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Physical Therapy Utilization and Length of Stay among Patients with Low Back Pain in Florida Hospitals

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Physical Therapy Utilization and Length of Stay among Patients with Low Back Pain in Florida Hospitals

by

Kyle A. Watterson

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy with a concentration in Health Services Research Department of Health Policy and Management College of Public Health University of South Florida

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Keywords: policy, hospitalization, physical therapist

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Abstract

Purpose: The purpose of this work was identify key factors associated with inpatient physical therapy utilization and length of stay for patients with low back pain (LBP) in Florida hospitals.

Rationale: Little is known about factors associated with inpatient physical therapy or length of hospitalization for patients with LBP. This group of works identified the key factors associated with inpatient physical therapy and long lengths of hospitalization for this patient population. Since physical therapy and reduced length of stay are known cost-reducers, identifying key factors may represent significant cost savings to the health care system.

Methods: Several mixed method procedures were utilized to examine physical therapy utilization and length of hospitalization between the years of 1992 and 2014. Policy, patient and hospital characteristics, as well as, hospital procedures during a patient’s stay were examined as contributors to either physical therapy utilization or length of hospitalization.

Conclusion: Many factors are associated with inpatient physical therapy utilization and length of stay for patients with LBP in Florida hospitals.
Chapter 1

Introduction

Abstract

Purpose: The purpose of this work was identify key factors associated with inpatient physical therapy utilization and length of stay for patients with low back pain (LBP) in Florida hospitals.

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Methods: Several mixed method procedures were utilized to examine physical therapy utilization and length of hospitalization between the years of 1992 and 2014. Policy, patient and hospital characteristics, as well as, hospital procedures during a patient’s stay were examined as contributors to either physical therapy utilization or length of hospitalization.

Conclusion: Many factors are associated with inpatient physical therapy utilization and length of stay for patients with LBP in Florida hospitals.
The overall goal of this body of work is to examine the population in Florida hospitalized with low back pain (LBP) in three distinct analyses. The main focal areas were physical therapy utilization for the entire hospitalized LBP population and length of stay from a sample of those having surgery for LBP. The importance of looking at physical therapy utilization was to assess the extent to which patients received this clinical practice guideline concordant treatment while hospitalized for LBP. Length of stay was examined to assess lengthy stays, which is an adverse outcome that results in significant costs for patients and their health plans. The purpose for the three analysis papers are described in the following sections.

The purpose of the first analysis was to examine a federal discharge policy written for patients with Medicare insurance to assess whether it had an effect on physical therapy utilization for the 3 years before and the 3 years after its implementation in 1995. The importance associated with this study was to see if treatment behavior changed as a result of the public policy in a change-resistant provider population. The hypothesis was that the federal discharge policy partially explained physical therapy utilization.

The purpose of the second analysis was to examine physical therapy utilization for patients hospitalized with LBP. This paper had 2 objectives. The first objective was to describe the patient population hospitalized in Florida for LBP between the years of 1991 – 2014. The second objective was to find patient and hospital characteristics as well as, hospital procedures associated with physical therapy utilization for inpatients with LBP over the timeframe of the data. This objective included a secondary, more in-depth examination of factors associated with physical therapy utilization from 2010 – 2014. The hypotheses were that the Florida LBP population would resemble other national samples,
where several patient and hospital factors, as well as hospital procedures, were associated with physical therapy utilization.

The purpose of the third analysis was to identify factors associated with lengths of stay greater than 7 days for patients who had surgery for LBP in Florida hospitals between the years of 2010 – 2014. This study had broad significance as length of stay is directly associated with charges and costs. The objective was to identify key variables that could improve selection for patients undergoing low back surgery. The hypothesis was that those receiving more invasive surgery, those with higher comorbidity counts, those in for-profit facilities, and those with post-operative complications would be directly associated with having lengths of stay greater than 7 days.

Overall, these analyses give insight into a population that has historically demonstrated significant medical waste. This insight may help policy makers and other stakeholders make informed decisions about the pathway of care that patients with LBP receive during an inpatient stay. The analyses shed light on the possibility of physical therapy having a larger intervention role in the care of patients hospitalized with LBP.

**Literature Review**

Low back pain (LBP) is pain, muscle tension, or stiffness occurring at the posterior trunk between the 12th ribs (costal margin) and the inferior gluteal folds and can occur with or without leg pain (sciatica).\(^1\)\(^-\)\(^5\) It lasts longer than 1 day and interferes with daily activities.\(^6\) LBP is widely reported in the United States and other industrialized countries with a lifetime prevalence of 60 - 85 percent,\(^7\)\(^-\)\(^9\) a point prevalence of around 30 percent,\(^8\)\(^,\)\(^10\)\(^,\)\(^11\) and an annual incidence of 5 - 15 percent.\(^8\)\(^,\)\(^12\) It is the most reported musculoskeletal problem\(^8\)\(^,\)\(^12\) and a leading reason for health care utilization and
hospitalization\textsuperscript{13}. Approximately one-fourth to one-half of all persons with LBP will seek medical care\textsuperscript{14,15} accounting for 2.3 - 4.5 percent of all general physician visits\textsuperscript{12,16,17}. It is the most common reason for sick leave and missed work\textsuperscript{2,16,18} often the first reason to seek medical care as an adult\textsuperscript{4} and the leading cause of years lived with disability\textsuperscript{16,19,20}.

Fortunately, most LBP is self-limiting, has an excellent prognosis, and resolves in 80 – 90 percent of the population within 12 weeks\textsuperscript{7,8,11,21,22}. Pain that is present for up to 12 weeks from onset is referred to as acute LBP\textsuperscript{4}. Risk factors for the development of acute LBP are multifactorial and are due to individual characteristics, psychosocial factors, and occupation levels\textsuperscript{1,3,23}. Table 1.1 provides a list of risk factors contributing to the development of acute LBP. Goals of treatment during the acute phase are to “reduce pain, improve function, reduce time away from work, and to develop coping strategies through education.”\textsuperscript{4} Acute LBP is often recurrent and is usually non-specific meaning a clear anatomic cause cannot be identified in 80 – 90 percent of patients\textsuperscript{1,4,24}. When symptoms persist beyond 12 weeks, LBP is classified as chronic LBP\textsuperscript{1,24,25}. Chronic LBP is responsible for considerable suffering throughout the world\textsuperscript{19} and is responsible for vast use of health care services.

**Table 1.1 – Risk Factors for LBP.**

<table>
<thead>
<tr>
<th>Risk Factors for the Occurrence of LBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual factors</td>
</tr>
<tr>
<td>Age, low level of fitness, high BMI, weakness in the back and abdominal muscles, smoking, education level</td>
</tr>
<tr>
<td>Psychosocial factors</td>
</tr>
<tr>
<td>Stress, pain behaviors , anxiety and depression</td>
</tr>
<tr>
<td>Occupational factors</td>
</tr>
<tr>
<td>Manual labor, recurrent bending or twisting motions, whole body vibration, job dissatisfaction, monotonous tasks, poor work relations, lack of control</td>
</tr>
</tbody>
</table>

Prevalence of chronic LBP is rising nationwide\textsuperscript{11} and, according to Freburger et al\textsuperscript{26} chronic LBP in North Carolina more than doubled between 1992 and 2006. This has
become a challenge to the health care system as it encompasses a large population of people with a nebulous condition looking for treatment.\textsuperscript{27,28} It is expected that as the population ages this number will continue to increase.\textsuperscript{11}

When a specific structural “pain generator” is not located, other individual, social, and economical risk factors contributing to the development of chronic LBP must be considered.\textsuperscript{1,11,21} Table 1.2 provides a list of risk factors contributing to the development of chronic LBP. Once individuals develop chronic LBP, their condition is not likely to improve,\textsuperscript{29} and it is often resistant to any treatment,\textsuperscript{30} including surgery.\textsuperscript{24,25} Two of the many reasons for the lack of improvement are due to inconsistent prescription and differing reimbursement policies.\textsuperscript{31} Another reason for the lack of improvement is due to the complexity of the patients being treated. Individuals with chronic LBP usually demonstrate high levels of anxiety and depression,\textsuperscript{19} as well as chronic widespread pain.\textsuperscript{1,24} Such persons, in a quest for relief, show high rates of invasive procedures and opioid dependence, as well as low rates of return to work.\textsuperscript{32} Once chronic symptoms develop, high levels of pain and disability and low rates of return to work remain constant\textsuperscript{22} with return to work dropping to zero percent at 2 years.\textsuperscript{1,8} Due in large part to this low rate of return to work, chronic LBP is responsible for a large economic burden on society.\textsuperscript{1,33}
Table 1.2 – Risk Factors for Chronic LBP.

<table>
<thead>
<tr>
<th>Risk Factors for the Development of Chronic LBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual factors</td>
</tr>
<tr>
<td>Psychosocial factors</td>
</tr>
<tr>
<td>Occupational factors</td>
</tr>
</tbody>
</table>

According to Moorin et al.\textsuperscript{34} LBP causes “personal, social, and economic cost through pain and disability, work absenteeism and the use of health services”. LBP is the most expensive musculoskeletal condition\textsuperscript{34} and consumes “substantial health care resources”.\textsuperscript{35} In the United States alone, during the decade between 1997 and 2007, the direct yearly economic burden was estimated to be between 12.2 and 90.6 billion\textsuperscript{33} with most authors citing a figure between 50 and 86 billion yearly.\textsuperscript{14,36} When indirect costs are further calculated this economic burden balloons substantially with amounts escalating to between 85 and 624 billion yearly as estimated in 2007.\textsuperscript{33} These indirect estimates take into account work absenteeism but they may not take into account significant reduced work performance when working while experiencing LBP.\textsuperscript{18}

The direct costs incurred while treating LBP makes it one of the most expensive medical condition in the United States\textsuperscript{2} with only the medical conditions of heart disease and stroke costing significantly more.\textsuperscript{36} The reasons for this high expenditure for LBP is due to two primary reasons. First, the prevalence of chronic LBP is increasing as is the number of patients seeking care.\textsuperscript{26} According to Martin et al.\textsuperscript{37} the treated prevalence for spinal care was 12.5 percent in 2006 accounting for 21.9 million patients. This was an
increase in prevalence of nearly 3 percent and an increase of more than 7 million people since 1997. The second reason for high expenditure for LBP is that costs for spinal care and spinal treatment are escalating. For example, “National expenditures for spine problems increased 82 percent, or an average of 7 percent per year, from 1997 to 2006”.36 Another study over nearly the same timeframe estimated an inflation-adjusted increase for spinal care at 65 percent over the 8 year sample.36 This is most likely due to more intensive use of expensive testing and treatment for the condition of LBP.38 In essence, LBP has a large and growing prevalence, and a high and rising cost for diagnosis and treatment for each health care service user. In the case of LBP those with chronic LBP contribute the most to costs with a small minority of patients generating a large majority of the costs.39 Luo et al.13 notes that 10 percent of patients are responsible for more than 50 percent of the expenditures, 25 percent for more than 75 percent of the expenditures and 50 percent for more than 90 percent. Often, these cases may be considered the most challenging and severe cases of chronic LBP.6

If the increase in expenditures resulted in significant improvements in the LBP population then the substantial costs could be justified. Unfortunately, this is not the case and overall, LBP care meets the definition of medical waste (increased expenditure without improvement in health status).36 Trends over time show that despite increased spending, health status is not improving for those individuals with LBP.36,37 “Significant savings to the health care system could be realized if the back pain population could receive more cost effective treatment.”13 Because LBP is one of the most costly public health issues in the 21st century it has become a major target for quality improvement40
and has prompted the federal Agency for Healthcare Research and Quality (with guidance by the Institute of Medicine) to name LBP as a top 15 priority condition.\textsuperscript{41,42}

The main reason that LBP is difficult to treat is because a universal effective treatment does not exist and clinicians are often left to their own beliefs as to what may be an effective treatment.\textsuperscript{43} A second reason that LBP is difficult to treat is that a wide variety of health care professionals are involved in the management of LBP.\textsuperscript{44,45} Table 1.3 provides a list of providers who commonly treat LBP. This results in high treatment variability and overlap that ultimately results in medical waste. In order to combat this variability and improve outcomes (and reduce medical waste), clinical practice guidelines for the diagnosis and treatment of LBP have been developed.

\textbf{Table 1.3 – Health Care Providers for LBP.}

<table>
<thead>
<tr>
<th>Common Primary Health Care Providers for LBP</th>
<th>Specialist physicians</th>
</tr>
</thead>
<tbody>
<tr>
<td>General physicians</td>
<td>Massage therapists</td>
</tr>
<tr>
<td>Physical therapists</td>
<td>Psychologists</td>
</tr>
<tr>
<td>Chiropractors</td>
<td>Kinesiologists</td>
</tr>
<tr>
<td>Osteopaths</td>
<td>Rehabilitation technicians</td>
</tr>
<tr>
<td>Manual therapists</td>
<td></td>
</tr>
</tbody>
</table>

Clinical practice guidelines are, "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances".\textsuperscript{31} There are at least 12 international clinical practice guidelines published for the treatment of LBP.\textsuperscript{44} Although some discrepancies exist between the international guidelines\textsuperscript{46,47} a general overview of some of the United States’ diagnostic and treatment clinical practice guidelines for LBP are discussed by topic as follows: imaging, education, medication, referrals, and surgery.
Imaging

Routine imaging (plain film x-rays or radiographs) for LBP is not indicated.\textsuperscript{48,49} Imaging is appropriate; however, for those cases exhibiting “red flags”\textsuperscript{47} or for those cases that are potential candidates for surgery.\textsuperscript{50,51} Red flags are signs, symptoms, or other findings that indicate a more serious underlying pathology may exist manifesting as LBP.\textsuperscript{7} Table 1.4 provides a list of etiologies that may present as LBP and may require imaging.\textsuperscript{4,7,24} Routine imaging is not useful for nonspecific LBP\textsuperscript{47} and does not improve outcomes.\textsuperscript{49} X-rays do not commonly direct treatment as, “there is no firm evidence of a causal relationship between radiographic findings and nonspecific low back pain.”\textsuperscript{52}

**Table 1.4** – Etiologies that may Require Imaging.

<table>
<thead>
<tr>
<th>Cancer</th>
<th>Cauda equine syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture (trauma, osteoporosis)</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td></td>
</tr>
<tr>
<td>Other severe mechanical derangements</td>
<td></td>
</tr>
</tbody>
</table>

Advanced imaging which is commonly either magnetic resonance imaging (MRI) or computed tomography (CT) is also not advised in the absence of red flags or surgical considerations.\textsuperscript{49} In fact, these imaging modalities are shown to be drivers of cost.\textsuperscript{53} Direct costs of the procedures are significant with charges estimated to be between $875 and $1,500 per procedure.\textsuperscript{53} There are also significant downstream costs from having advanced imaging including more follow-up visits, referrals, further testing, which may ultimately end with invasive procedures of small benefit.\textsuperscript{49,53} A study by Webster and Cifuentes\textsuperscript{51} revealed that an early MRI versus having no MRI resulted in more medical utilization, including repeated MRIs and an increased surgery rate. They found no benefit from early MRI utilization. Another study evaluated the rates of advanced imaging and
the rates of invasive procedures.\textsuperscript{54} The locations with the most imaging had the most surgeries and 22 percent of the variability in spinal procedures was attributed to the rates of imaging. The probable reason for the higher observed medical utilization is that imaging (especially advanced imaging) commonly finds abnormalities (which are sometimes shocking) that lack correlation with symptoms.\textsuperscript{5,52,55} A study by Jensen et al.\textsuperscript{5} revealed that MRI findings explained very little regarding patients’ complaints of LBP, but did explain more of reported leg pain. A proposed reason was that imaging cannot capture pain mechanisms including chemical changes that take place at the site of the complaint.\textsuperscript{5} Another reason that imaging is not recommended is due to harm incurred from the modality.\textsuperscript{53} Both radiographs and CT scans submit patients to low-level radiation exposure, which could contribute to the development of cancer.\textsuperscript{53} Berrington de Gonzalez and colleagues\textsuperscript{56} estimated an additional 1,200 future cancer cases from the CT scans performed in the United States in 2007 for evaluation of low back pain. The last reason that imaging is not recommended is due to the effects of labeling. Labeling occurs when a patient is told that they have a condition that they were not aware of previously, which results in higher care seeking behavior.\textsuperscript{49}

**Education**

Education should be considered the primary emphasis for the treatment of LBP.\textsuperscript{57} This is a strong recommendation with moderate quality evidence supporting the need of education for the condition of LBP.\textsuperscript{48} Education should include the following:\textsuperscript{47,48,50,57}

- LBP has an overall favorable prognosis.
- Significant improvements in pain and disability are expected in the first few months of the condition.
- Imaging is not recommended, usually cannot identify a specific cause, does not improve outcome, and incurs cost.
- Self-management should include remaining active, progressing activity, and limiting bed rest.
- Psychosocial factors are risk factors for developing chronic LBP.

