divergent patterns in patient mortality among SNFs, LTCHs and IRFs among patients with and without respiratory failure present during the PAC stay. Among patients where respiratory failure is not present during the PAC stay, LTCHs appear to produce substantially better mortality results than SNFs and IRFs. However, among patients where respiratory failure is present during the PAC stay, LTCH patients experience significantly higher mortality than SNF and IRF patients. We propose that, among this higher severity group of patients, LTCHs substitute more appropriately for acute care hospital care than PAC, and confounds the comparison of patient outcomes among SNFs, LTCHs and IRFs.

Tables presented in this section include tables of observed outcomes rates (mortality, complications, readmission, etc) among SNF, LTCH and IRF users, as well as uninstrumented, basic linear probability models, and the instrumented linear probability models. The uninstrumented models correct for differences in the observable among SNF, LTCH and IRF users. Our main findings are based on the instrumented model results, as these models use the instrumented PAC choice to help control for unobserved differences across facilities.

Tables 4.9, 4.10 and 4.11 present observed mortality, PAC complication, and acute hospital readmission rates, as well as 6-month follow up Medicare spending among SNF, LTCH and IRF patients with and without respiratory failure reported in their PAC claims. Patients with ICD-9 codes 518.81, 518.82, 518.83 or 518.84 in at

Table 4.9: Mortality in PAC Setting, by Respiratory Failure Status

	No Respiratory Failure			Respiratory Failure Present		
	SNF	LTCH	IRF	SNF	LTCH	IRF
1 Year Mortality	47%	50%	24%	52%	63%	33%
90 Day Mortality	33%	34%	13%	36%	44%	20%
60 Day Mortality	27%	28%	10%	28%	35%	16%
30 Day Mortality	19%	17%	6%	18%	21%	11%
Sample N	1,350	3,553	2,998	676	8,830	877

Source: 2004 Medicare Denominator, Inpatient and SNF claim files, 2004 POS file

least one of up to 12 diagnosis fields from SNF, LTCH and IRF claims are assigned to the respiratory failure group. Patients with respiratory failure are commonly treated in each of the three settings.[5] Table 4.9 shows that within each site of care, mortality is consistently higher among patients with respiratory failure than without. In addition, mortality is consistently highest is among patients who use LTCHs than those who choose SNFs and IRFs. Patients treated in LTCHs have consistently higher rates of PAC complications than SNF and IRF patients; these rates are fairly comparable between patients with and without respiratory failure in the PAC setting. LTCH patients have lower readmission rates to hospitals than SNF and IRF patients; average spending following an LTCH stays is much higher than among SNF and IRF patients.

Superficially, it appears that LTCH produce the worse mortality outcomes among all patients, those with respiratory failure and those without. However, there are several potential causes of higher mortality among LTCH patients that are not related to the care patients receive in LTCHs. Not least of these is that LTCHs may draw a sicker, higher disease severity set of patients than do SNFs and IRFs. Chap-

[5]Recall that the analysis sample consists of roughly 10% patients who use SNFs and the universe of patients who use LTCHs and IRFs for PAC services. Based on the 10% sample, we estimate that a total of 6,760 and 13,500 patients with and without respiratory failure choose SNFs for the PAC setting. Taking this into account, about 70% of patients without respiratory failure are treated in SNFs and about 40% of patients with respiratory failure are treated in SNFs.

Table 4.10: Complications in PAC Setting, by Respiratory Failure Status

	No Respiratory Failure			Respiratory Failure Present		
PAC Complications	SNF	LTCH	IRF	SNF	LTCH	IRF
C. Difficile Colitis	0.9%	8.7%	4.1%	0.3%	8.8%	4.2%
Deep Vein Thrombosis	1.1%	5.0%	3.3%	1.6%	4.7%	2.2%
GI Hemorrhage	1.6%	3.3%	1.2%	1.5%	4.2%	1.5%
Pneumonia	7.3%	15.2%	5.5%	6.1%	17.2%	7.5%
Acute Renal Failure	1.2%	5.4%	1.6%	1.5%	6.2%	2.9%
Urinary Tract Infection	2.1%	15.5%	9.5%	3.1%	15.2%	7.3%

Source: 2004 Medicare Denominator, Inpatient and SNF claim files, 2004 POS file

Table 4.11: Readmission and Follow-up Costs following PAC, by Respiratory Failure Status

	Respiratory Failure Present			Respiratory Failure Absent		
	SNF	LTCH	IRF	SNF	LTCH	IRF
Acute Readmission	28%	12%	16%	30%	13%	22%
Acute Readmission: Surgery	3%	4%	3%	3%	3%	4%
6-month Follow Up Medicare Spending	$145,493	$676,917	$466,341	$130,337	$620,553	$502,528

Source: 2004 Medicare Denominator, Inpatient, SNF and other claim files, 2004 POS file

ter 2 of this dissertation compares disease severity measures among LTCH, SNF and IRF caseloads and found that patients who were discharged to LTCHs longer acute hospital stays (14 days, compared to 4- 7 days among SNF and IRF patients), and slightly higher Charlson Comorbidity Index scores (2.15, compared to 1.44 to 2.0 among SNF and IRF patients). To adjust for differential sorting of patients into LTCHs, SNFs and IRFs along the dimension of disease severity, we control for observable patient factors and instrument for choice of PAC setting to control for unobservable factors related to choice of setting. First, results for mortality, PAC complications, readmission and follow-up cost outcomes are presented for patients without respiratory failure in the PAC setting. Second, we present regression results for patients with respiratory failure. To test if substitution potentially confounds the relationship between patient outcomes and PAC setting, we test whether LTCH patients have significantly shorter acute hospital length of stay than SNFs and IRFs using the same instrumental variables approach used in other models.

4.4.1 Results for Patients without Respiratory Failure in the PAC Setting

Tables 4.12 and 4.13 present results from two sets of regression models for each measure of mortality, PAC complication, readmission, and follow-up outcomes. The top panel of each table presents the basic, uninstrumented, linear probability regression results. Each line represents a single regression model where the outcome variable is regressed upon indicators for LTCH and IRF use, as well as patient characteristics, discharging hospital characteristics, and region. These tables present coefficients and standard errors for variables of interest; the full models are presented in the appendix. The bottom panel presents the two-stage least squares regression (IV models) results. The first stage models (regressions of LTCH use and IRF use on differential distance to the nearest LTCH and IRF, as well as the number of SNFs, LTCHs and IRFs located within 100 miles from each beneficiary, patient and hospital characteristics, and region) are presented in the appendix. In the second stage models, LTCH and IRF indicators are the predicted indicators from the first stage models.

Model results from Table 4.12 suggest that LTCHs produce significantly better mortality outcomes among patients who do not have respiratory failure in the PAC setting. The basic linear probability models show that after controlling for observable patient characteristics and other factors, LTCHs' one-year mortality is about 4 percentage points above the SNF rate. Other LTCH mortality rates cannot be distinguished from SNF mortality rates. Instrumenting for PAC choice yields significantly lower mortality in LTCHs than SNFs. SNF patients in this have an observed one-year mortality rate of 47%; instrumented models suggest that LTCH patient mortality is lower than comparable SNF patients by 27.7 percentage points. With

Table 4.12: No Respiratory Failure in PAC: Basic and Instrumented Regression Models

Linear Probability Model	Independent Variables					
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
1 Year Mortality	0.041	0.019 **	-0.200	0.017 ***	0.0915	7,869
90 Day Mortality	0.017	0.018	-0.178	0.016 ***	0.0737	7,869
60 Day Mortality	0.005	0.017	-0.160	0.015 ***	0.0621	7,869
30 Day Mortality	-0.013	0.015	-0.110	0.013 ***	0.0566	7,869
Instrumented Linear Probability Model						
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
1 Year Mortality	-0.277	0.119 **	-0.362	1.034	0.046	7,612
90 Day Mortality	-0.225	0.111 **	0.111	0.989	0.0188	7,612
60 Day Mortality	-0.242	0.108 **	0.735	0.953	.	7,612
30 Day Mortality	-0.216	0.095 **	0.286	0.828	.	7,612

Source: 2004 Medicare Denominator, Inpatient and SNF claims, 2004 POS file.
Note: Each line represents a single regression model, where LTCH and IRF are independent variables.
Note: Full models are presented in the appendix.
*** p-value <0.001; ** p-value <0.05

respect to IRFs, the basic linear models suggest that after controlling for patient observables, IRF patients experience lower mortality than SNF patients. However, instrumentation does not produce differentiable rates from SNFs.

Observed differences in PAC complication rates among SNF, LTCH and IRF patients are confirmed in the basic linear models in Table 4.13. These models show that after controlling for patient observables, LTCH and IRF patients experience higher rates of many PAC complications than SNF patients. These conditions are clinically relevant to mechanically ventilated patients and are newly present during the PAC stay. The IV models produce somewhat mixed results. For C. Difficile Colitis, Acute Renal Failure, and Urinary Tract Infection, the IV models suggest that LTCH patients experience higher complication rates than comparable SNF patients. In all cases, the IV coefficients are larger than the basic linear probability models. If LTCHs drew patients with relatively high disease severity and a greater risk of developing these complications, we would expect the IV coefficients to be smaller

Table 4.13: No Respiratory Failure in PAC: Basic and Instrumented Regression Models