These educational recommendations are consistently found through all international guidelines.\textsuperscript{47,50} Some international guidelines also mention continuation or early return to work as important to increase patient motivation.\textsuperscript{50} Education alone is not an effective treatment for LBP and must be combined with other traditional elements to significantly effect change in the LBP population.\textsuperscript{58}

**Medication**

Medication, or drug therapy, is the most commonly prescribed treatment for LBP.\textsuperscript{16} In a review of the evidence for an American Pain Society/American College of Physicians clinical practice guideline, Chou and Huffman\textsuperscript{59} found good evidence that moderate effects in short term pain relief is expected form acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDS), and skeletal muscle relaxants for acute LBP. Likewise, they cited small to moderate effects are expected from anti-depressants for chronic LBP.\textsuperscript{59} This was echoed in another review by van Tulder and colleagues.\textsuperscript{44} However, when opioids were evaluated, evidence was “sparse and inconclusive”\textsuperscript{59} and use of narcotic medication should be used judiciously for select cases with severe, disabling pain.\textsuperscript{48} Their final recommendations were that trials of medications should be as presented in Table 1.5. In both the original and updated international clinical practice guideline reviews for the treatment of LBP in primary care, Koes et al.\textsuperscript{47,50} noted that there is consistent agreement in the use of acetaminophen and NSAIDS as an initial medicinal treatment therapy. However, beyond those medications there is significant international discrepancies for the use of anti-depressants, skeletal muscle relaxants, and opioids. In
conclusion, trials of medicinal therapy for the treatment of LBP should include acetaminophen or NSAIDS as a first attempt in pain control, and other appropriate medications may be appropriate for carefully selected patients.44,48,57

Table 1.5 – Medication Recommendations for LBP.

<table>
<thead>
<tr>
<th>Mild to moderate pain</th>
<th>Acetaminophen</th>
</tr>
</thead>
<tbody>
<tr>
<td>More severe pain</td>
<td>NSAIDS</td>
</tr>
<tr>
<td>Severe, disabling pain</td>
<td>Opioids in appropriately selected patients</td>
</tr>
</tbody>
</table>

**Referrals**

For acute LBP, referrals to orthopedic surgeons, neurologists, or other specialists are generally not recommended unless the patient exhibits red flags or is a surgical candidate.48 This recommendation follows that of imaging. However, if after screening for psychosocial factors the patient exhibits risks for chronicity, then referral to behavioral counseling is recommended.44,50 This type of behavioral counseling is commonly termed cognitive behavior therapy (CBT) which is a type of treatment that assists individuals in alterations of the way they act, feel, think, and cope with a situation or condition.60 The cognitive aspect of treatment helps to identify and modify one’s thoughts about their pain or disability while the behavior component works to reinforce thoughts by acting in a manner consistent with those beliefs.44

The last recommended referral for acute LBP is for spinal manipulation. Manipulation is often performed by a chiropractor or an osteopath for small to moderate short term benefits for acute LBP.44,48 However, international guidelines show variability for this treatment with recommendations both for and against spinal manipulation.47

Referrals for chronic LBP are slightly different than those for acute LBP. For chronic LBP, supervised exercises, exercise therapy, or active physical therapy is
recommended for clinical practice.\textsuperscript{44,48,50,57} Primary efforts of physical therapy in the treatment of chronic LBP is to retrain muscles, improve coordination, increase strength, develop core stabilization, and elevate both muscle and cardiovascular endurance.\textsuperscript{44,61} The goals of physical therapy include reducing pain and disability, improving function, and preventing reoccurrences.\textsuperscript{45,62} Clinical practice guidelines for physical therapy for patients with LBP base their recommendations of active interventions on symptoms instead of the traditional time-based criteria (acute < 4 weeks, subacute 4 - 12 weeks, and chronic > 12 weeks).\textsuperscript{62,63} In this manner higher intensity exercises are prescribed to those with less pain/disability while lower level, sub maximal exercises are prescribed for those with higher reports of pain/disability regardless of the time from onset.\textsuperscript{62,63} Since the physical therapy guidelines are based on symptoms instead of duration, the timing of when exercise therapy is utilized has been examined. The Philadelphia Panel Evidence-Based Clinical Practice Guidelines (for rehabilitation) found evidence to support the use of therapeutic exercise for chronic, subacute, and post-surgical patients with LBP.\textsuperscript{45} There is also a current movement evaluating early physical therapy (defined as within 14 days of onset of LBP) to examine the outcomes of supervised exercise during the acute phase of LBP.\textsuperscript{64-67} These studies will be briefly reviewed in a later portion of this analysis. Regardless, physical therapy is perceived as an effective treatment for LBP by patients having the condition, but it has a low rate of utilization in the United States.\textsuperscript{6} Despite LBP being a primary reason for therapy and accounting for approximately 25 percent of physical therapy discharges,\textsuperscript{68} only about 15 percent of patients diagnosed with LBP in the United States will follow-up with physical therapy.\textsuperscript{67,69}
Several studies have looked at types of exercise interventions performed in physical therapy that may benefit chronic LBP. In a systematic review and meta-analysis of randomized control trials for exercise interventions in chronic LBP, Searle and colleagues found that the exercise groups reported lower pain than other control and treatment groups. They also found that specific exercises of strength/resistance and coordination/stabilization groups were superior to other interventions as well as other types of exercises. Likewise, Kim et al. showed reduction in pain at rest and during movement, increased range of motion and proprioception following their 40th visit of 30 minute CORE exercise program in female office workers with chronic LBP when they were compared against usual care. These results remained after 2 years.

CBT, as discussed previously, is also highly recommended for the chronic LBP population with CBT taking several forms. CBT is either directly or indirectly referred to in the literature as a component of treatment in models for continuum of care, multidisciplinary biopsychosocial rehabilitation, comprehensive rehabilitation, cognitive-behavior-based physical therapy, patient activation, health behavior change counseling, and interdisciplinary rehabilitation to name several. The variability in which CBT is referred may be because there is no established definition of multidisciplinary biopsychosocial rehabilitation and because there is limited access and a lack of available structured comprehensive non-operative programs in the United States. Regardless, structured CBT has similar disability outcomes to that of surgery without invasive, irreversible procedures. Some of the variety of studies that have examined CBT in light of LBP and as components of physical therapy are listed with their respective programs and results in Appendix A.
Surgery

Operative, or invasive, therapies are indicated when a comprehensive examination leads to a specific diagnosis and location that is causing pain and disability. Generally surgery is considered when improvements have plateaued and outcomes are unacceptable after 6 - 12 weeks of active therapies. Common types of LBP related surgeries and their descriptions, indications, and supporting evidence are listed in Table 1.6.

**Table 1.6 – Common Surgeries for LBP.**

<table>
<thead>
<tr>
<th>Type of surgery</th>
<th>Description</th>
<th>Indications</th>
<th>Supporting evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discectomy</td>
<td>Removal of disc material from between vertebral bodies</td>
<td>Nerve root compression from disc material with radicular symptoms verified with MRI/CT after failure of 6 weeks of active therapy.</td>
<td>Effective relief in appropriate patients with complaints of leg pain; good evidence of superior results compared to non-surgical treatment</td>
</tr>
<tr>
<td>Laminectomy</td>
<td>Removal of the posterior spinal, bony matrix decompressing neural components</td>
<td>Nerve root compression from bone with radicular symptoms verified with MRI/CT after failure of conservative care for 6-12 weeks.</td>
<td>Good evidence of decompression being superior to non-surgical care in spinal stenosis</td>
</tr>
<tr>
<td>Fusion</td>
<td>Use of bone grafts with and without instrumentation to eliminate movement between adjacent vertebrae</td>
<td>Structural compromise (such as fracture, dislocation) resulting in significant functional loss after failure of conservative care for at least 5 months.</td>
<td>Effective for LBP in serious structural pathology; Insufficient evidence for spondylosis or degenerative conditions</td>
</tr>
</tbody>
</table>

Unfortunately, there is little evidence available to evaluate the effectiveness for lumbar surgery in chronic LBP. Van Tulder et al. in an evidence-based review stated that,
“there is insufficient evidence on the effectiveness of surgery for degenerative lumbar spondylosis on clinical outcomes to draw any firm conclusions”.\textsuperscript{76} This conclusion stems from a collection of at least three studies in which fusions surgeries were compared against non-operative care.\textsuperscript{74,75,80} Two studies found no significant benefit of fusion surgery over “cognitive intervention”\textsuperscript{74,75} while one study reported some benefit of fusion over non-standardized physical therapy.\textsuperscript{80} These studies compel others to commonly report that in the absence of serious structural pathology\textsuperscript{79} surgery for generalized chronic LBP (especially lumbar fusions) should be reserved for carefully selected patients who did not improve with conservative management.\textsuperscript{76} Furthermore, surgical fusion in the chronic LBP population should not be favored over cognitive-behavioral and exercise rehabilitation programs\textsuperscript{28} and that, “any advantage of surgery over nonsurgical care is modest” and near or below the minimally important change in disability scores.\textsuperscript{27} Unfortunately, there is a lack of structured, comprehensive CBT rehabilitation programs in the United States. This has prompted the Medicare Evidence Development and Coverage Advisory Committee to conclude that lumbar fusion, “is probably better [treatment] than currently available nonsurgical care in the United States”.\textsuperscript{72} In conclusion, the general United States diagnosis and treatment clinical practice guideline for LBP are as follows by topic:

- **Imaging** – Imaging is generally not indicated unless underlying pathology is suspected or the patient is a surgical candidate.
- **Education** – Education is indicated regarding the overall good prognosis of LBP, the limitation of bed rest, the need to progress activities, and the risk factors for chronicity.
- **Medication** – Trials of acetaminophen and/or NSAIDs are indicated. Opioids, or narcotic pain medications are not indicated except in select patients.
- **Referrals** – Referrals are indicated for CBT (including physical therapy) or comprehensive rehabilitation. Referrals to other physicians are generally not
indicated unless underlying pathology is suspected or the patient is a surgical candidate.

- Surgery – Surgery is indicated for specific radicular pathology or structural compromise after failed therapy when a specific location of treatment is identified. Surgery is not indicated for nonspecific LBP but is acceptable if severe functional limitations are present and the patient has failed conservative treatment including comprehensive therapy for more than 5 months.

**Current Practice in the United States**

Trends for the care of LBP deviate significantly from clinical practice guidelines in the United States.\(^{15,43}\) This demonstrates the know-do gap, or the gap between what is known and what is actually done in clinical practice.\(^{43}\) Jackson and Browning\(^{15}\) evaluated the impact of the Agency for Health Research and Quality’s clinical practice guidelines for LBP in the United States for the 3 years before and after its release in 1994. They found no trend towards clinical practice guideline compliance. Mafi et al.\(^{38}\) found that trends for the management of LBP are worsening. They found significant increases in guideline discordant care including advanced imaging, narcotic pain prescription, and referrals to other physicians. They also found reduction in guideline concordant care for the prescription of acetaminophen or NSAIDs.\(^{38}\) (Physical therapy utilization, a guideline concordant procedure, and standard radiographic imaging, a guideline discordant procedure, were both unchanged.) Other studies for guideline adherence are addressed by the following topics: imaging, education, medication, referrals, and surgery.

**Imaging**

Lurie et al.\(^{54}\) found high variability for advanced imaging for Medicare patients with LBP. There was a 5.5 fold variation based on geographic areas. They found that 22 percent of the variation in the spinal surgery rate was explained by the rates of spinal imaging. They also found that areas of high CT usage also had high MRI usage and no
substitution effect took place. Similarly, Chou reports that approximately one-third of Medicare patients undergo a lumbar spine MRI prior to having any other treatment. In another population Webster and Cifuentes compared worker’s compensation cases of early MRI (within the first 30 days of LBP) to cases of no MRI. They found that nearly 22 percent had an early MRI and the majority of those had no early MRI indications. They also found that an early MRI had downstream effects of worsened disability, higher medical costs, and was more likely to end in surgery. There are hypotheses for the increased and early use of imaging observed in the LBP population. They include patient’s expectations of imaging, physicians practicing defensive medicine, the lack of time for proper patient education on why imaging is not needed, and physician’s financial incentives for ordering imaging, especially that of self-referral. Mitchell found that advanced imaging grew rapidly between 2000 and 2004 in California and the highest usage rate was by self-referral providers. Regardless of the reason for guideline discordance, imaging for LBP remains an extremely costly and overused intervention that has grown rapidly in the recent decades.

**Education**

Despite education being considered an area of primary emphasis for successful treatment of LBP, little has been researched on the actual education that takes place between a physician and a first-time care seeker for LBP. There are two surveys that discussed education during physician visits for patients with LBP. A physician survey in Australia reports only 20.5 percent of patients received education for a new onset of LBP after the release of clinical practice guidelines. Another survey performed in the United States, the National Ambulatory Medical Care Survey, revealed a slightly higher rate of
“counseling” for LBP with 34 - 38 percent generalist physicians providing education for LBP prior to the release of the clinical practice guidelines.\textsuperscript{16}

**Medication**

The usage of opioids, or narcotic pain medication, can result in many medical side effects, drug addiction, and the development of drug tolerance.\textsuperscript{13} Despite these risks opioid usage for LBP continues to rise significantly.\textsuperscript{13,38} Deyo et al.\textsuperscript{84} explaining the Medical Expenditure Panel Survey data revealed a 108 percent increase in opioid treatment for spinal problems from 1997 to 2004.

**Referrals**

Referrals to allied health practitioners other than physical therapy or cognitive-behavioral therapists is generally considered discordant care. However, in Australia referrals to allied practitioners was 17.2 percent while referrals to specialists was more in line with guidelines at 1.5 percent.\textsuperscript{14} In the United States, prior to guideline release, referrals were low to other physician specialties with internists referring the most (7 percent) and neurosurgeons referring the least (3 percent).\textsuperscript{16} Also, this study reported that physical therapy was ordered 21 - 33 percent of the time based on physician specialty. Both of these studies are based solely on physician surveys.

**Surgery**

Surgery rates in the United States for the spine are higher than anywhere else in the world.\textsuperscript{85} Depending on the time frame evaluated, rates of surgery are 2 - 5 times higher in the United States than in any other nation.\textsuperscript{46,49} Fusion surgery has increased sharply since 1990 with an increase of 220 percent from 1990 to 2001\textsuperscript{10} and has increased 4 fold in the last 20 years.\textsuperscript{33} The acceleration began after the Food and Drug
Administration’s approval of fusion cages. Other reasons cited for the increase in fusion and overall spinal surgery include differences in physician beliefs, opinions, and financial incentives, as well as new surgical technology, improved advanced imaging, and health seeking behavior. Geography (indicating supply of surgical capabilities) has also been shown to be a strong driver of surgery.

Costs surrounding lumbar fusions are staggering. In 2006, a 1 level fusion cost about $65,000 and in 2003 Medicare spent $1 billion on fusions alone accounting for nearly one-half of the dollars spent on all spinal surgeries. Now almost one million surgeries are performed on the spine in the United States, with an expected reoperation rate for fusions of 15-20 percent in the decade after surgery and a 4.6 percent chance of requiring two or more surgeries. After fusion surgery, accelerated adjacent segment disease and increased facet arthropathy can be expected. Initial “successful” surgery is estimated to be between 20 to 40 percent which declines with each subsequent surgery. Performance of back surgery (especially fusion surgery) is highly discordant and controversial care in the United States.