Linear Probability Model	Independent Variables					
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
C. Difficile Colitis	0.082	0.005 ***	0.036	0.004 ***	0.050	7869
Deep Vein Thrombosis	0.042	0.004 ***	0.026	0.004 ***	0.029	7869
GI Hemorrhage	0.014	0.006 **	-0.005	0.005	0.028	7869
Pneumonia	0.081	0.010 ***	-0.014	0.009	0.041	7869
Acute Renal Failure	0.043	0.005 ***	0.008	0.004 **	0.024	7869
Urinary Tract Infection	0.125	0.008 ***	0.070	0.007 ***	0.079	7869
Instrumented Linear Probability Model						
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
C. Difficile Colitis	0.111	0.029 ***	0.036	0.157	0.045	7612
Deep Vein Thrombosis	0.013	0.031	0.510	0.268 *	.	7612
GI Hemorrhage	0.011	0.024	-0.417	0.255	.	7612
Pneumonia	0.184	0.068	-0.522	0.584	.	7612
Acute Renal Failure	0.053	0.020 ***	-0.234	0.161	.	7612
Urinary Tract Infection	0.132	0.031 ***	-0.149	0.262	0.027	7612

Source: 2004 Medicare Denominator, Inpatient and SNF claims, 2004 POS file.
Note: Each line represents a single regression model, where LTCH and IRF are independent variables.
*** p-value <0.001; ** p-value <0.05; * p-value <0.10

Table 4.14: No Respiratory Failure in PAC: Basic and Instrumented Regression Models

Linear Probability Model	Independent Variables					
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
Acute Readmission	-0.183	0.017 ***	-0.136	0.016 ***	0.066	7,869
Acute Readmission: Surgery	0.002	0.007	-0.006	0.007	0.046	7,869
Log Medicare Spending	1.758	0.267 ***	3.623	0.235 ***	0.1122	4,623
Instrumented Linear Probability Model						
	LTCH		IRF		Model Fit	
Dependent Variable	Coefficient	Std. Err	Coefficient	Std. Err	R-Sqrd	N
Acute Readmission	-0.235	0.111 **	-1.916	0.957 **	.	7,612
Acute Readmission: Surgery	0.029	0.032	-0.601	0.390	.	7,612
Log Medicare Spending	2.51	1.71	5.51	11.67	0.106	4,623

Source: 2004 Medicare Denominator, Inpatient and SNF claims, 2004 POS file.
Note: Each line represents a single regression model, where LTCH and IRF are independent variables.
Note: Full models are presented in the appendix.
*** p-value <0.001; ** p-value <0.05

than coefficients in the basic linear model. Consequently, it appears that LTCHs do not draw patients with higher underlying risk for these complications. For other conditions, the IV models are inconclusive as to whether LTCH patients experience different rates of complications than SNF patients. Only for Deep Vein Thrombosis do IRF patients experience significantly higher complication rates than SNF patients. For other conditions related to mechanical ventilation, the models are inconclusive.

We conduct analogous two-stage least squares regression analysis to test whether LTCH patients have fewer readmission to hospitals for any reason and for surgery (using the surgery DRGs to indicate whether a patient had surgery during a hospital stay). We find that, following PAC stays, LTCH and IRF patients have significantly fewer readmission to hospitals for any reason, but not significantly fewer readmissions for surgery than comparable SNF patients. In addition, although LTCH and IRF patients had much higher follow-up spending following their PAC stay, the IV results suggests that spending is not conclusively different than spending by SNF patients. These outcomes are meant to offer a sense of the economic outcomes of LTCH and IRF care compared to SNF care. Unfortunately, they are not very conclusive. It is not surprising that LTCHs care is less often followed by acute readmission; as accredited hospitals, LTCHs and IRFs are designed to address many of their patients health needs and would be capable treating emergent conditions.

4.4.2 Results for Patients with Respiratory Failure in the PAC Setting

Tables 4.15 and 4.16 present the basic and two-stage least squares mortality and complications results for patients with respiratory failure reported during the PAC stay. The mortality results are quite divergent from patterns among patients who do not have respiratory failure reported during the PAC stay. Unlike those results, the IV models suggest that LTCH patients experience higher mortality rates than

Table 4.15: Respiratory Failure Present in PAC: Basic and Instrumented Regression Models

Linear Probability Model	Independent Variables					
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
1 Year Mortality	0.154	0.021 ***	-0.134	0.025 ***	0.113	10,321
90 Day Mortality	0.124	0.019 ***	-0.105	0.022 ***	0.097	10,321
60 Day Mortality	0.102	0.018 ***	-0.078	0.021 ***	0.070	10,321
30 Day Mortality	0.043	0.016 **	-0.045	0.018 **	0.037	10,321
Instrumented Linear Probability Model						
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
1 Year Mortality	0.287	0.069 ***	-1.256	1.387	.	10,168
90 Day Mortality	0.200	0.064 **	-0.380	1.336	0.084	10,168
60 Day Mortality	0.210	0.061 ***	0.192	1.305	0.054	10,168
30 Day Mortality	0.227	0.052 ***	1.452	1.260	.	10,168

Source: 2004 Medicare Denominator, Inpatient and SNF claims, 2004 POS file.
Note: Each line represents a single regression model, where LTCH and IRF are independent variables.
Note: Full models are presented in the appendix.
*** p-value <0.001; ** p-value <0.05

SNF patients. For example, one-year mortality among SNF patients is 52%. The IV models suggest that the LTCH mortality rate is 28.7 percentage points above the rate of comparable SNF patients.