**Interventions to Reduce Costs/Improve Outcomes**

CBT, as previously discussed, has been shown to be as effective as invasive treatment for chronic LBP but few of these programs exist in the United States. Other studies that have shown improvement in either guideline concordant care, reduced costs, or other improved outcomes for the care of LBP are discussed below. For the purposes of this paper, the studies will be grouped as follows: multidisciplinary pathways, increased concordance with clinical practice guidelines, and early physical therapy.
Multidisciplinary Pathways

The IMPaCT Back developed in the United Kingdom showed a significant benefit compared to usual care with reductions in disability and time away from work, as well as, health care cost savings. The protocol began at the level of the primary care physician using the STarT back screening tool. The tool is used to stratify patients based on the risk of developing chronic LBP. After using this tool, screening for red flags, and performing an evaluation, the physician stratifies the risk for the developing chronic LBP using low, medium, and high-risk categories. Low-risk individuals receive education, reassurance, and medication if needed. Medium and high-risk patients are sent to physical therapy. Medium-risk patients receive physical therapy care to decrease their pain and disability through activity and exercise. High-risk patients have physical therapy that integrates cognitive-behavior therapies to reduce pain and disability and improve their psychological functioning. Allgeier et al. replicated this pathway in Chicago, Illinois and reported successful outcomes by means of reduced pain and disability, as well as reduced cost for the patient.

Another multidisciplinary pathway developed in Canada is the Saskatchewan Spine Pathway. The pathway begins with the primary care physician who refers to physical therapy after a trial of time and medication, if required. The physical therapist then determines if the pathway needs to be changed and educates and directs the patient towards mechanical therapy, imaging, or referral to a spine surgeon. This pathway resulted in more appropriate patients reaching the spinal surgeon, but costs and outcomes were not calculated.
Increased Concordance with Clinical Practice Guidelines

When adherence to physical therapy established guidelines of care in the Netherlands was examined against patient outcomes, Rutten et al.\textsuperscript{94} found that higher adherence to guidelines directly correlated with higher function and reduced cost. They recommend a comprehensive process to evaluate physical therapy care to improve guideline adherence. This result was also seen in a study by Karlen and McCathie\textsuperscript{95} in Minneapolis, Minnesota. In their report, guideline adherence in physical therapy resulted in improvement in patient function and reduction in visits (cost). Both studies found higher-value in physical therapy with improved guideline adherence.

Early physical therapy

Physical therapy provided early in care (14 to 16 days after diagnosis of LBP) has been examined for improved outcomes and reduced cost. Early physical therapy compared to usual care showed a reduction in disability at 4 weeks but no other changes in disability at 1 year or pain at any point.\textsuperscript{66} Health care utilization was no different between groups. However, a similar study by Gellhorn et al.\textsuperscript{67} using Medicare outpatient claims data showed that early physical therapy was associated with reduced lumbar injections, physician visits, and lumbar surgery.

In another study of early physical therapy, physical therapy as an initial treatment for LBP was not a significant contributor to total health care costs.\textsuperscript{69} In this study opioids, corticosteroids, muscle relaxers and spinal radiographs were significant predictors for increased overall cost. Fritz et al.\textsuperscript{81} has also looked at the difference in initial management strategies of advanced imaging versus physical therapy. Advanced imaging resulted in
significantly more health care utilization and cost when compared to physical therapy. Patient outcomes were not evaluated in either of these studies.

The most recent early physical therapy study showed that those who received early physical therapy compared to delayed physical therapy (after 14 days) had a reduced likelihood of having advanced imaging, additional physician visits, surgery, lumbar injections, and opioid medication prescription. In this study, both early and adherent physical therapy was examined and both had significantly reduced costs with early physical therapy having the lowest overall cost.

All of these studies lend support that clinical practice guideline adherence can improve outcomes and decrease costs. Early physical therapy and multidisciplinary care may further improve outcomes and costs.

**Purpose of Inpatient Studies**

These studies highlight the treatment of LBP in an outpatient setting. Little is reported on their inpatient procedures, their resultant inpatient care, and their discharge location. The purpose of the following chapters are to examine the course of treatment in an inpatient setting following hospitalization for low back pain. The chapters build on physical therapy knowledge for the LBP population by including their inpatient procedures to help explain physical therapy utilization and excessive lengths of stay. Questions that will be answered include, “Who receives physical therapy after elective surgical intervention for LBP?” and “What was the impact on physical therapy utilization from a federally mandated discharge policy for those with LBP discharged to skilled facilities?” and finally, “Who has lengths of stay greater than one week after elective surgical intervention for LBP?”. Answering these questions may assist in finding another pathway
of intervention for patients with low back pain that require hospitalization while identifying cost centers.

**Statistical Models Utilized**

All three analyses use generalized linear mixed models. The procedures of PROC MIXED and PROC GLIMMIX were used within Statistical Analysis System Software 9.4 from the SAS Institute, Cary, NC. These models are ideal for this data because they allow writing of a single model at a hierarchical level (in our case patients within a hospital) while allowing correlation of outcomes for each level. The PROC GLIMMIX model allows for the dependent variable to come from distributions other than Gaussian (present in papers 2 and 3) hence the name “generalized”. The procedures allow for a variety of optimization methods and structures which allows for repeated measures. Repeated measures are present in paper 1 examining behavior change after policy implementation. The models also allow for both fixed and random effects hence the “mixed” terminology. The RANDOM component allows for covariance calculation between and within subjects (in this work; hospitals) essentially pulling error from the model and isolating the fixed effects. The fixed effects are reported in each study.
Abstract

Purpose: The purpose of this study was to evaluate a federally-mandated, hospital discharge policy to see if physical therapy utilization increased as a result of the policy.

Rationale: Healthcare policy is often a driver of change in healthcare institutions. These policy changes can alter the consumption of healthcare resources. The study uses Medicare insured patients with a diagnosis of low back pain. This is a population that has shown resistance to change despite the validation of evidence-based and evidence-informed medicine.

Methods: The retrospective study used encounter level data for hospitalized patients in Florida for the years of 1992-1998. Encounters were reduced to patients with Medicare insurance, aged between 18 and 84, a primary diagnosis related to low back pain, a hospital stay $\geq$ 1 day, and a discharge to either home or a skilled care facility. To examine hospital practice as a result of the policy, variables of interest were averaged for each hospital for each quarter for 3 years pre (1992 - 1994) and post (1996 - 1998) policy implementation. Using SAS, a mixed methods procedure was used to evaluate physical therapy utilization at the hospital level.
Results: Physical therapy utilization was changed as a result of the policy implementation. Physical therapy utilization was also explained by length of stay, discharge location, and the presence of a surgical procedure during hospitalization.

Conclusion: The federally-mandated hospital discharge policy altered hospital practice and increased physical therapy utilization after its implementation for Medicare insured patients with low back pain in the state of Florida.

Introduction

Federal Policy

In December of 1994, a hospital discharge process was implemented for any hospital participating in Medicare or Medicaid reimbursement. The law went into effect January, 12th, 1995. The policy states that a formal discharge planning process is required for all patients that may suffer from an adverse health consequence if there is not adequate planning. This includes an evaluation of the patient’s needs for post-hospital services and their capacity for self-care (or for the patient to be cared for in the environment from which they were admitted). This policy was implemented to “assure coordination” of post-hospital “rehabilitative and restorative treatments”. It was left up to the hospital to determine the appropriate personnel to carry out the discharge plan and evaluation. This was expected to require personnel in multiple disciplines with knowledge regarding social and physical factors that affect function. These are duties consistent with the role of a physical therapist. Therefore, it is hypothesized that the policy change should affect physical therapy utilization for patients with Medicare insurance who were discharged from the hospital to a skilled care facility. The population studied are those with low back pain.
**Background**

Low back pain (LBP) is pain, muscle tension, or stiffness occurring at the posterior trunk between the 12th ribs (costal margin) and the inferior gluteal folds and can occur with or without leg pain (sciatica).\(^1\)\(^-\)\(^5\) It lasts longer than 1 day and interferes with daily activities.\(^6\) LBP is widely reported in the United States and other industrialized countries with a lifetime prevalence of 60-85 percent.\(^7\)\(^-\)\(^9\) It is the most reported musculoskeletal problem\(^8\)\(^,\)\(^12\) and a leading reason for health care utilization and hospitalization.\(^13\) Approximately one-quarter up to one-half of all patients with LBP will seek medical care.\(^14\)\(^,\)\(^15\) It is the most common reason for sick leave and missed work,\(^2\)\(^,\)\(^16\)\(^,\)\(^18\) often the first reason to seek medical care as an adult,\(^4\) and the leading cause of years lived with disability.\(^16\)\(^,\)\(^19\)\(^,\)\(^20\)

LBP is the most expensive musculoskeletal condition in the United States.\(^34\) In fact, the only medical conditions costing significantly more are heart disease and stroke.\(^36\) The yearly economic burden of LBP has been estimated well into the hundreds of billions of dollars yearly.\(^33\) This is due to its rising prevalence,\(^26\) increased care seeking behavior,\(^37\) as well as, more intensive use of expensive testing and treatment for LBP.\(^38\) One of the largest drivers of cost for LBP care is lumbar surgery with spinal surgery rates significantly higher in the United States than anywhere else in the world.\(^46\)\(^,\)\(^49\)\(^,\)\(^85\)

**LBP Clinical Practice Guidelines**

To help curb the variety of treatments delivered and ultimately reduce costs and improve outcomes, clinical practice guidelines (CPG) for the treatment of LBP have been developed. A brief summation for the CPG for LBP are as follows:

- Imaging – Imaging is generally not indicated unless underlying pathology is suspected or the patient is a surgical candidate.
• Education – Education is indicated regarding the overall good prognosis of LBP, the limitation of bed rest, the need to progress activities, and the risk factors for developing chronic LBP.
• Medication – Trials of acetaminophen and/or non-steroidal anti-inflammatory drugs (NSAIDS) are indicated. Opioids, or narcotic pain medications, are not indicated except in carefully selected patients.
• Referrals – Referrals are indicated for physical therapy including cognitive-based therapy or comprehensive rehabilitation. Referrals to other physicians are generally not indicated unless underlying pathology is suspected or the patient is a surgical candidate.
• Surgery – Surgery is indicated for specific radicular pathology or structural compromise after failed therapy when a specific location of treatment is identified. Surgery is not indicated for nonspecific LBP, but it is acceptable if severe functional limitations are present and the patient failed conservative treatment including comprehensive therapy for more than 5 months.

Since physical therapy is considered an appropriate referral for the treatment of LBP it has been studied as an overall cost reducer. Many studies have found significant cost savings with utilization of outpatient physical therapy for the treatment of LBP.\[64,67,69,81,94,95\] However, despite the publication of CPGs the overall treatment for LBP has either not changed,\[15\] or has worsened.\[38\] In the United States, medical treatment options are often determined by the payer’s policy rather than current beliefs or CPGs.\[31\] The patients examined in this study have come to the end of one cycle of CPGs for LBP (see Figure 2.1). The purpose of this paper is to examine a federally-mandated discharge policy and see if it indirectly influenced inpatient physical therapy utilization for patients with LBP. If physical therapy utilization was altered, the policy could be viewed as creating an additional intervention point for patients with LBP. The hypothesis was that the policy, length of stay, discharge location, comorbidity count, and surgery resulted in increased physical therapy utilization.
Figure 2.1 – The CPG Cycle for LBP*
*The orange circle indicates the point in the cycle in which this study takes place. The numbered arrows roughly represent the order in which CPG concordant care is given.

Methods

Statistical Analysis

The Florida Agency for Health Care Administration (AHCA) inpatient data set was used to evaluate this question. The Florida AHCA data is part of the nationwide Healthcare Cost and Utilization Project (HCUP) which is the largest collection of longitudinal hospital care data in the United States. The data includes all inpatient encounters for all Florida hospitals every day of the year. Patient identifying information was not included. For the years studied, the Florida data set contains 1.77 – 2.10 million encounters per year. Statistical Analysis System Software 9.4 from the SAS Institute, Cary, NC, was used to perform all data preparation and procedures as described below.
In order to reduce the encounters to only those with chronic low back pain, the *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) codes\textsuperscript{107} were used to pull the appropriate encounters. Only records with the following ICD-9-CM codes as the primary diagnosis were included in this study:

- 721.\_\_ (30, 42, 50, 60, 70, 80, 90, 91)
- 722.\_\_ (10, 20, 32, 52, 73, 83, 93)
- 724.\_\_ (00, 02, 09, 20, 30, 40, 50, 60, 90)
- 729.2
- 737.\_\_ (20, 21, 22, 29, 30, 39, 80, 90)
- 738.\_\_ (40, 50)
- 739.\_\_ (30, 40)
- 756.\_\_ (10, 11, 12)
- 846.\_\_ (00, 10, 20, 30, 80, 90)
- 847.\_\_ (20, 30, 90)
- 922.31

These codes were extrapolated using the ICD-9-CM guide and from other studies looking at procedures consistent with physical therapy and low back pain. (See Appendix 1 for a comparison of ICD-9-CM codes used by this study and other referenced studies.)

The years included in this study were 1992-1994 (3 years prior to the policy) and 1996-1998 (3 years after the policy). The year in which the change took place (1995) was removed to allow for change to occur. This was modelled after Jackson and Browning\textsuperscript{15} and their study in evaluating LBP CPG on practice. To further reduce the dataset and as an initial attempt to keep the severity relatively equal between the patients, only those admitted as an elective status were used. This eliminated all encounters in which patients may have had a progressive neurologic or severe structural deformity which required emergency or urgent care. Table 2.1 is a summary of all inclusion criteria along with their respective explanations that were used to align the data.
Table 2.1 – Summary of Inclusion Criteria for Study Variables.

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years from 1992 - 1994 and 1996 - 1998</td>
<td>This allowed evaluation of 3 years pre and post-policy implementation.</td>
</tr>
<tr>
<td>Medicare Insurance</td>
<td>Since the policy was written for Medicare compliance, only this insurance type was examined.</td>
</tr>
<tr>
<td>Patient age: 18 - 84</td>
<td>Age group restriction was used to reduce both the influence of frailty and congenital spinal abnormalities that may require surgery.</td>
</tr>
<tr>
<td>Elective admission</td>
<td>This eliminated any urgent or emergency admissions that may have required alternative treatments.</td>
</tr>
<tr>
<td>Discharge location of home or further skilled care</td>
<td>Since the policy only addressed those needing post-hospital rehabilitation skilled care was compared against a discharge to home. This eliminated any encounters in which a patient was discharged to home health, against medical advice, to hospice, to psychiatric hospitals, or to law enforcement.</td>
</tr>
<tr>
<td>Length of stay of at least 1 day</td>
<td>Since at least 1 day may be required for physical therapy to take place only those admitted for at least 1 day were considered.</td>
</tr>
</tbody>
</table>

In order to evaluate the research question at the hospital level, each hospital’s low back pain encounters were summed and averaged for all variables of interest for each of the 195 hospitals for each quarter of each year. This resulted in a possible summed and averaged encounter number of 4,680 (195 hospitals x 6 years x 4 quarters). Tables 2.2 and 2.3 are comparisons of the raw encounter data and the averaged hospital data. Table 2.2 is the encounter level data for two patients. Table 2.3 is the averaged hospital data for the same two encounters.
Table 2.2 – Two Patient Encounters.*

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Gender</th>
<th>Race</th>
<th>Ethnicity</th>
<th>Length of Stay</th>
<th>Discharge location</th>
<th>Surgery?</th>
<th>Disabled?</th>
<th>Secondary psychological diagnosis?</th>
<th>Count of comorbidities</th>
<th>Physical therapy?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>71</td>
<td>M</td>
<td>Caucasian</td>
<td>Non-Hispanic</td>
<td>1</td>
<td>home</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>63</td>
<td>F</td>
<td>Caucasian</td>
<td>Non-Hispanic</td>
<td>3</td>
<td>home</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>0</td>
<td>N</td>
</tr>
</tbody>
</table>

*Encounters are for hospital A in the 3rd quarter of 1996 (post-policy).

Table 2.3 – A Summed Hospital Encounter.

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Number of encounters</th>
<th>Year</th>
<th>Quarter</th>
<th>Pre or post-policy?</th>
<th>Avg. age</th>
<th>% female</th>
<th>% African American</th>
<th>% Caucasian</th>
<th>% Other race</th>
<th>% Hispanic</th>
<th>Avg. length of stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>1996</td>
<td>3</td>
<td>post</td>
<td>67</td>
<td>50</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% discharged home</th>
<th>% discharged to skilled care</th>
<th>% having surgery</th>
<th>% disabled</th>
<th>% with a secondary psychological diagnosis</th>
<th>Avg. comorbidities</th>
<th>% having physical therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
<td>100</td>
<td>50</td>
<td>0</td>
<td>.5</td>
<td>0</td>
</tr>
</tbody>
</table>

Mixed Methods Model

After transformation of the data a mixed methods procedure was used with the percentage of LBP patients receiving physical therapy prior to discharge as the dependent variable. Using averaged data for each hospital for each quarter of the included years, the following mixed methods model was used:
Percent Physical Therapy = $\beta_0 + \beta_1^{*}\text{Female} + \beta_2^{*}\text{Age} + \beta_3^{*}\text{African American} + \beta_4^{*}\text{Other Race} + \beta_5^{*}\text{Hispanic} + \beta_6^{*}\text{Comorbidity Count} + \beta_7^{*}\text{Length of Stay in Days} + \beta_8^{*}\text{Home Discharge} + \beta_9^{*}\text{Low Back Surgery} + \beta_{10}^{*}\text{Secondary Psychological Diagnosis} + \beta_{11}^{*}\text{Social Security Disability Insurance} + \beta_{12}^{*}\text{Policy} + \epsilon$.

The base of the model was a white, non-Hispanic male who was neither disabled nor had a psychological condition but was discharged to a skilled facility. A description of the variables and the rationale for their inclusion follows the model section.

The basic assumptions of this model are that the data 1) are normally distributed, 2) are independent, and 3) have constant variance. However, since the studied data was in clusters (hospitals) it was most likely not independent. This assumption is relaxed in the mixed method by using a random statement. A random statement was used to adjust for the random effects of the hospital and the differences between hospital care at other locations. Likewise, since the data was taken over time (up to every quarter) a repeated statement was utilized to control for the repeated measures at the hospital level. A “TYPE=” statement was then applied to specify the appropriate covariance matrix. Several covariance structure types were examined and using the Akaike Information Criterion (AIC) the covariance structure that showed the best fit was AR(1), or auto-regressive. Auto-regressive (1) allows for changes in covariance over time with higher correlation occurring when measures are taken closer together in time. Influential diagnostics were then performed using Cook’s D and the PRESS statistic. Four outliers (defined as residuals that were more than 3 standard deviations away from their mean of 0) were removed. Three were removed as they were the only LBP patient in their respective hospital for the quarter and had excessively long length of stays (> 46 days each) which were influencing the overall model. One final outlier was removed as it appeared to be a data entry error with a length of stay of 177 days despite only 1
inpatient procedure and a total hospital charge of $568 dollars. The data was then plotted and the normality assumption was verified completing the model requirements.

**Variables**

The dependent variable was the presence or absence of having physical therapy as an inpatient procedure. The following patient specific independent variables were initially used to examine the research question: gender, age, race, ethnicity, comorbidity count, length of stay, discharge location, the presence of a surgical procedure, the presence of a psychological secondary diagnosis, the presence of Social Security Disability Insurance, and finally, whether the hospitalization occurred pre or post-policy implementation. Variables were averaged across all encounters for each hospital for each quarter of each year of the data. The following section discusses the purpose and rationale regarding the inclusion of each variable.

Gender is a risk factor of LBP with females consistently suffering from the condition more often. The increased prevalence of LBP in females is consistent across all age groups, races, and ethnicity. However, incidence of LBP is bimodal with males aged 10-49 and females aged 65-94 incurring LBP onset more often than their age-matched counterparts. Due to this distribution more males miss work due to LBP than females. Regardless, females have more low back related surgeries, more intense and invasive low back surgeries, poorer low back surgical outcomes, longer hospitalizations, as well as, more opioid use for LBP. As gender is a risk factor for many facets of LBP it was included in this study to examine its effect on physical therapy consumption in an inpatient setting.
Aging is a risk factor for any degenerative musculoskeletal condition including LBP with most LBP studies reporting a mean age of between 46 - 60 years. Specific to LBP, increased age has been linked to chronicity and increased opioid use. Likewise, those receiving low back related surgery at a younger age have a higher rate of reoperation later in life. Since aging is a risk factor for LBP and is associated with declining function, age was included to examine its effect on receiving physical therapy. However, age was restricted to less than 85 years to help to control for frailty and the possibility of altered treatment due to frailty.

Race has some influence in the development of LBP with the highest incidence occurring in African Americans and white Caucasians. Most convenience samples in the United States are predominantly white and compose for about 85 percent of the studied LBP population. However, when low back surgery is performed on those in the Medicare population whites have shorter hospitalizations and less surgical complications when compared to non-whites. Since race has an effect in the development of LBP, as well as, in the post-surgical care of LBP patients it was included in the study.

While gender, age, and race all play a role in the incidence of LBP, ethnicity has been less reported in recent LBP literature. Descriptive statistics of most LBP studies reveal that LBP affects more non-Hispanics than Hispanics. The reasons for ethnic differences seen in the LBP population has not yet been theorized. However, ethnicity was included in this examination to see if it was a significant predictor of physical therapy utilization.
The presence of any comorbidity in the LBP population has been shown to increase back pain related disability, overall health care cost, and increased length of hospitalization. Any comorbidity is present in about 9 percent of patients having low back related surgery. Despite the concerns of comorbidities on cost, hospitalization, and disability, comorbidities have not been shown to be significant predictors of further low back surgical procedures. However, since comorbidities increase disability and length of stay in patients with LBP it was examined as a predictor of physical therapy. A comorbidity was defined as present if the encounter contained a secondary diagnosis of any of the 17 conditions listed in Appendix C.

Hospitalization for patients with LBP is usually between 1 - 7 days (96.6 percent of the time) with most patients having an inpatient stay of 3 - 7 days (51.6 percent of the time). Length of stay is associated with the type of low back surgery with more invasive procedures resulting in longer hospitalizations. For many reasons (including nosocomial infections, altered function, and surgical complications) increased length of stay may have an effect on physical therapy utilization and it was included in this study.

Location of discharge relies on a myriad of information including hospital and institutional procedures, insurance policies, and medical care requirements. Patient functions (including transfers, walking, basic activities of daily living, and cognition) also affect discharge location. A discharge to a skilled care facility for those with LBP has been linked to older age, a higher number of comorbidities, and more invasive surgical techniques. In fact, about 20 percent of patients over 65 years old with lumbar fusions are discharged to a skilled facility. In accord with the policy studied in this paper, one
would expect that discharge location would alter physical therapy utilization. It was examined as a predictor in this study.

Greater than 90 percent of hospital admissions for LBP result in surgical procedures with roughly 23 percent involving arthrodesis or spinal fusion. Re-operation rates in the 11 years following low back related surgery are nearly 20 percent which is double that of total hip and knee replacements. Higher re-operation rates exist for those having surgery earlier in life with the subsequent surgery demonstrating increased complexity, more resultant complications, and poorer outcomes. Recently, the number of complex, multi-level lumbar surgeries have risen dramatically. Since lumbar surgery can greatly alter function it was used as an independent variable for the consumption of physical therapy. Surgery was noted to occur if the patient encounter had an International Classification of Disease, 9th Revision (ICD-9-CM) procedure code indicating a discectomy (80.51), a spinal decompression laminectomy (03.09) or a lumbosacral fusion (81.06-81.08). Only these 3 surgeries were considered.

Psychological conditions of anxiety, depression, as well as, pain catastrophizing, and kinesophobia (fear of movement) are risk factors for developing chronic LBP. Low back patients with documented psychosocial histories have poor surgical outcomes and are at risk for failed back surgery syndromes (FBSS). The purpose of including this as a variable was to see if it was an influence in physical therapy consumption.

A subgroup of the Medicare population are those receiving Social Security Disability Insurance. Since this population’s growth parallels the increase in chronic LBP a variable was created to represent this population and examine its effect on physical therapy. Similar to the study performed by Freburger et al. any persons
younger than 65 years old (Freburger et al. used a cut-off of 62 years old) with Medicare insurance were categorized as receiving Social Security. Table 2.4 shows the variables and their respective measures.

**Table 2.4 – Variables and Their Measures.**

<table>
<thead>
<tr>
<th>Independent variable(s)</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>2 categories (0 = male, 1 = female)</td>
</tr>
<tr>
<td>Race</td>
<td>3 categories (black, white, other race)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>2 categories (0 = Non-Hispanic, 1 = Hispanic)</td>
</tr>
<tr>
<td>Age</td>
<td>Count in years (range 18 – 84)</td>
</tr>
<tr>
<td>Comorbidity count</td>
<td>Count of comorbidities</td>
</tr>
<tr>
<td>Length of stay</td>
<td>Count in days of hospitalization</td>
</tr>
<tr>
<td>Discharge location</td>
<td>2 categories (0 = home, 1 = skilled discharge)</td>
</tr>
<tr>
<td>Presence of a surgical procedure</td>
<td>2 categories (0 = no surgery, 1 = surgery)</td>
</tr>
<tr>
<td>Presence of a secondary diagnosis indicating anxiety or depression</td>
<td>2 categories (0 = no anxiety or depression diagnosis, 1 = anxiety or depression diagnosis present)</td>
</tr>
<tr>
<td>Pre or post-policy encounter</td>
<td>2 categories (0 = pre-policy, 1 = post-policy)</td>
</tr>
<tr>
<td>Social Security Disability Insurance recipient</td>
<td>2 categories (0 = greater than 64 years old, 1 = less than 65 years old)</td>
</tr>
</tbody>
</table>

**Results**

**Descriptive Statistics**

As expected, the sample was dominated by a nearly 95 percent white, non-Hispanic population accounting for 26,176 of the 28,535 patients that were included in this study. (See Table 2.5 for some of the descriptive statistics of the full sample.) The sample contained nearly 53 percent female with an average age of 70, an average length of hospitalization nearly 4.5 days, and an average comorbidity count of .5. Eighty-five percent of the sample had spinal surgery with nearly one-half of those having a spinal decompression or laminectomy. Fifty-five percent of the sample had physical therapy and almost 20 percent were discharged to further skilled care facilities. Nearly 80 percent
of the sample was contained within the 3 ICD-9-CM diagnoses codes of 724.02 (lumbar spinal stenosis), 722.10 (displaced lumbar intervertebral disc without myelopathy), and 721.3 (lumbosacral spondylosis without myelopathy).

Table 2.5 – Descriptive Statistics from the Full Sample.*

<table>
<thead>
<tr>
<th>Sample/Variables</th>
<th>Number or Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td>28,535</td>
</tr>
<tr>
<td>Number of Observations when Averaged per Year and Quarter</td>
<td>3,058</td>
</tr>
<tr>
<td>Number of Hospitals</td>
<td>195</td>
</tr>
<tr>
<td>Females</td>
<td>52.96%</td>
</tr>
<tr>
<td>White Caucasian (Race)</td>
<td>94.99%</td>
</tr>
<tr>
<td>African American (Race)</td>
<td>2.73%</td>
</tr>
<tr>
<td>Other Races</td>
<td>2.28%</td>
</tr>
<tr>
<td>Hispanic (Ethnicity)</td>
<td>3.31%</td>
</tr>
<tr>
<td>Skilled Facility Discharge</td>
<td>19.63%</td>
</tr>
<tr>
<td>Lumbar Surgery</td>
<td>85.19%</td>
</tr>
<tr>
<td>Discectomy</td>
<td>39.09%</td>
</tr>
<tr>
<td>Laminectomy</td>
<td>48.31%</td>
</tr>
<tr>
<td>Fusion</td>
<td>18.55%</td>
</tr>
<tr>
<td>Secondary Psychological Diagnosis</td>
<td>8.99%</td>
</tr>
<tr>
<td>Social Security Disability Insurance</td>
<td>11.34%</td>
</tr>
<tr>
<td>Average Age</td>
<td>70.6</td>
</tr>
<tr>
<td>Average Comorbidity Count</td>
<td>.509</td>
</tr>
<tr>
<td>Inpatient Length of Stay</td>
<td>4.43 days</td>
</tr>
<tr>
<td>ICD-9</td>
<td></td>
</tr>
<tr>
<td>721.3</td>
<td>10.42%</td>
</tr>
<tr>
<td>722.10</td>
<td>32.18%</td>
</tr>
<tr>
<td>724.02</td>
<td>35.78%</td>
</tr>
<tr>
<td>Physical Therapy</td>
<td>55.61%</td>
</tr>
</tbody>
</table>

*All averages and percentages are based off of the full sample.

Of those discharged to skilled care, 90 percent received physical therapy and over 92 percent of them had inpatient spinal surgery. Table 2.6 provides statistics for those discharged to skilled care. Those discharged to skilled care had an average age of 74 and a length of hospitalization of just over 6 days. More than one-half (53 percent) of these patients had no comorbidities. Among those having surgery, skilled care was
required for 15 percent of discectomies, nearly one-fourth of decompressions, and almost one-half of fusions performed in this population.

**Table 2.6 – Descriptive Statistics from Those Discharged to Further Skilled Care.**

<table>
<thead>
<tr>
<th>Sample/Variables</th>
<th>Number or Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Discharged to a Skilled Facility</td>
<td>5,602</td>
</tr>
<tr>
<td>No Comorbidities</td>
<td>53.02%</td>
</tr>
<tr>
<td>Lumbar Surgeries</td>
<td></td>
</tr>
<tr>
<td>Discectomy</td>
<td>30.67%</td>
</tr>
<tr>
<td>Decompression</td>
<td>58.76%</td>
</tr>
<tr>
<td>Fusion</td>
<td>44.95%</td>
</tr>
<tr>
<td>Received Physical Therapy</td>
<td>90.34%</td>
</tr>
<tr>
<td>Average Age</td>
<td>73.87 years</td>
</tr>
<tr>
<td>Average Hospitalization Stay</td>
<td>6.12 days</td>
</tr>
</tbody>
</table>

**Regression Statistics**

**Initial Model**

Results from the mixed methods for the full model shows that the average length of stay, the federal discharge policy, and the percentage of patients having surgery had a direct and significant association with receiving inpatient physical therapy. Likewise, the percentage discharged home was inversely related to receiving physical therapy. All of these predictors were significant with p-values <.0001. Table 2.7 provides the results of the fixed effects model. Average age and Hispanic ethnicity were also significant but at the < .05 alpha level. No other variables were significant.
Table 2.7 – Estimates of Fixed Effects for Initial Model.

| Effect                              | Estimate | Standard Error | DF  | t Value | Pr > |t| |
|-------------------------------------|----------|----------------|-----|---------|-------|-----|
| Intercept                           | 0.253    | 0.111          | 194 | 2.27    | 0.024 |
| Percentage Female                   | -0.019   | 0.017          | 2851| -1.15   | 0.251 |
| Average Age                         | 0.003    | 0.001          | 2851| 2.23    | 0.026 |
| Percentage of African American      | 0.078    | 0.042          | 2851| 1.87    | 0.062 |
| Percentage of Other Race            | 0.098    | 0.051          | 2851| 1.94    | 0.053 |
| Percentage of Hispanic Ethnicity    | 0.107    | 0.040          | 2851| 2.65    | 0.008 |
| Average Comorbidity Count           | -0.008   | 0.011          | 2851| -0.75   | 0.456 |
| Average Length of Stay              | 0.033    | 0.002          | 2851| 14.92   | <.0001|
| Percent Discharged Home             | -0.245   | 0.022          | 2851| -11.37  | <.0001|
| Percentage of Lumbar Surgery        | 0.157    | 0.019          | 2851| 8.28    | <.0001|
| Percentage Having a Psychological Diagnoses | -0.037 | 0.028 | 2851 | -1.35  | 0.179 |
| Percent Receiving SS Disability     | 0.038    | 0.039          | 2851| 0.97    | 0.332 |
| Policy                              | 0.076    | 0.011          | 2851| 6.92    | <.0001|

An example of the interpretation of the coefficients are as follow: a 1 unit increase in length of stay (a 1 day increase) resulted in a 3.3 percent increase in the probability of having physical therapy. The policy was responsible for a 7.6 percent probability increase, surgery was a 15.7 percent increase, and a home discharge decreased the probability of receiving physical therapy by 24.5 percent.