Results for PAC complications follow roughly the same pattern as found among patients without respiratory failure. That is, the basic linear models confirm higher observed rates of many complications among LTCH and IRF patients than SNF patients with positive and significant coefficients. The IV results are again mixed: for several conditions, the IV results suggest that the LTCH and IRF complication rates cannot be distinguished from SNF rates; in other words, instrumenting does not give a conclusive answer as whether LTCHs and IRFs produce different complication rates than SNFs. But, for a few conditions (Pneumonia, Acute Renal Failure, and Urinary Tract Infection) LTCH patients experience higher complication rates than comparable SNF patients.

The divergent patterns in mortality between patients with and without respira-

Table 4.16: Respiratory Failure Present in PAC: Uninstrumented and Instrumented Regression Models

Linear Probability Model	Independent Variables					
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
C. Difficile Colitis	0.084	0.005 ***	0.037	0.007 ***	0.050	10,321
Deep Vein Thrombosis	0.022	0.007	-0.001	0.008	0.022	10,321
GI Hemorrhage	0.028	0.006 ***	0.004	0.006	0.023	10,321
Pneumonia	0.101	0.011 ***	0.012	0.014	0.045	10,321
Acute Renal Failure	0.047	0.005 ***	0.016	0.007 **	0.025	10,321
Urinary Tract Infection	0.118	0.008 ***	0.042	0.011 ***	0.061	10,321
Instrumented Linear Probability Model						
	LTCH		IRF		Model Fit	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err	R-Sqrd	N
C. Difficile Colitis	0.085	0.011	0.115	0.198	0.047	10,168
Deep Vein Thrombosis	0.015	0.019	-0.247	0.393	.	10,168
GI Hemorrhage	0.004	0.017	0.369	0.392	.	10,168
Pneumonia	0.169	0.041 ***	0.484	0.605	.	10,168
Acute Renal Failure	0.038	0.013 ***	-0.337	0.272	.	10,168
Urinary Tract Infection	0.099	0.024 ***	-0.317	0.509	0.030	10,168

Source: 2004 Medicare Denominator, Inpatient and SNF claims, 2004 POS file.
Note: Each line represents a single regression model, where LTCH and IRF are independent variables.
Note: Control variables (patient characteristics and discharging hospital characteristics) presented in appendix.
*** p-value <0.001; ** p-value <0.05; * p-value <0.10

tory failure suggest that instrumentation does not perfectly correct for differential sorting into PAC settings among patients with respiratory failure reported in their PAC claims. Its seems unlikely that LTCHs would produce significantly better mortality outcomes among patients without respiratory failure, but perform worse among patients with greater disease severity when LTCHs are designed specifically to treat high disease severity patients with complex medical conditions. As such, this analysis is not able to make strong conclusions about how LTCH care compares to care provided by other PAC providers. We are left with a puzzle regarding the value of LTCH care for mechanically ventilated patients. On one hand, patients who have higher disease severity or are less likely to recover (in ways that are not directly observable in the claims data) may systematically sort into LTCHs, driving the differential results among respiratory failure patients. On the other hand, it is possible that LTCHs play a fundamentally different role in treating respiratory failure patients compared to SNFs and IRFs than they do in treating patients without respiratory failure. In either case, it is difficult to draw causal inferences about the value of LTCH care for either group.

Sensitivity analysis (results not presented), using a proxy for whether patients are weaned from the ventilator at acute hospital discharge (using ICU and total length of stay, and ventilation procedure dates), revealed the same patterns in mortality in patients with and without respiratory failure (among patients who appear to not be ventilated during the PAC stay). Regression results among patients who appear to be ventilated during the PAC stay are not precisely estimated to draw conclusions. These results suggest that the mystery of how LTCH care compares to other PAC settings might be better understood by examining differences between patients with and without respiratory failure, understanding the clinical sequelae of the medical condition, patient characteristics related to choice of PAC setting, as well as differences in treatment across PAC settings.

4.5 Conclusion

Long-Term Care Hospitals are paid substantially more to treat patients following acute hospital stays than are SNFs and IRFs. Differences in payment rates for treating apparently similar patients may reflect a number of factors, including differences in treatment regimen, labor and other inputs devoted to patient care, and the cost of those inputs. However, by maintaining separate payment systems for SNFs, LTCHs and IRFs, the Medicare program runs the risk of paying providers vastly different amounts to provide very similar treatment to similar patients. The risk of inefficiency in PAC payment systems was highlighted in Chapter 2 of this dissertation. In that analysis, we found that LTCH patient caseloads are much more similar to the caseloads of SNFs and IRFs than previously thought. Although treatment was found to be more medically intense than treatment provided by SNFs and IRFs, the differences do not seem substantial enough to fully explain the difference in payment that we observed for patients who received mechanical ventilation during their acute hospital stay. For patients in DRG 475 and 483 during the acute hospital stay, LTCHs receive between \$31,000 and \$45,000 more than SNFs for treating the same class of patients.