**Reduced Model**

When the model was reduced to only the significant variables at an alpha level of .01 the model fit improved slightly (see Appendix B “Policy Model” for goodness of fit
measures for the reduced model) and interpretation remained nearly identical to the full model. Table 2.8 provides the reduced model output.

**Table 2.8 – Estimates of Fixed Effects for the Fully Reduced Model.**

| Effect                          | Estimate | Standard Error | DF   | t Value | Pr > |t| |
|--------------------------------|----------|----------------|------|---------|------|------|
| Intercept                      | 0.472    | 0.032          | 194  | 14.56   | <.0001 |
| Average Length of Stay         | 0.033    | 0.002          | 2859 | 15.11   | <.0001 |
| Percentage Discharged Home     | -0.248   | 0.021          | 2859 | -11.91  | <.0001 |
| Percentage of Lumbar Surgery   | 0.156    | 0.019          | 2859 | 8.38    | <.0001 |
| Policy                         | 0.077    | 0.011          | 2859 | 7.11    | <.0001 |

**Discussion**

**Variable review**

As expected, and consistent with the literature, the patient sample was predominantly white, non-Hispanic with more females than males. Of these variable (gender, race, ethnicity) only ethnicity was significant at an alpha level of .05. Since there was no theoretical reason to expect those with Hispanic ethnicity to receive physical therapy more often than non-Hispanics, it was removed from the final model.

Likewise, average age was also significant at an alpha level of .05. Average age performed as hypothesized with increased age resulting in more physical therapy. However, due to its weak clinical significance (.3 percent change in receiving physical therapy per year of age), it was also removed from the final reduced model.

Comorbidity count did not perform as expected and was not a predictor of inpatient physical therapy. This could be due to several reasons. The most obvious reason may
be that a simple count of comorbidities is not indicative of function and the need of physical therapy. A better predictor for receiving physical therapy related to patient severity in this population may be a frailty index which has been shown to predict post-operative institutionalization.\textsuperscript{118}

Length of stay was significant (as hypothesized) with increased length of stay resulting in more physical therapy. As previously discussed, longer hospitalizations may be due to complications, further procedures, deconditioning etc. which may require physical therapy services. The chances of receiving physical therapy increased by 3.3 percent per day of hospitalization.

Discharge location was also highly significant as hypothesized. In fact, discharge location had the highest estimated effect on receiving physical therapy. A discharge to home reduced the chances of having inpatient physical therapy by nearly 25 percent. This finding is concerning as it means that patients discharged home were most likely discharged without a functional evaluation, instructions to improve function, or given individualized home exercise programs. However, having no inpatient physical therapy does not mean that the patient did not receive outpatient physical therapy, but we know that only about 15 percent of patients with LBP will seek care.\textsuperscript{95} Physical therapy care seeking behavior after a lumbar surgical intervention is unknown. At minimum, these patients had no inpatient or home physical therapy and worked on their functional progressions and strengthening without professional guidance until their next scheduled outpatient appointment. Typically post-operative, physical therapy for this population takes place 3 months after surgery.\textsuperscript{61}
As hypothesized, having surgery was a strong predictor of requiring physical therapy. The functional deficits and the patient's change in status following surgery was most likely enough to warrant the need of physical therapy. The presence of surgery increased the probability of having physical therapy by 15.6 percent.

The variables indicating Social Security Disability Insurance and a secondary psychological diagnosis are both known risk factor of chronic LBP. However, these variables had no significant bearing on the consumption of physical therapy services. This was opposite of what was hypothesized. These variables were dropped in the final model.

The policy variable was, in fact, a significant predictor of the utilization of physical therapy. Most likely, the self-care and functional components of the policy resulted in an increase in the frequency of physical therapy evaluations. Although this policy was written to protect either patients that might have adverse reactions without discharge planning or patients that need coordinated post-hospitalization care, the result shows a carry-over effect to uncomplicated Medicare patients being discharged home. When the mixed method analysis was repeated on only those discharged to skilled care the results remained unchanged (at an alpha level of .05) with a reduction in the coefficient of the policy variable for predicting physical therapy. See Table 2.9 for output from only those discharged to further institutions. Since the coefficient was reduced we can draw the conclusion that even though the policy as written for a population requiring post-hospitalization care its carryover to the home discharge group was also significant. This brings us to the limitations of this study.
Table 2.9 – Estimates of Fixed Effects for Skilled Discharges Only.

| Effect             | Estimate | Standard Error | DF  | t Value | Pr > |t| |
|--------------------|----------|----------------|-----|---------|------|---|
| Intercept          | 0.680    | 0.026          | 165 | 25.91   | <.0001 |   |
| Length of Stay     | 0.007    | 0.001          | 1528| 5.85    | <.0001 |   |
| Lumbar Surgery     | 0.139    | 0.023          | 1528| 5.99    | <.0001 |   |
| Policy             | 0.030    | 0.015          | 1528| 1.97    | 0.049 |   |

Limitations

There are several limitations to this study. First of all, the created policy variable was time-based and could represent a conglomerate of activity during the timeframe that increased physical therapy treatment. For example, an increase in the supply of physical therapists in the hospital workforce after 1995 could have resulted in more rendered treatments. Likewise, a shortage of physical therapists prior to 1995 (resulting in less treatments rendered) would also skew this policy variable towards the alternative hypothesis. The author is not, however, aware of either of these trends occurring during the timeframe of the study.

Secondly, this study is only applicable to Medicare recipients through a selected age group and diagnostic population. An age reduction to less than 85 years old (to control for frailty) should move the proposed research towards the null hypothesis and reduce the overall physical therapy treatment given as an inpatient procedure. However, testing of this was not performed. While it is known that frailty in the elderly is correlated with age and poor surgical results the use of less than 85 years was a somewhat arbitrary cutoff to control for frailty. Similarly, this sample was limited to patients with LBP
and applying these finding to other populations who receive physical therapy may not be appropriate.

Thirdly, this study only looked at one state. Since this was a federal policy, finding the same results in another state would lend credence to the findings of this report. Likewise, the state of Florida has a relatively higher percentage of for-profit hospitals when compared to other states nationwide. Profit status could theoretically affect the results, but a reputable source to control for hospital status was not available for use at the time of this study. Regardless, care and diligence must be used to not extrapolate these results to other populations or other states.

Another assumption of this study was that physical therapy treatment was assumed to be appropriate and beneficial. Inappropriate physical therapy by way of poor examination, evaluation, and prescription could possibly worsen outcomes or cause undo harm. Since there were no quality or functional indicators for the dataset this could not be examined. Thus, the use of an administrative dataset, instead of clinical data, is a limiting factor.

**Future Direction**

Performing a similar study in another patient population (such as an alternative diagnostic group in the same state or a similar group in another state) would help to clarify the results of this study. Another direction would be to examine the readmission rates after administration of physical therapy in this population. It is known that readmit rates are reduced when physical therapist's discharge recommendations are followed, but it is not known if the treatment alone has a protective effect on the population. Lastly, a seemingly extraneous finding in this study was that ethnicity was a significant predictor in
receiving physical therapy. This is easily examined but is difficult to theorize why this occurred.

**Conclusion**

Using the hospital as the unit of analysis, a federal discharge policy, discharge location, length of hospitalization, and surgery were significantly associated in determining what patients with Medicare insurance and LBP received physical therapy. This finding is significant as a policy, which was not directly related to the patient condition, resulted in altered treatment behavior in a diagnostic-related group that has historically been resistant to change. This study shows a possible point of intervention for patients discharged home. This finding also lends further support that policy alters medical care at a much quicker rate than published evidence guidelines.
Chapter 3:
Factors Associated with Inpatient Physical Therapy Utilization for Patients with Low Back Pain in the State of Florida from 1992 - 2014

Abstract

Purpose: The study purpose was to identify both patient and hospital factors associated with physical therapy utilization for patients with low back pain in Florida hospitals from 1992 – 2014.

Rationale: Understanding the factors associated with physical therapy utilization would help in finding additional treatment intervention points for patients with low back pain.

Methods: The retrospective study used encounter level data for patients with low back pain hospitalized in Florida from 1992 - 2014. Two mixed method regressions examined the dependent variable of physical therapy utilization. The first regression used patient characteristics and inpatient procedures to examine physical therapy utilization for the years of 1992 – 2014. The second regression used patient and hospital characteristics, as well as, hospital procedures for the same population from 2010 – 2014. Patient encounters were restricted to the following: a primary diagnosis of low back pain, a length of stay greater than or equal to one day, an age between 18 and 84, an elective admission, a discharge to either home, further skilled care, or home health care.
Results: Physical therapy utilization was positively associated with patient age and further associated by hospitalization procedures of surgery, discharge location, and length of stay. Physical therapy utilization also showed significant increases over time.

Conclusion: Physical therapy utilization for patients with low back pain is better explained by characteristics of the hospital stay. Physical therapy consumption is not well defined by patient and hospital factors alone.

Introduction

Background

Low back pain (LBP) is defined as pain, muscle tension, or stiffness occurring at the posterior trunk between the 12th ribs (costal margin) and the inferior gluteal folds. In the United States, LBP is the most common pain disorder, one of the most common reasons to seek physician care, the most common musculoskeletal reason for hospitalization, and a major contributor to disability. In fact, LBP is the second leading cause of disability and results in more years lived with a disability than any other medical condition.

The prevalence of a person developing LBP over their lifetime is between 60 - 85 percent with a point prevalence of around 30 percent. Unfortunately, up to 40 percent of patients with LBP develop chronic LBP. Those with chronic LBP are responsible for a majority of the health care costs associated with LBP treatment with 10 percent of the LBP population causing 50 percent of the costs and 25 percent of the population causing greater than 75 percent of the costs.
Costs

Health care costs for LBP are escalating at a faster rate than other medical conditions. The specialized diagnostic procedures and treatments associated with LBP has made it the single most expensive musculoskeletal problem in the United States. In fact, due to the high prevalence of LBP and the high per person cost associated with spinal treatment, heart disease and stroke are the only medical conditions that entail significantly more spending in the United States. The direct costs associated with LBP is between 12.2 and 90.6 billion dollars yearly, with most estimates falling between 30-50 billion dollars.

Medical conditions such as LBP represent a major societal burden, present a challenge to the health care system, and result in health care costs that are threatening the United States economy. For these reasons (and others) LBP has become a major target for quality improvement and has been identified as a top 15 priority condition in the United States by the Institute of Medicine.

Surgery

Spinal surgery is one of the most common inpatient surgical procedures. While there is some evidence that surgical outcomes are better than non-invasive treatments others argue that any advantage of surgery over non-surgical care [for generalized LBP] is near or below the minimal important change and benefits over conventional treatment is marginal. In the absence of clear and specific pathology (which happens up to 85 percent of the time) most patients with LBP do not benefit from surgery and will have poorer psychological and physical functioning as a result of surgery. If surgery is performed, success rates range from 20 - 40 percent with a
reduction in success for each subsequent surgery. In spinal fusion cases only 29 percent report feeling “much better” two years after surgery with the benefits of surgery often gone within five years. When the cause of LBP cannot be precisely determined, fusion outcomes are equivocal to comprehensive rehabilitation.

Despite less than optimal outcomes 300,000 - 400,000 lumbar surgeries are performed in the United States yearly. These surgeries are at a rate that is 5 times higher than what is observed in England. This elevated rate in the United States exists despite similar incidence and prevalence of LBP with other industrialized countries. From 1990 - 2001 alone, the surgery rates of spinal fusions in the United States increased 220 percent.

Lumbar surgery also has reoperation rates between 18 - 23 percent in the decade following surgery. This is twice the rate seen in total hip or total knee arthroplasties. Often recurrent lumbar invasive procedures are needed due to adjacent level degeneration (ALD). ALD develops from the excessive stress and motion placed on the joints adjacent to a fixated joint and causes recurrent LBP after surgery. Lumbar fusions accelerate ALD with symptoms present in 16.5 percent of cases within 5 years and 36.1 percent in 10 years. If pain or other symptoms continue after multiple invasive procedures at the lumbar spine than the patient is diagnosed with failed back surgery syndrome (FBSS). This occurs in 5 - 10 percent of the LBP surgical population. Patients undergoing spinal surgery also have a 3.3 percent readmission rate secondary to surgery site infection and wound complications within the first 90 days.

Despite the small likelihood of resolved symptoms and the risks of surgical complications, readmission, and developing FBSS, many costly lumbar surgeries are
performed in the United States. In 2006, the charge assessed for a single level fusion charge was approximately $65,000\textsuperscript{23} and charges have increased dramatically in the last decade. Hospitalization with any type of spinal surgery had a median cost of $14,202 and a mean cost of $21,928 in 2015.\textsuperscript{86} Medicare alone spends $482 million yearly for spinal arthrodesis.\textsuperscript{121} Other costs associated with LBP care include the direct costs of diagnostic imaging, treatments from a variety of specialists (chiropractors, osteopaths, physical therapists, etc.), hospitalizations, as well as, the indirect costs from disability insurance and work absenteeism.\textsuperscript{19}

**Cost Reduction**

One method shown to reduce costs in the care of LBP is the implementation of evidence based medicine (EBM).\textsuperscript{93} For the majority of LBP cases, EBM advises against imaging, surgery, and opioids and recommends early activity and anti-inflammatories.\textsuperscript{4} Clinical practice guidelines also recommend general fitness and supervised exercise as prescribed in physical therapy.\textsuperscript{4}

Outpatient physical therapy during the initial bout of LBP has shown to reduce the likelihood of surgery,\textsuperscript{67} as well as, reduce the need for further care and their associated costs.\textsuperscript{64} Outpatient physical therapy has also demonstrated lower total costs when used as a first strategy when compared to imaging.\textsuperscript{81} Inpatient physical therapy has been less studied and rehabilitation immediately following low back surgery currently lacks strong evidence.\textsuperscript{125} However, inpatient physical therapy has a profound influence on discharge recommendations\textsuperscript{104,105} and resulting readmissions.\textsuperscript{120,126} The primary goal of inpatient physical therapy is to maximize function and implement an appropriate discharge plan.\textsuperscript{104} These discharge plans take into account the patients function and disability, their wants
and needs, their ability to participate in care, and the patient’s living environment. When physical therapists’ discharge recommendations are omitted, Polnaszek et al. reported a trend towards hospital readmissions while Smith et al. reported that patients discharged against a physical therapist’s recommendations result in a 2.9 times increase in the odds of being readmitted to the hospital.

The purpose of this study is to examine patient and hospital factors associated with patients hospitalized in Florida with LBP, as well as, the factors and hospital procedures associated with receiving inpatient physical therapy. The hypothesis is that those hospitalized longer, those discharged to further skilled care, the more aged, and the more involved patients (those having more comorbidities and more invasive procedures) would utilize physical therapy.

**Methods**

To examine this purpose, two separate mixed method regressions were performed. The first analysis used only patient characteristics and hospital procedures from 1992 - 2014. The second analysis used both hospital and patient characteristics and hospital procedures from 2010 – 2014. A complete sample for the second analysis was only available for these years. The methods for each regression are discussed separately in their entirety in the following sections.