This study examined differences in patient health and cost outcomes of care provided in SNFs, LTCHs, and IRFs to test whether LTCHs, being paid substantially more than other providers, were able to produce better health outcomes. The answer to our research question is not an unequivocal yes.

We found that among patients without respiratory failure during their PAC stay, LTCHs appear to achieve substantially lower mortality than among comparable SNF patients. However, the rates of some PAC complications are higher among LTCH patients than SNF patients. However, because the results for patients with respiratory failure are large and statistically significant, but counterintuitive, we do not conclude that there is a causal link between treatment setting and patient outcomes for either group.

Further studies would do well to investigate the relationship between respiratory failure and treatment and outcomes across PAC settings. In addition, future study should concentrate on differences in payments to acute care hospitals and LTCHs to better understand how payment for the whole episode compares across patients.

CHAPTER V

Conclusion

The purpose of this dissertation was to investigate the market behavior of Long-Term Care Hospitals (LTCHs), to examine payment system incentives impact LTCHs treatment decisions, and to measure the extent of substitution, and the quality of substitution between LTCHs and other PAC providers. This work focused on a few specific questions. First, are LTCHs more similar to conventional post-acute care (PAC) providers in their patient caseloads and practices; and can local market characteristics explain LTCHs uneven geographical distribution? Second, to what extent does LTCHs eligibility criterion (that they must maintain length of stay averages above 25 days) affect their practice patterns under prospective payment? Finally, how well do SNFs, LTCHs and IRFs substitute for each other in the care of mechanically ventilated patients?

The major findings of this work are the following. First, LTCHs are fairly similar to conventional PAC providers like SNFs and IRFs. LTCH care appears to be substituted for hospital-based PAC, and LTCH caseloads and practices are not unlike these other providers. Moreover, LTCHs tend to be located in areas that may be underserved by other providers of relatively intense PAC. Like other health care providers, LTCHs appear to favor areas that appear to have a higher propensity to use acute and post-acute services. Second, also like other health care providers, LTCHs respond strongly to changes in financial incentives, and appear to protect their financial well-being. Finally, although the Medicare program risks inefficiency in their PAC payment systems by allowing payment to vary across payment systems for essentially the same care, it does appear that paying LTCHs more than other providers supports better outcomes. This might not be the case across the board, but at least for this set of patients, differential payment does not appear inefficient.

The common goal among these three separate analyses was to consider LTCHs within the larger contexts of post-acute care, of intricate systems of financial incentives, and of health care markets. To this end, the analysis has revealed some important lessons about how policy can shape the future of the LTCH industry. Similarity between LTCHs and hospital-based PAC providers calls into question Medicare's practice of reimbursing, regulating and covering services along the same dimension. Currently, all LTCHs, all SNFs, and all IRFs face the same coverage and reimbursement rules. Fairness and equity dictate that classes of providers that treat similar sets of patients, provide similar treatment and produce comparable patient outcomes, ought to be treated similarly. That LTCHs are more similar to, and appear to substitute for hospital-based SNFs and IRFs suggests that payment could be calibrated within this set of providers. Calibration of payment rates should not ignore the specific clinical benefits of receiving care in LTCHs, hospital-based SNFs or IRFs for particular patient groups.

Growth and clustering of LTCHs in metropolitan areas also has implications for Medicare's governance of payment to LTCHs. Findings from Chapter 3 suggest that the 25-day eligibility criterion for LTCHs is probably not too strict. The eligibility criterion is a policy tool that can be used to protect access to LTCH care for the most resource-needy patients. Requiring that LTCHs provide stays lasting at least 25 days on average may counteract the forces of competition among LTCHs, as well as the financial incentive inherent to prospective payment to admit patients with relatively low resource needs. As LTCHs grow, and cluster in areas with greater propensity to use acute and post-acute services, the eligibility criterion will continue to be an important tool to protect the integrity of Medicare's LTCH benefit. Other policy tools are available to Medicare, including using patient criteria to limit LTCH admissions among patients who could be more appropriately treated in other types of PAC settings. This may slow the growth of LTCHs in some areas, and, potentially, indirectly encourage new LTCHs to locate in communities that are not currently served.

This dissertation has also reveals directions for future research in post-acute care. First, it is important to understand how the value of LTCH care compares to care provided in other settings for a broader set of patients. This work focused specifically on the set of patients that LTCHs are best known for, but these patients do not represent the full population served by LTCHs. Second, further attention should be given to measuring the substitutability of LTCH and acute hospital care. The instrumental variables approach used in Chapter 4 was not able to fully capture this phenomenon. Consequently, alternative estimation strategies need to be considered.

APPENDICES

APPENDIX A

Appendix for Chapter 3

Table A.1: Length of Stay Models: Full Models

		Model 1			Model 2		
		Coeff.	SE		Coeff.	SE	
	PPS	-9.10	2.99	**	-5.69	2.05	**
	Middle Group	-13.07	3.76	**	-10.71	3.02	***
	Middle Group x PPS	8.89	3.51	*	4.14	2.22	*
	Low Group	-16.03	4.62	*	-13.33	3.81	**
	Low Group x PPS	11.15	3.91	**	5.78	2.72	*
	Fiscal Month	-0.13	0.05	**	-0.44	0.17	**
	Middle Group x Fiscal Month				0.43	0.19	*
	Low Group x Fiscal Month				0.49	0.25	*
	LTCH For-Profit	-1.17	1.53		-1.14	1.52	
	LTCH Age Cohort: Before 10/1983	3.98	4.21		3.95	4.21	
	LTCH Age Cohort: 10/1983-1993	-1.01	1.86		-1.01	1.86	
	LTCH No. of Beds	0.05	0.04		0.05	0.04	
	Patient Age	-0.07	0.03	*	-0.07	0.03	*
	Patient Sex: Male	0.01	0.41		0.01	0.41	
	No. of Major Diagnostic Categories	-3.97	0.93	***	-3.96	0.93	***
1	Nervous System	6.34	1.05	***	6.32	1.04	***
2	Eye	7.06	4.83		7.04	4.83	
3	Ear, Nose, Mouth & Throat	4.05	0.79	***	4.04	0.79	***
4	Respiratory System	6.16	0.82	***	6.14	0.82	***
6	Digestive System	6.22	1.10	***	6.22	1.09	***
7	Hepatobiliary Sys. & Pancreas	-0.52	1.32		-0.54	1.32	
8	Musculoskeletal System and Connective Tissue	3.09	0.79	***	3.09	0.79	***
9	Skin, Subcutaneous Tissue & Breast	9.27	0.69	***	9.26	0.69	***
10	Endocrine, Nutritional, & Metabolic System	2.94	0.59	***	2.93	0.59	***
11	Kidney & Urinary Tract	6.42	0.74	***	6.41	0.74	***
12&13	Reproductive System	1.76	0.84	*	1.75	0.84	*
16	Blood, Blood Forming Organs, & Immunological Disorders	3.75	0.95	***	3.73	0.95	***
17	Myeloproliferative & Poorly Differentiated Disorders	-1.39	0.96		-1.42	0.97	
18	Infectious & Parasitic Diseases	6.95	0.69	***	6.94	0.69	***
19	Mental Diseases & Disorders	3.87	1.71	*	3.86	1.71	*
20	Alcohol/Drug Use or Induced Mental Disorders	1.58	1.04		1.58	1.04	
21	Injuries, Poison, & Toxic Effect of Drugs	7.46	0.77	***	7.44	0.77	***
22	Burns	4.48	2.06	*	4.46	2.06	*
23	Factors Influencing Health Status	1.55	0.73	*	1.53	0.73	*
25	HIV Infection	0.59	7.79		0.52	7.79	
	Constant	40.68	5.69	***	39.01	5.32	***
	Observations	154,555			154,555		
	F-Statistic	49.85			46.84		
	Pr > F	0.00			0.00		
	R-squared	0.03			0.03		

Source: 2001-2003 MedPAR, 2004 Medicare Claims, 2004 POS file
*** p-value < 0.000, ** p-value < 0.01, * p-value < 0.10