**Data Selection for Analysis from 1992 - 2014**

Florida’s Agency for Health Care Administration (AHCA) inpatient data were used to evaluate this question. The AHCA data is part of the nationwide Healthcare Cost and Utilization Project (HCUP), which is the largest collection of longitudinal hospital care data in the United States. The data includes all inpatient admissions for all Florida hospitals.
The data was further reduced to only those patients who had a length of stay of at least 1 day. This was performed to ensure that enough time had elapsed to allow a physical therapy consult to occur. Further, the years 2006 - 2009 had to be removed due to the dependent variable (the presence/absence of physical therapy) not being reported for those years. Since the main interest of this study was the care of patients with standard LBP, the admission type was limited to “elective” only. This removed any admissions due to trauma, emergency or urgent conditions. As a means to further control for possible alternative treatment needs, any patients who were discharged to a location annually. The patient identifying information is removed prior to release for research. The Florida data set contains between 1.77 - 2.74 million admissions per year. In order to reduce the admissions to only those with chronic low back pain, the *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) codes were used to identify the appropriate encounters. These codes were extrapolated using the ICD-9-CM Diagnosis Code Book and from other studies looking at procedures consistent with physical therapy and low back pain. (See Appendix 1 for a comparison of ICD-9-CM codes used by this study and other referenced studies.) Only records with the following ICD-9-CM codes as the primary diagnosis were included in this study:

- 721._ _ (30, 42, 50, 60, 70, 80, 90, 91)
- 722._ _ (10, 20, 32, 52, 73, 83, 93)
- 724._ _ (00, 02, 09, 20, 30, 40, 50, 60, 90)
- 729.2
- 737._ _ (20, 21, 22, 29, 30, 39, 80, 90)
- 738._ _ (40, 50)
- 739._ _ (30, 40)
- 756._ _ (10, 11, 12)
- 846._ _ (00, 10, 20, 30, 80, 90)
- 847._ _ (20, 30, 90)
- 922.31

The data was further reduced to only those patients who had a length of stay of at least 1 day. This was performed to ensure that enough time had elapsed to allow a physical therapy consult to occur. Further, the years 2006 - 2009 had to be removed due to the dependent variable (the presence/absence of physical therapy) not being reported for those years. Since the main interest of this study was the care of patients with standard LBP, the admission type was limited to “elective” only. This removed any admissions due to trauma, emergency or urgent conditions. As a means to further control for possible alternative treatment needs, any patients who were discharged to a location...
other than home, home health, or another skilled treatment center (such as a skilled nursing facility, a long term care hospital, etc.) were removed. This eliminated any patients that were discharged to cancer centers, hospice, law enforcement, psychological centers, or expired during their hospitalization. Furthermore, patients under the age of 18 were excluded due to the possibility of their encounter being related to congenital low back anomalies and not standard LBP. Likewise, those over 84 were also removed from the data. Since frailty syndrome is present in 25 percent of those 85 years and older, a restriction on age was done as a measure to control for frailty syndrome and the possible resultant alternative discharge strategies associated with the frail elderly. Figure 3.1 provides the breakdown of the selection process. Subsequently, G*Power 3.1.9.2 was used to calculate the required sample size to detect significance in the proposed model. Using the parameters of an alpha level at .01, a power level of .99, and an expected pseudo-$R^2$ level of .01 for a random model indicated the need of 6,218 observations. Therefore, a 2 percent random sample was drawn. A 2 percent sample was used to limit the significant effects to only those highly significant while maintaining a stable result. In other words, a larger sample revealed that most or all variables were significant while a smaller sample was unstable with different significant effects for each sample. A 2 percent random sample was drawn and revealed the same significant results in three consecutive analyses to ensure accurate and robust results.
Figure-3.1 – Data Selection Process for Analysis from 1992 - 2014.

Model for Analysis of Years 1992 - 2014

After drawing the 2 percent random sample a mixed method regression procedure was performed using the following model:

\[ \text{Physical Therapy (Y)} = \beta_0 + \beta_1\text{*gender} + \beta_2\text{*age} + \beta_3\text{*black race} + \beta_4\text{*other race} + \beta_5\text{*Hispanic ethnicity} + \beta_6\text{*comorbidity count} + \beta_7\text{*length of stay 3 – 7 days} + \beta_8\text{*length of} \]
stay > 7 days + \beta^9 \ast \text{skilled facility discharge} + \beta^10 \ast \text{home health discharge} + \beta^11 \ast \text{low back surgery} + \beta^12 \ast \text{Medicare insurance} + \beta^13 \ast \text{Medicaid insurance} + \beta^14 \ast \text{Worker's Compensation insurance} + \beta^15 \ast \text{other insurance} + \beta^16 \ast \text{no insurance} + \beta^17 \ast \text{secondary psychological diagnosis} + \beta^{18-35} \ast \text{year} + \varepsilon.

This model is a generalized linear mixed model (GLMM). The GLMM allows for non-Gaussian distributions and the logit link function required for the above outlined model. Additionally, this procedure is “mixed” allowing the use of a RANDOM component. The random component makes allowances for correlated data. The random component in this model was the hospital facility. Using the hospital as the random component allows for correlations of encounters that occurred in the same facility. This helped to control for institutional differences. The base for this model (for comparison) was a white, non-Hispanic male who did not have surgery, had a hospital stay less than 3 days, was discharged home, and had commercial insurance. The year of 1992 was indicated as the base year for yearly comparisons.


The following patient specific variables were initially used to examine the research question: gender, age, race, ethnicity, comorbidity count, length of stay, discharge location, the presence of a surgical procedure, the insurance type and status, the presence of a secondary psychological diagnosis, the year of hospitalization, and the dependent variable which was the presence or absence of having physical therapy as an inpatient procedure. The following section discusses the purpose and rationale regarding each tested variable.

Gender is a risk factor of LBP with females consistently suffering from the condition more often. The increased prevalence of LBP in females is consistent across all age groups, races, and ethnicity. However, incidence of LBP is bimodal with males...
aged 10 - 49 and females aged 65 - 94 incurring LBP onset more often than their age-matched counterparts.\textsuperscript{10} Due to this distribution, males miss work more frequently than females due to LBP.\textsuperscript{18} Regardless, females have more low back related surgeries,\textsuperscript{113} more intense and invasive low back surgeries,\textsuperscript{89} poorer low back surgical outcomes,\textsuperscript{114} longer hospitalizations,\textsuperscript{115} as well as more opioid use for LBP.\textsuperscript{13} As gender is a risk factor for many facets of LBP it was included in this study to examine its effect on physical therapy utilization in an inpatient setting.

Aging is a risk factor for any degenerative musculoskeletal condition including LBP\textsuperscript{73} with most LBP studies reporting a mean age of between 46 - 60 years.\textsuperscript{36,89,113,116,117} Specific to LBP, increased age has been linked to chronicity\textsuperscript{2} and increased opioid use.\textsuperscript{13} Likewise, those receiving low back related surgery at a younger age have a higher rate of reoperation later in life.\textsuperscript{89} Since aging is a risk factor for LBP and is associated with declining function, age was included to examine its effect on receiving physical therapy. However, as mentioned previously, only those aged 18 – 84 were included in this analysis.

Race has some influence in the development of LBP with the highest incidence occurring in African Americans and white Caucasians.\textsuperscript{10} Most convenience samples in the United States are predominantly white\textsuperscript{113} and compose about 85 percent of the studied LBP population.\textsuperscript{36,68} However, when low back surgery is performed on those in the Medicare population whites have shorter hospitalizations and less surgical complications when compared to non-whites.\textsuperscript{115} Since race has an effect in the development of LBP, as well as an effect in the post-surgical outcomes of LBP, a patient’s race was included in the study.
While gender, age, and race all play a role in the incidence of LBP,\textsuperscript{10} ethnicity has been less reported in recent LBP literature. Descriptive statistics of most LBP studies reveal that LBP affects more non-Hispanics than Hispanics.\textsuperscript{2,10,116} The reasons for ethnic differences seen in the LBP population has not yet been theorized. However, ethnicity was included in this examination to see if it has an association with physical therapy utilization.

The presence of any comorbidity in the LBP population has been shown to increase back pain related disability, overall health care cost,\textsuperscript{11} and length of hospitalization.\textsuperscript{115} Any comorbidity is present in about 9 percent of patients having low back related surgery.\textsuperscript{89} Despite the concerns of comorbidities on cost, hospitalization, and disability, comorbidities are not significant predictors of further low back surgical procedures.\textsuperscript{89} Since comorbidities increase disability and the length of a hospital stay for patients with LBP it was examined for an association with physical therapy consumption. A comorbidity was defined as present if the encounter contained a secondary diagnosis of any of the 17 conditions listed in Appendix C.

Hospitalization for patients with LBP is usually between 1 - 7 days (96.6 percent of the time) with most patients having an inpatient stay of 3 - 7 days (51.6 percent of the time).\textsuperscript{116} Length of stay is associated with the type of low back surgery with more invasive procedures resulting in longer hospitalizations.\textsuperscript{115} For many reasons (including nosocomial infections, altered function, and surgical complications) an increased length of stay may have an effect on physical therapy utilization and it was included in this study. Similar to the study by Rhee et al.\textsuperscript{116} the length of hospitalization was categorized at 3 levels: < 3 days, 3 - 7 days, and > 7 days.
Location of discharge relies on a myriad of information including hospital and institutional procedures, insurance policies, and medical care requirements. Patient functions (including transfers, walking, basic activities of daily living, and cognition) also affect discharge location. A discharge to a skilled care facility for those with LBP has been linked to older age, a higher number of comorbidities, and more invasive surgical techniques. In fact, about 20 percent of patients over 65 years old with lumbar fusions are discharged to a skilled facility. Since physical therapists are often involved in the discharge planning process, discharge location was examined as a possible contributor to seeing a physical therapist in the hospital.

Greater than 90 percent of hospital admissions for LBP result in surgical procedures with roughly 23 percent involving arthrodesis or spinal fusion. Re-operation rates in the 10 to 11 years following low back related surgery range between 18 - 23 percent. Higher re-operation rates exist for those having surgery earlier in life with the subsequent surgery demonstrating increased complexity, more resultant complications, and poorer outcomes. Recently, the number of complex, multi-level lumbar surgeries have risen dramatically. Since lumbar surgery can greatly alter function it was used as a predictive variable for the consumption of physical therapy services. Surgery was noted to occur if the patient encounter had an *International Classification of Disease, 9th Revision, Clinical Modification* (ICD-9-CM) procedure code indicating a discectomy (80.51), a spinal decompression laminectomy (03.09) or a lumbosacral fusion (81.06 - 81.08 and 81.62 - 81.64). Only these three types of surgery were considered.
Since treatment (especially treatment for LBP) is often determined by the payer’s medical policy in the United States,\textsuperscript{31} insurance status and type of insurance was included in the study. Insurance was collapsed to place each encounter into 1 of the following 6 mutually exclusive categories: Medicare, Medicaid, Commercial insurance, Worker’s Compensation, Other insurance, and no insurance.

Psychological conditions of anxiety, depression, as well as, pain catastrophizing, and kinesophobia (fear of movement) are risk factors for developing chronic LBP.\textsuperscript{11} Low back patients with documented psychosocial histories have poor surgical outcomes and are at risk for failed back surgery syndromes (FBSS).\textsuperscript{114} In this study, the patient was classified as having a psychological condition if they had a secondary diagnosis of a mental disorder as indicated by an ICD-9-CM code of 290–319. In addition to examining the prevalence of anxiety and depression in this population the variable was included to for examination of a possible effect on physical therapy application.

Lastly, since this study was a retrospective, longitudinal study the effect of time was controlled by using the year of each encounter as multiple independent variables. Spinal care has substantially changed over the time period examined.\textsuperscript{37,117} However, Mafi et al.\textsuperscript{38} showed that physical therapy utilization for LBP was relatively unchanged from 1999 to 2010. Regardless, year was used as a variable to predict physical therapy consumption from 1992 – 2014. See Table 3.1 for a synopsis of all of the included model variables.
Table 3.1 – Model Variables.*

<table>
<thead>
<tr>
<th>Fixed Effect Variables</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical therapy utilization</td>
<td>Yes – physical therapy utilized (PT = 1)</td>
</tr>
<tr>
<td>(dependent variable)</td>
<td>No – physical therapy not utilized (PT = 0)</td>
</tr>
<tr>
<td>Female gender</td>
<td>Male* (gender = 0)</td>
</tr>
<tr>
<td></td>
<td>Female (gender= 1)</td>
</tr>
<tr>
<td>Age</td>
<td>Age in years</td>
</tr>
<tr>
<td>Race</td>
<td>Caucasian/white*</td>
</tr>
<tr>
<td></td>
<td>African American/black</td>
</tr>
<tr>
<td></td>
<td>Other race</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Non-Hispanic* (ethnicity = 0)</td>
</tr>
<tr>
<td></td>
<td>Hispanic (ethnicity = 1)</td>
</tr>
<tr>
<td>Comorbidity count</td>
<td>Number of comorbidities</td>
</tr>
<tr>
<td>Length of hospitalization</td>
<td>Number of days hospitalized (3 categories): &lt;3*, 3-7, &gt;7 days</td>
</tr>
<tr>
<td>Discharge location</td>
<td>Home*</td>
</tr>
<tr>
<td></td>
<td>Skilled care – another skilled medical location</td>
</tr>
<tr>
<td></td>
<td>Home health care</td>
</tr>
<tr>
<td>Low back surgery</td>
<td>Absent* (surgery=0)</td>
</tr>
<tr>
<td></td>
<td>Present (surgery=1)</td>
</tr>
<tr>
<td>Insurance status</td>
<td>Commercial insurance*</td>
</tr>
<tr>
<td></td>
<td>Medicare</td>
</tr>
<tr>
<td></td>
<td>Medicaid</td>
</tr>
<tr>
<td></td>
<td>Worker’s compensation</td>
</tr>
<tr>
<td></td>
<td>Other insurance – auto, etc.</td>
</tr>
<tr>
<td></td>
<td>No insurance</td>
</tr>
<tr>
<td>Secondary psychological diagnosis</td>
<td>Absent* (psychological diagnosis = 0)</td>
</tr>
<tr>
<td></td>
<td>Present (psychological diagnosis = 1)</td>
</tr>
<tr>
<td></td>
<td>1992 was used as the reference year for comparisons</td>
</tr>
</tbody>
</table>

Random Effects Variable: Categories

| Facility                                      | All patients grouped by facility                                           |

* Base variables are italicized and marked with a “*”.

Data Selection for Analysis from 2010 - 2014

The second analysis was performed using the same AHCA data set but it was joined to the AHCA financial dataset that was available from 2008 - 2014. This dataset contained data regarding a hospital’s financial status with indicators describing
the hospital’s total revenue, cost centers, number of employees, profit status, number of licensed beds, etc. Literature suggests that some of these variables may be important in explaining health service utilization.\textsuperscript{130-132} Since the dependent variable, the presence or absence of physical therapy, was only available from 2010 onward, the data was reduced to the years of 2010 - 2014. The data was further reduced by using the same process as described previously with inclusion criteria requiring the following: a primary ICD-9-CM diagnostic code indicating low back pain, a length of stay of at least 1 day, an elective admission, a discharge location of home, home health, or skilled care, and aged 18-84. Additionally, this data included 58 hospitals that changed their profit status at some point during the 7 years that the data encompassed. Patient encounters that occurred during the year of the hospital profit status change were removed from the dataset. Since the interest of this study is limited to inpatient care for LBP, any encounters indicating care at long term care hospitals were also removed. Additionally, if the hospital did not report employing any physical therapists and they had no physical therapy services billed for the entirety of this sample, the encounters were removed. Likewise, if the hospital did not report any physical therapy FTEs but billed for physical therapy which may indicate the use of contracted physical therapy, the encounters were removed. Lastly, the encounters were reduced to patients who had lumbar surgery. This allowed further examination into surgery type and its effect on physical therapy utilization. After joining, coding, and restriction of the data G\textsuperscript{*}Power 3.1.9.2\textsuperscript{129} was used to calculate the appropriate sample size. The previously described parameters revealed the need of at least 6,392 observations for the proposed model. Therefore, a 10 percent random draw was taken
from the remaining sample. See Figure 3.2 for a depiction of how the population was reduced and the sample drawn.