APPENDIX B

Appendix for Chapter 4

Table B.1: First Stage Regression Models: Full Models
Respiratory Failure Absent

	Dependent Variables					
	Use LTCH			Use IRF		
Independent Variables	Coeff.	SE		Coeff.	SE	
Intercept	0.46	0.06	***	0.22	0.02	***
Log DD to LTCH	-0.05	0.01	***	0.01	0.00	**
Log DD to IRF	0.02	0.00	**	0.00	0.00	*
No. SNFs/100 miles	0.00	0.00	***	0.00	0.00	
No. LTCHs/100 miles	0.01	0.00	***	0.00	0.00	***
No. IRFs/100 miles	0.00	0.00	***	0.00	0.00	***
Age	0.00	0.00	**	0.00	0.00	***
Patient Sex: Male	0.01	0.01		0.00	0.00	
Race: Black	-0.04	0.01	**	-0.01	0.00	**
Race: Hispanic	-0.03	0.03		-0.02	0.01	*
Race: Other	-0.01	0.03		0.00	0.01	
Region: Northeast	-0.07	0.02	***	-0.02	0.01	*
Region: Midwest	-0.07	0.02	***	-0.03	0.01	***
Region: West	0.04	0.02	*	0.00	0.01	
Current MCR Entitlement: DI	-0.02	0.02		-0.02	0.01	*
Current MCR Entitlement: ESRD	-0.22	0.09	*	-0.09	0.03	**
Orig. MCR Entitlement: DI	-0.02	0.01		-0.02	0.00	***
Orig. MCR Entitlement: ESRD	0.23	0.09	*	0.07	0.04	
Charlson Comorbidity Score	0.00	0.00		0.00	0.00	**
Nervous System	0.09	0.02	***	0.01	0.01	
Eye	0.04	0.02		0.91	0.01	***
Ear, Nose, Mouth and Throat	0.08	0.05		-0.01	0.02	
Circulatory System	0.19	0.02	***	0.01	0.01	*
Digestive System	0.24	0.03	***	0.02	0.01	*
Hepatobiliary Sys and Pancreas	0.20	0.10	*	0.02	0.03	
Musc. Sys and Connective Tissue	0.26	0.05	***	0.04	0.02	**
Skin, Subcut. Tissue and Breast	0.16	0.09		-0.02	0.02	
Endocrine, Nut. and Metabolic Sys	0.02	0.04		-0.02	0.01	
Kidney and Urinary Tract	0.11	0.04	**	-0.02	0.01	
Reproductive System	0.12	0.13		-0.02	0.03	
Blood, Bld Form. Organs & Immun. Dis.	0.26	0.12	*	0.06	0.04	
Myeloproliferative and Poorly Diff. Dis	-0.12	0.05	**	-0.02	0.04	
Infectious and Parasitic Diseases	0.04	0.02	*	-0.01	0.01	
Mental D & D	0.04	0.05		0.00	0.02	
Alcohol/Drug Use or Induced Mental Dis	0.86	0.06		-0.06	0.02	***
Injuries, Poison, and Toxic Effect of Drugs	0.16	0.06	**	0.03	0.02	
Burns	0.27	0.21		0.03	0.06	
Factors Inflncng Health Status	0.00	0.03		-0.02	0.01	
HIV	0.04	0.09		0.02	0.06	

Note: Regression results continued on the next page.

Table B.2: First Stage Regression Models: Full Models, Continued
Respiratory Failure Absent

	Dependent Variables					
	Use LTCH			Use IRF		
Independent Variables	Coeff.	SE		Coeff.	SE	
ARDS: comorbid	-0.06	0.01	***	0.00	0.00	
Cardiac Arrest: comorbid	0.01	0.05		-0.05	0.03	
Clostridium Difficile Colitis: comorbid	-0.01	0.02		-0.01	0.01	
Stroke/Intrcrnl Hemorrhage: comorbid	0.01	0.02		0.02	0.01	*
Deep Vein Thrombosis: comorbid	0.01	0.02		0.01	0.01	
Ileus Gastroparesis	0.06	0.16		-0.03	0.04	
GI Hemorrhage: comorbid	-0.04	0.02	*	0.00	0.01	
Hypotension: comorbid	0.01	0.04		0.06	0.02	**
Pulmonary Embolism: comorbid	-0.01	0.04		0.03	0.02	
Pleural Effusion: comorbid	0.00	0.02		0.00	0.01	
Pneumothorax: comorbid	0.08	0.04	*	0.02	0.01	
Pneumonia: comorbid	-0.01	0.01		0.00	0.00	
Renal Failure/Insuff: comorbid	0.04	0.01	**	0.01	0.00	
Sepsis with Shock: cormorbid	0.01	0.02		0.01	0.01	
UTI: comorbid	-0.03	0.01	**	-0.02	0.00	***
Hospital has LTC Unit	-0.01	0.01		0.00	0.00	
Hospital has Rehab Unit	0.03	0.01	**	0.03	0.00	***
Hospital has SNF Unit	-0.05	0.01	***	-0.03	0.00	***
Hospital is Swing Bed	-0.08	0.03	**	-0.01	0.01	
Hospital: For-Profit	0.06	0.02	**	0.02	0.01	**
Hospital: Government	-0.02	0.01		0.00	0.01	
No. of Residents	0.00	0.00		0.00	0.00	
No. of Beds	0.00	0.00		0.00	0.00	
F-Stat	40.04			4.50		
Pr >F	0.00			0.00		
N	7,612			7,612		

Source: 2004 Denominator file, Claims file, 2004 POS file.
*** p-value < 0.000, ** p-value < 0.01, * p-value < 0.05

Table B.3: First Stage Regression Models: Full Models
Respiratory Failure Present