**Population of LBP encounters 1991 - 2014**
N = 707,888

**Years of 2010 - 2014**
153,857

**Discharge to home, home health, or skilled facility**
152,201

**Elective admission**
101,154

**Aged 18 - 84**
95,838

**Length of stay at least 1 day**
93,849

**Acute care hospitals only**
93,833

**No hospital profit status change within the year**
87,384

**Neither physical therapists employed nor physical therapy charged**
87,337

**Surgery performed and in-house physical therapy**
73,905

**10% random sample**
7,293

**Figure 3.2** – Data Selection Process for Analysis from 2010 – 2014.
Model for Analysis of Years 2010 - 2014

The second model predicting the presence/absence of physical therapy using both hospital and patient specific variables, as well as hospital procedural variables was as follows:

\[ \ln \text{Physical Therapy (Y)} = \beta_0 + \beta_1 \times \text{gender} + \beta_2 \times \text{age} + \beta_3 \times \text{race} + \beta_4 \times \text{ethnicity} + \beta_5 \times \text{comorbidity count} + \beta_6 \times \text{length of stay 3 - 7 days} + \beta_7 \times \text{length of stay > 7 days} + \beta_8 \times \text{discharge to skilled facility} + \beta_9 \times \text{discharge to home health} + \beta_{10} \times \text{Medicare} + \beta_{11} \times \text{Medicaid} + \beta_{12} \times \text{Worker's Compensation} + \beta_{13} \times \text{Other insurance} + \beta_{14} \times \text{No insurance} + \beta_{15} \times \text{discectomy} + \beta_{16} \times \text{laminectomy} + \beta_{17} \times \text{fusion 4 – 8 levels} + \beta_{18} \times \text{fusion > 7 levels} + \beta_{19} \times \text{secondary psychological diagnosis} + \beta_{20} \times \text{government profit status} + \beta_{21} \times \text{investor profit status} + \beta_{22} \times \text{medium hospital size} + \beta_{23} \times \text{large hospital size} + \beta_{24} \times \text{medium physical therapy workforce} + \beta_{25} \times \text{large physical therapy workforce} + \beta_{26-29} \times \text{year (2010-2014)} + \varepsilon. \]

Variable Selection for Model 2010 - 2014

Patient Variables

The following patient specific variables were used to examine the utilization of physical therapy from 2010 - 2014: gender, age, race, ethnicity, comorbidity count, length of stay, discharge location, surgery type, insurance type, the presence of a secondary psychological disorder, the year of hospitalization, and the presence of a physical therapy intervention. All of these patient variables were previously described; however, surgery type requires an explanation. Surgery was further developed as to the type of surgery performed. As discussed, three commonly reported back surgeries during inpatient stays are discectomies, spinal decompressions, and lumbar fusions.\textsuperscript{37} The following ICD-9-CM procedure codes\textsuperscript{107} were used to identify the presence or absence of these 3 specific surgeries as described below:

- Discectomies – 80.51: Excision of an intervertebral disc
- Decompressions – 03.09: Other exploration and decompression of the spinal canal
- Fusions – lumbar and lumbosacral fusion
  - 81.06: anterior approach, anterior technique
  - 81.07: posterior approach, lateral transverse technique
81.08: anterior approach, posterior technique
81.62: fusion of 2 - 3 vertebrae
81.63: fusion of 4 - 8 vertebrae
81.64: fusion of 9 or more vertebrae

These codes are not mutually exclusive and patients having a discectomy, for example, could also have a decompression or a fusion procedure.

**Hospital Variables**

The hospital variables included ownership type, hospital size, and the number of physical therapy full-time equivalencies (FTEs) employed per 1,000 patient admissions. Since the literature suggests that a hospital’s ownership type is associated with differences in both services provided and outcomes,\textsuperscript{130,131} ownership type was included in the model, which include three types: private not-for-profit, government not-for-profit, and investor-owned for-profit.

Hospital size (categorized by the number of licensed beds) has been associated with some differences in physical therapy utilization. Freburger et al.\textsuperscript{132} found that patients having total joint replacements in a large hospital were more likely to have physical therapy. In the same study, they found no difference in physical therapy utilization based on hospital size for patients having a stroke. Mimicking Freburger’s study, categories for hospital size based on the number of licensed beds were created using tertiles for small, medium, and large hospitals.

A variable was created based on the number of physical therapy FTE’s per 1,000 admissions for each hospital. The technique published by Freburger et al.\textsuperscript{132} used tertiles for this variable to categorize a large, medium, and small physical therapy workforces based on hospital admissions. The same definition was used in this study.
Results

Overall Population Descriptive Statistics

The overall descriptive statistics were obtained from the initial population of 707,888 patients hospitalized with LBP in the state of Florida from 1991 – 2014. These statistics represent the entire population prior to the exclusion processes described previously to obtain the studied sample. The statistics will be discussed in roughly the same order as the variables described previously.

The most common ICD-9-CM diagnoses for LBP in order of occurrence were 722.10 (displacement of lumbar intervertebral disc without myelopathy), 742.02 (spinal stenosis, lumbar region, without neurogenic claudication), 722.52 (degeneration of lumbar or lumbosacral intervertebral disc), and 721.3 (lumbosacral spondylosis without myelopathy). These 4 diagnoses captured 73 percent of those diagnosed with LBP with no other diagnosis capturing more than 5 percent of the population. The most referenced LBP diagnoses have changed over time. While 722.10 is the most referenced code in this study it no longer encompasses 70 percent of the surgical cases as reported by Cherkin et al. in 1992. Figure 3.3 provides the percent frequency of by diagnosis code.

The number of patients hospitalized with LBP slightly increased over the 24 years; however, when compared with all hospitalizations the rate of LBP hospitalizations decreased from 1.49 percent in 1991 to 1.06 percent in 2014. Figure 3.4 provides the number of LBP hospitalizations and Figure 3.5 provides the rate of LBP hospitalizations per 100,000 admitted patients in Florida from 1991 – 2014.
**Figure 3.3** – Primary Diagnoses Codes for Patients Hospitalized with LBP in Florida from 1991-2014.

**Figure 3.4** – The Number of LBP Hospitalizations in Florida from 1991 – 2014.
Figure 3.5 – The Rate of LBP Hospitalizations in Florida from 1991 – 2014.

Over time, gender moved from a slightly more male population to a more female population. It has stabilized at about 53.5 percent female since 2003. Figure 3.6 provides LBP as it relates to gender.

Figure 3.6 – Percentage of Female Patients Hospitalized with LBP in Florida from 1991 - 2014.
The average age of patients hospitalized with LBP has steadily increased from 52.1 years to 60.7 over the 24 year timeframe. Figure 3.7 provides the average age of patients hospitalized with LBP by year.

![Figure 3.7 – Average Age of Patients with LBP Hospitalized in Florida from 1991-2014.](image)

Race and ethnicity varied little throughout the dataset. The population was predominantly white, non-Hispanic.

Comorbidity count (range 0 – 7) remained under an average of 1 but tripled over the timeframe. The average comorbidity count was .21 in 1991 and increased to .66 in 2014. Figure 3.8 provides this trend.

Length of hospitalization reduced dramatically in the early 1990’s from a stay of 5.5 days to approximately 3.5 days. This has remained stable since 1996 (see Figure 3.9).

The discharge location reflected a time trend toward needing further care after the hospitalization. Both discharges to a further skilled facility and to home health increased over 4-fold over the 24 year time period. Patients discharged to home after LBP
hospitalization and surgery declined by approximately one-half over the time period (see Figure 3.10).

**Figure 3.8** – Average Comorbidity Counts for Patients Hospitalized with LBP in Florida from 1991 – 2014.

**Figure 3.9** – Average Length of Stay for Those Hospitalized with LBP in Florida 1991 - 2014.
Insurance type and status during hospitalization revealed a steady reduction in commercial insurance, declining to 28.5 percent in 2014. Public insurance types have increased steadily. Medicare rose to approximately 55 percent and Medicaid to approximately 6 percent. Worker’s Compensation insurance peaked in the early 1990’s and has stabilized at about 3 percent since then. Those without insurance were stable during the study period at 3 percent. Figure 3.11 provides insurance type/status and related changes over the 24 year period.

Patients with a primary diagnosis of LBP and a secondary diagnosis of depression or anxiety increased over 7 fold from 1992 – 2014, as depicted in Figure 3.12.

The percent of patients receiving physical therapy increased at a steady rate across the time period (see Figure 3.13) from a low of 45.5 percent occurring in 1991 to a high of 84.4 percent occurring in 2014. For the years of 2006 – 2009, which was missing the data regarding the utilization of physical therapy, the approximate value was obtained.
from the average yearly change nearest to the missing timeframe. In contrast to physical therapy, those hospitalized with LBP had a relatively stable rate of surgery over the time frame from a low of 64.0 percent in 1992 to a high of 75.6 percent in 2010 (see Figure 3.14).

**Figure 3.11** – Insurance Type/Status for Patients Hospitalized with LBP in Florida from 1992 - 2014.

**Figure 3.12** – Percentage of Patients Hospitalized for LBP with a Secondary Diagnosis of Depression or Anxiety, 1991 - 2014.
Despite a relatively stable surgery rate overall, the types of surgery performed varied greatly. Decompression surgeries peaked in the year 2000 and the percentage of decompressions performed in 2014 was less than what was performed in 1992. Discectomies varied slightly but accounts for around 40 percent for the last decade. Lumbar fusions have increased dramatically with over a 6.6 fold increase since 1992. Figure 3.14 provides for lumbar surgery types over the study period.

**Figure 3.13** – Percent of LBP Patients Having Surgery and/or Physical Therapy in Florida Hospitals from 1992 - 2014.

![Percent of Patients with LBP Having Surgery/Physical Therapy](image)

- **Descriptive Statistics Comparing the Overall Sample to the Two Percent Random Sample**

There were some differences as a result of the exclusion process between the entire LBP population and the “full sample”. Those differences, as well as, a comparison to the 2 percent random sample for all variables are listed in table 2. There were no significant differences between the “full sample” and the 2 percent sample which was drawn from the “full sample.”
Figure 3.14 – Surgery Types for Patients Hospitalized with LBP in Florida from 1992 - 2014.

Table 3.2 – Comparison of the LBP Population and the Samples for All Studied Variables.

<table>
<thead>
<tr>
<th>Principal Diagnosis Code</th>
<th>Population</th>
<th>Full sample</th>
<th>2% sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>722.1</td>
<td>37.72%</td>
<td>43.38%</td>
<td>43.11%</td>
</tr>
<tr>
<td>724.02</td>
<td>17.64%</td>
<td>20.85%</td>
<td>20.70%</td>
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<td>9.12%</td>
<td>8.95%</td>
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<td>8.46%</td>
<td>8.16%</td>
<td>8.34%</td>
</tr>
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<td>724.2</td>
<td>4.60%</td>
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</tr>
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<td>738.4</td>
<td>3.84%</td>
<td>5.00%</td>
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<td>722.83</td>
<td>2.33%</td>
<td>2.63%</td>
<td>2.47%</td>
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<td>724.4</td>
<td>2.26%</td>
<td>1.24%</td>
<td>1.38%</td>
</tr>
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<td>724.5</td>
<td>2.07%</td>
<td>0.30%</td>
<td>0.26%</td>
</tr>
<tr>
<td>other codes</td>
<td>26.92%</td>
<td>18.49%</td>
<td>18.90%</td>
</tr>
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<table>
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<tr>
<th>Gender</th>
<th>% female</th>
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<th>47.79%</th>
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<td>56.9</td>
<td>56.8</td>
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<td>58</td>
<td>58</td>
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<tr>
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<td>18-84</td>
<td>18-84</td>
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<td>Caucasian</td>
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<td>90.85%</td>
<td>90.34%</td>
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<td>African American</td>
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<td>5.40%</td>
<td>5.67%</td>
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<tr>
<td>Other race</td>
<td>7.43%</td>
<td>3.74%</td>
<td>3.98%</td>
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<td>Population</td>
<td>Full sample</td>
<td>2% sample</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hispanic</td>
<td>11.70%</td>
<td>6.04%</td>
<td>6.31%</td>
</tr>
<tr>
<td>non-Hispanic</td>
<td>86.57%</td>
<td>93.96%</td>
<td>93.69%</td>
</tr>
<tr>
<td><strong>Comorbidity Count</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>.46</td>
<td>.38</td>
<td>.37</td>
</tr>
<tr>
<td>Median</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Range</td>
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<td>0-7</td>
<td>0-5</td>
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<td><strong>Length of Stay</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.71</td>
<td>3.27</td>
<td>3.31</td>
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<tr>
<td>Median</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Range</td>
<td>0-304</td>
<td>1-209</td>
<td>1-46</td>
</tr>
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<td><strong>Discharge location</strong></td>
<td></td>
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</tr>
<tr>
<td>Home</td>
<td>68.49%</td>
<td>70.62%</td>
<td>70.60%</td>
</tr>
<tr>
<td>Skilled Facility</td>
<td>13.83%</td>
<td>11.44%</td>
<td>11.36%</td>
</tr>
<tr>
<td>Home Health</td>
<td>16.95%</td>
<td>17.94%</td>
<td>18.04%</td>
</tr>
<tr>
<td>other</td>
<td>0.73%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>71.63%</td>
<td>91.75%</td>
<td>92.23%</td>
</tr>
<tr>
<td><strong>Payer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>44.04%</td>
<td>41.37%</td>
<td>40.92%</td>
</tr>
<tr>
<td>Medicaid</td>
<td>3.86%</td>
<td>2.53%</td>
<td>2.35%</td>
</tr>
<tr>
<td>Commercial</td>
<td>36.33%</td>
<td>38.58%</td>
<td>38.85%</td>
</tr>
<tr>
<td>Worker’s Comp</td>
<td>8.74%</td>
<td>12.07%</td>
<td>12.55%</td>
</tr>
<tr>
<td>Other Ins.</td>
<td>3.94%</td>
<td>3.41%</td>
<td>3.23%</td>
</tr>
<tr>
<td>No Insurance</td>
<td>3.09%</td>
<td>2.04%</td>
<td>2.08%</td>
</tr>
<tr>
<td><strong>Secondary Psychological Diagnosis</strong></td>
<td>22.51%</td>
<td>19.83%</td>
<td>19.70%</td>
</tr>
</tbody>
</table>

Results of Model Encompassing the Years of 1992 - 2014

Statistical Analysis System Software 9.4 from the SAS Institute, Cary, NC, was used to perform all data preparation and procedures as described within this work. Table 3 provides the results of the analysis for years 1992 – 2014. The base for this model was a white, non-Hispanic male with commercial insurance, who did not have a surgery or a secondary psychological diagnosis, with a length of stay of 1-3 days, and was discharged.
home. For yearly comparison 1992 was designated as the base year. Table 3.3 provides the results of the initial (generalized linear mixed method) model.

**Table 3.3 – Initial Model Output for Analysis from 1992 - 2014.**

| Effect                  | Estimate | Standard Error | t Value | Pr > |t| |
|-------------------------|----------|----------------|---------|------|---|
| Intercept               | -.3087   | .237           | -13.02  | <.0001 |
| Female                  | .008     | .064           | .12     | .907 |
| Age                     | .010     | .003           | 3.47    | .005*|
| African American        | .163     | .143           | 1.14    | .254 |
| Other race              | -.192    | .167           | -1.15   | .251 |
| Hispanic                | .169     | .152           | 1.11    | .268 |
| Comorbidity count       | .016     | .057           | .29     | .773 |
| Length of stay 3-7 days | 1.647    | .074           | 22.36   | <.0001* |
| Length of stay > 7 days | 2.563    | .196           | 13.09   | <.0001* |
| Skilled discharge       | 1.626    | .186           | 8.76    | <.0001* |
| Home health discharge   | 1.320    | .120           | 11.03   | <.0001* |
| Surgery                 | .912     | .117           | 7.83    | <.0001* |
| Medicare                | -.118    | .100           | -1.19   | .236 |
| Medicaid                | -.127    | .207           | -61     | .541 |
| Worker’s Compensation   | .091     | .098           | .93     | .352 |
| Other insurance         | .046     | .185           | .25     | .805 |
| No insurance            | .261     | .217           | 1.20    | .229 |
| Secondary psychological diagnosis | .043 | .088 | .49 | .623 |

*Significant p-values (<.05) are marked with an “*”.

Interpretation of the coefficients are in log odds form, therefore, they require modification to be interpreted. For example, the variable “surgery” has an estimate of .912. This requires the following modification for interpretation: e^ .912 - 1 = 1.49. This means that if the patient had surgery they were 149 percent more likely to receive physical therapy holding all other variables constant. Since there were several variables that were not significant they were dropped from the final model. This resulted in deleting gender,
race, ethnicity, comorbidity count, insurance status, and a secondary psychological diagnosis. Using the same generalized linear mixed method procedure the final model was reduced as follows:

Physical therapy (Y) = β₀ + β₁*age + β₂*length of stay 3-7 days + β₃*length of stay > 7 days + β₄*discharge to a skilled facility + β₅*discharged to home health + β₆*surgery + β₇-β₁₀*year of hospitalization + ε.