	Dependent Variables					
	Use LTCH			Use IRF		
Independent Variables	Coeff.	SE		Coeff.	SE	
Intercept	-0.08	0.01	***	0.07	0.01	***
Log DD to LTCH	0.03	0.01	**	0.00	0.00	***
Log DD to IRF	0.00	0.00	**	-0.01	0.00	***
No. SNFs/100 miles	0.01	0.00	***	0.00	0.00	
No. LTCHs/100 miles	0.00	0.00	***	0.00	0.00	***
No. IRFs/100 miles	0.00	0.00	***	0.00	0.00	***
Age	-0.03	0.02	**	0.00	0.00	***
Patient Sex: Male	0.01	0.02		0.00	0.00	
Race: Black	0.12	0.05		-0.01	0.00	***
Race: Hispanic	-0.01	0.04	*	0.00	0.00	
Race: Other	-0.13	0.03		0.00	0.00	
Region: Northeast	0.05	0.03	***	0.01	0.00	*
Region: Midwest	0.01	0.03	*	-0.01	0.00	*
Region: West	-0.03	0.04		-0.01	0.00	*
Current MCR Entitlement: DI	-0.16	0.20		0.00	0.00	
Current MCR Entitlement: ESRD	0.01	0.02		-0.01	0.01	
Orig. MCR Entitlement: DI	0.11	0.21		-0.01	0.00	***
Orig. MCR Entitlement: ESRD	-0.01	0.01		0.01	0.01	***
Charlson Comorbidity Score	0.22	0.04	**	0.00	0.00	
Nervous System	0.43	0.07	***	0.00	0.00	
Eye	0.35	0.11	***	-0.04	0.01	**
Ear, Nose, Mouth and Throat	0.20	0.03	**	0.00	0.02	
Circulatory System	0.28	0.04	***	0.00	0.00	
Digestive System	0.28	0.10	***	-0.01	0.00	*
Hepatobiliary Sys and Pancreas	0.25	0.07	**	-0.02	0.01	
Musc. Sys and Connective Tissue	0.21	0.15	***	0.01	0.01	
Skin, Subcut. Tissue and Breast	0.28	0.07		0.00	0.01	
Endocrine, Nut. and Metabolic System	0.12	0.06	***	-0.01	0.00	
Kidney and Urinary Tract	0.46	0.03	***	-0.01	0.00	***
Reproductive System	0.24	0.18		-0.02	0.00	***
Blood and Blood For. Organs and Immun. Dis.	-0.06	0.17	***	-0.03	0.00	***
Myeloproliferative and Poorly Diff. Dis	0.09	0.05		-0.02	0.01	***
Infectious and Parasitic Diseases	0.48	0.04		-0.01	0.00	**
Mental Diseases and Disorders	-0.20	0.12	***	0.00	0.02	
Alcohol/Drug Use or Induced Mental Disorders	0.29	0.09		0.03	0.05	
Injuries, Poison, and Toxic Effect of Drugs	-0.07	0.23	**	0.00	0.01	
Burns	0.13	0.07		0.00	0.02	
Factors Influencing Health Status	0.55	0.15		0.00	0.01	
HIV	-0.03	0.02	***	-0.03	0.01	**

Note: Regression results continued on the next page.

Table B.4: First Stage Regression Models: Full Models, Continued
Respiratory Failure Present

	Dependent Variables					
	Use LTCH			Use IRF		
Independent Variables	Coeff.	SE		Coeff.	SE	
ARDS: comorbid	0.00	0.08		0.00	0.00	
Cardiac Arrest: comorbid	0.09	0.04		-0.02	0.01	
Clostridium Difficile Colitis: comorbid	0.11	0.04	*	0.00	0.00	
Stroke/Intrcrnl Hemorrhage: comorbid	-0.03	0.04	**	0.00	0.00	
Deep Vein Thrombosis: comorbid	-0.07	0.13		0.00	0.00	
Ileus Gastroparesis	0.03	0.04		-0.02	0.01	
GI Hemorrhage: comorbid	0.06	0.06		0.00	0.00	
Hypotension: comorbid	0.10	0.08		0.02	0.01	*
Pulmonary Embolism: comorbid	0.13	0.03		0.01	0.01	
Pleural Effusion: comorbid	0.14	0.05	***	0.01	0.00	*
Pneumothorax: comorbid	0.00	0.02	**	0.00	0.00	
Pneumonia: comorbid	0.02	0.02		0.00	0.00	
Renal Failure/Insuff: comorbid	0.05	0.04		0.00	0.00	
Sepsis with Shock: cormorbid	-0.03	0.02		-0.01	0.00	*
UTI: comorbid	-0.01	0.02		-0.01	0.00	**
Hospital has LTC Unit	0.03	0.02		0.00	0.00	
Hospital has Rehab Unit	-0.06	0.02		0.00	0.00	
Hospital has SNF Unit	-0.10	0.08	**	-0.01	0.00	***
Hospital is Swing Bed	0.01	0.03		0.00	0.01	
Hospital: For-Profit	-0.05	0.03		0.00	0.00	
Hospital: Government	0.00	0.00		0.00	0.00	
No. of Residents	0.00	0.00	*	0.00	0.00	
No. of Beds				0.00	0.00	
F-Stat	45.05			4.55		
Pr>F	0.00			0.00		
N	10,168			10,168		

Source: 2004 Denominator file, Claims file, 2004 POS file.
*** p-value < 0.000, ** p-value < 0.01, * p-value < 0.05

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