The base model changed to any person not having surgery, with a length of stay of 1-3 days, who was discharged home. Table 3.4 provides the resulting solution with Type III estimates and Table 3.5 provides the odd ratios and estimates for the fixed effect of time (year). Goodness of fit measures for the final model can be found in Appendix B under “Physical Therapy Utilization Model #1”.

**Table 3.4 – Mixed Method, Final Model Output of Fixed Effects Type III for LBP Sample from 1992 - 2014.*

<table>
<thead>
<tr>
<th>Effect</th>
<th>F Value</th>
<th>Pr &gt; F</th>
<th>OR estimate</th>
<th>OR Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>3.28</td>
<td>.0010</td>
<td>1.007</td>
<td>1.003 – 1.011</td>
</tr>
<tr>
<td>Length of stay 3-7 days</td>
<td>510.82</td>
<td>&lt;.0001</td>
<td>5.233</td>
<td>4.534 – 6.041</td>
</tr>
<tr>
<td>Length of stay &gt; 7 days</td>
<td>172.98</td>
<td>&lt;.0001</td>
<td>12.87</td>
<td>8.794 – 18.834</td>
</tr>
<tr>
<td>Skilled discharge</td>
<td>77.19</td>
<td>&lt;.0001</td>
<td>5.06</td>
<td>3.524 – 7.267</td>
</tr>
<tr>
<td>Home health discharge</td>
<td>121.07</td>
<td>&lt;.0001</td>
<td>3.71</td>
<td>2.936 – 4.684</td>
</tr>
<tr>
<td>Surgery</td>
<td>61.71</td>
<td>&lt;.0001</td>
<td>2.477</td>
<td>1.975 – 3.106</td>
</tr>
<tr>
<td>Year</td>
<td>39.79</td>
<td>&lt;.0001</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*The Odds Ratio for year is included in Table 3.5.*

Since these variables were not examined for significant interactions direct odd ratios and their respective confidence intervals can be calculated for each variable and are included in Table 3.4. Odds ratios (OR) can be interpreted as follows: Each ratio means that if all other variables are held constant, a patient exhibiting a variable is that
many times more likely to receive physical therapy. As an example, for “surgery,” a patient was nearly 2.5 times more likely to receive physical therapy. For the purpose of this analysis, the year of 1992 was used as the base year. As can be seen in the odds ratio table for year (Table 3.5) the odds of receiving physical therapy has substantially increased over the years. Any OR confidence interval that contains a value of “1” is not significantly different from the base variable. In this example, the base year of 1992 is not significantly different from 1993 – 1995.

**Table 3.5 – Odds Ratio Estimates and Confidence Intervals for Year.**

<table>
<thead>
<tr>
<th>Year</th>
<th>OR Estimate</th>
<th>OR Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>1.411</td>
<td>.990 – 2.011</td>
</tr>
<tr>
<td>1994</td>
<td>1.404</td>
<td>.983 – 2.005</td>
</tr>
<tr>
<td>1995</td>
<td>1.383</td>
<td>.963 – 1.987</td>
</tr>
<tr>
<td>1996</td>
<td>1.906</td>
<td>1.316 – 2.761</td>
</tr>
<tr>
<td>1997</td>
<td>2.062</td>
<td>1.437 – 2.959</td>
</tr>
<tr>
<td>1998</td>
<td>2.316</td>
<td>1.636 – 3.280</td>
</tr>
<tr>
<td>1999</td>
<td>2.551</td>
<td>1.804 – 3.606</td>
</tr>
<tr>
<td>2000</td>
<td>3.820</td>
<td>2.678 – 5.451</td>
</tr>
<tr>
<td>2001</td>
<td>3.680</td>
<td>2.611 – 5.188</td>
</tr>
<tr>
<td>2002</td>
<td>4.803</td>
<td>3.383 – 6.819</td>
</tr>
<tr>
<td>2005</td>
<td>7.664</td>
<td>5.291 – 11.100</td>
</tr>
<tr>
<td>2010</td>
<td>16.070</td>
<td>10.648 – 24.252</td>
</tr>
<tr>
<td>2011</td>
<td>11.500</td>
<td>7.653 – 17.280</td>
</tr>
<tr>
<td>2012</td>
<td>15.677</td>
<td>10.030 – 24.504</td>
</tr>
<tr>
<td>2013</td>
<td>23.091</td>
<td>13.997 – 38.093</td>
</tr>
<tr>
<td>2014</td>
<td>34.014</td>
<td>18.889 – 61.250</td>
</tr>
</tbody>
</table>

**Results of Model Encompassing the Years of 2010 – 2014**

The model encompassing the years of 2010 – 2014 included hospital level variables and clarification variables for surgery. The estimating procedure was similar to the 1992 – 2014 model with an adjustment using the classical “sandwich” estimator to adjust the standard errors of the fixed effects based on clustering as described by
In addition, the LaPlace (which approximates the marginal distribution) likelihood approximation method was utilized and fit by the maximal likelihood estimate. This modification improved convergence and overall model fit by means of the Pearson statistic utilized by the LaPlace method in PROC GLIMMIX. Table 3.6 provides the full model fixed effects solution. The base for this model is a white, non-Hispanic male without a secondary psychological diagnosis with commercial insurance, undergoing a 1 - 3 level fusion, discharged home after a length of stay of 1 – 3 days, in a small hospital with a small physical therapy workforce in the year of 2010 at a not-for profit hospital.

Table 3.6 – Solution for Full Model 2010 – 2014.

<table>
<thead>
<tr>
<th>Effect</th>
<th>year</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>DF</th>
<th>t Value</th>
<th>Pr &gt;</th>
<th>t</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>1.866</td>
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<td>114</td>
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<tr>
<td>Female gender</td>
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<td>0.025</td>
<td>0.109</td>
<td>7148</td>
<td>0.23</td>
<td>0.820</td>
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</tr>
<tr>
<td>Age</td>
<td></td>
<td>0.002</td>
<td>0.005</td>
<td>7148</td>
<td>0.45</td>
<td>0.654</td>
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<td></td>
</tr>
<tr>
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<td>0.242</td>
<td>0.206</td>
<td>7148</td>
<td>1.17</td>
<td>0.241</td>
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<tr>
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<td>0.320</td>
<td>7148</td>
<td>0.96</td>
<td>0.337</td>
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<tr>
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<td>0.404</td>
<td>0.315</td>
<td>7148</td>
<td>1.28</td>
<td>0.201</td>
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</tr>
<tr>
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<td>0.075</td>
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<td>1.77</td>
<td>0.077</td>
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</tr>
<tr>
<td>Length of stay 3-7</td>
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<td>1.379</td>
<td>0.151</td>
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<td>9.13</td>
<td>&lt;.0001</td>
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</tr>
<tr>
<td>Length of stay &gt;7</td>
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<td>2.444</td>
<td>0.823</td>
<td>7148</td>
<td>2.97</td>
<td>0.003</td>
<td></td>
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</tr>
<tr>
<td>Skilled discharge</td>
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<td>2.169</td>
<td>0.282</td>
<td>7148</td>
<td>7.70</td>
<td>&lt;.0001</td>
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<tr>
<td>Home health discharge</td>
<td></td>
<td>1.883</td>
<td>0.185</td>
<td>7148</td>
<td>10.20</td>
<td>&lt;.0001</td>
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<td></td>
</tr>
<tr>
<td>Medicare insurance</td>
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<td>-0.061</td>
<td>0.133</td>
<td>7148</td>
<td>-0.46</td>
<td>0.647</td>
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<tr>
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<td>0.387</td>
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<td>0.407</td>
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<tr>
<td>Worker's compensation</td>
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<td>7148</td>
<td>-1.35</td>
<td>0.176</td>
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</table>
## Solutions for Fixed Effects

<table>
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<th>Estimate</th>
<th>Standard Error</th>
<th>DF</th>
<th>t Value</th>
<th>Pr &gt;</th>
<th>t</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Other insurance</td>
<td>0</td>
<td>0.314</td>
<td>0.217</td>
<td>7148</td>
<td>1.45</td>
<td>0.148</td>
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</tr>
<tr>
<td>No insurance</td>
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<td>-0.254</td>
<td>0.366</td>
<td>7148</td>
<td>-0.70</td>
<td>0.487</td>
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<td></td>
</tr>
<tr>
<td>Discectomy</td>
<td></td>
<td>-1.876</td>
<td>0.193</td>
<td>7148</td>
<td>-9.72</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laminectomy</td>
<td></td>
<td>-1.159</td>
<td>0.212</td>
<td>7148</td>
<td>-5.47</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fusion 4-8 levels</td>
<td></td>
<td>-0.587</td>
<td>0.291</td>
<td>7148</td>
<td>-2.02</td>
<td>0.044</td>
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</tr>
<tr>
<td>Fusion &gt;8 levels</td>
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<td>7148</td>
<td>5.40</td>
<td>&lt;.0001</td>
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</tr>
<tr>
<td>Secondary psychological Diagnosis</td>
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<td>-0.129</td>
<td>0.112</td>
<td>7148</td>
<td>-1.15</td>
<td>0.250</td>
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<tr>
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<td>0.258</td>
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<td>0.25</td>
<td>0.802</td>
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</tr>
<tr>
<td>Medium sized hospital</td>
<td></td>
<td>-0.134</td>
<td>0.301</td>
<td>7148</td>
<td>-0.44</td>
<td>0.657</td>
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</tr>
<tr>
<td>Large sized hospital</td>
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<td>0.362</td>
<td>7148</td>
<td>-1.18</td>
<td>0.237</td>
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</tr>
<tr>
<td>Medium PT workforce</td>
<td></td>
<td>0.230</td>
<td>0.193</td>
<td>7148</td>
<td>1.19</td>
<td>0.232</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large PT workforce</td>
<td></td>
<td>0.315</td>
<td>0.267</td>
<td>7148</td>
<td>1.18</td>
<td>0.239</td>
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</tr>
<tr>
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<td>0.142</td>
<td>7148</td>
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<td>0.925</td>
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</tr>
<tr>
<td>year</td>
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<td>0.097</td>
<td>0.183</td>
<td>7148</td>
<td>0.53</td>
<td>0.596</td>
<td></td>
<td></td>
</tr>
<tr>
<td>year</td>
<td>2013</td>
<td>0.104</td>
<td>0.186</td>
<td>7148</td>
<td>0.56</td>
<td>0.577</td>
<td></td>
<td></td>
</tr>
<tr>
<td>year</td>
<td>2014</td>
<td>0.547</td>
<td>0.217</td>
<td>7148</td>
<td>2.52</td>
<td>0.012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>year</td>
<td>2010</td>
<td>0</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The model for 2010 – 2014 shows no additional significant effects using any of the hospital variables (profit status, hospital size, and relative size of physical therapy workforce). The significant variables (p-value < .05) are discharge location, surgery type, and length of stay. Interpretation of surgery type is slightly confusing due to the fusion 4 – 8 levels variable. This variable indicates reduced physical therapy despite a more invasive procedure when compared to the base variable of a 1 – 3 level fusion. Other
surgery type variables align, as expected, with reduced log odds of physical therapy for less invasive procedures (discectomy and laminectomy) and increased log odds of physical therapy for fusions of 9 levels or greater. When the surgery type variable is reduced to fusion or no fusion and the overall model is reduced to only those variables with significant effects the model fit improves and the type III fixed effects and their respective odds ratio result as shown in Table 3.7. The base for comparison for this model is a person having either a discectomy or a laminectomy with a length of stay 1 – 3 days who was discharged home. Goodness of fit for the model can be found in Appendix B under “Physical Therapy Utilization” Model #2”.

**Table 3.7 – Type III Fixed Effects for the Reduced Model from the years of 2010 – 2014.**

<table>
<thead>
<tr>
<th>Effect</th>
<th>F Value</th>
<th>Pr &gt; F</th>
<th>Estimate</th>
<th>95% Confidence Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skilled discharge</td>
<td>62.87</td>
<td>&lt;.0001</td>
<td>9.176</td>
<td>5.305 15.873</td>
</tr>
<tr>
<td>Home health discharge</td>
<td>103.59</td>
<td>&lt;.0001</td>
<td>6.828</td>
<td>4.717 9.886</td>
</tr>
<tr>
<td>Fusion</td>
<td>65.35</td>
<td>&lt;.0001</td>
<td>4.204</td>
<td>2.968 5.955</td>
</tr>
<tr>
<td>Length of stay 3 – 7 days</td>
<td>82.06</td>
<td>&lt;.0001</td>
<td>4.101</td>
<td>3.022 5.566</td>
</tr>
<tr>
<td>Length of stay &gt; 7 days</td>
<td>9.05</td>
<td>0.0026</td>
<td>11.663</td>
<td>2.353 57.807</td>
</tr>
</tbody>
</table>

The significant differences between the model from 1992 – 2014 and the model from 2010 – 2014 is 1) the loss of the weak association between age and physical therapy, 2) the loss of the year variable, and 3) the surgery variable from the 1992 – 2014 model is further clarified by finding fusions are associated with an increase in receiving physical therapy.
Discussion

This study examines Florida’s population of patients hospitalized with LBP over a period of 24 years. The primary interest in examining this population was to find factors associated with seeing a physical therapist while hospitalized. There seem to be several factors that contribute to seeing a physical therapist when hospitalized with LBP. One of the strongest associations is that of time. The percentage of patients seeing a physical therapist rose steadily over the years studied. This finding falls in line with Martin et al.\textsuperscript{36} in which physical therapy utilization increased 78 percent for patients suffering from spinal conditions from 1997 – 2005. This finding was contrary to Mafi et al.\textsuperscript{38} that reported that physical therapy utilization for LBP was unchanged in their outpatient, longitudinal study from 1999 – 2010; however, the difference may occur in studying inpatient versus outpatient populations.

The increase in physical therapy utilization seen in this study could be due to a variety of reasons. First, it could be due to a steady change in the beliefs regarding the benefits of receiving physical therapy for this patient population. If this is in effect a true statement, one would expect that physical therapy utilization would remain at a high rate as new evidence supports reduced hospital readmissions for patients receiving physical therapy.\textsuperscript{120} This statement is also supported by the model results from 2010 – 2014. In this model time (year) had no significant effect on the utilization of physical therapy.

Another reason for the steady increase in physical therapy utilization could be secondary to an overall increase in the supply of physical therapists. This was not directly examined in the body of work. However, in this study there was no correlation with supply of physical therapy and the reception of its care at the hospital level. This finding goes
against the findings of Freburger et al.\textsuperscript{132} who found that inpatient physical therapy utilization was partially explained by staffing levels and contracted staffing of physical therapists.

A second factor associated with having inpatient physical therapy for LBP was length of stay. As length of stay increases the likelihood of seeing a physical therapist significantly increases. This has been shown previously in physical therapy by Freburger et al.\textsuperscript{132} for other patient populations (stroke and total joint replacements) and by Rhee et al.\textsuperscript{116} for alternative therapies. This finding is most likely due to the reduction in function and an increased need of functional rehabilitation after a prolonged hospital stay. Another obvious and probable reason for increased physical therapy utilization could simply be that a prolonged hospital stay results in more opportunities for physical therapy to take place. The third argument for increased length of stay correlating with the utilization of physical therapy is that patients who require a prolonged stay are possibly the more difficult cases and physical therapy routinely sees more difficult cases. This argument, however; was not supported by significant results expected of the comorbidity count or severity score which may or may not represent the truly difficult LBP cases.

Age was also associated with physical therapy utilization with the aged more likely to see a physical therapist. Age has previously been shown to predict inpatient physical therapy utilization.\textsuperscript{132} This finding was supported in the overall longitudinal analysis but was not supported in the 2010 - 2014 timeframe. This may be due to changes in beliefs over time with a recent trend indicating that patients of any age may benefit from inpatient physical therapy. In the final year of the study 84.4 percent of those hospitalized with LBP received physical therapy.
Of primary interest from this study, discharge location is highly associated with physical therapy utilization. The finding may be due to several reasons. First, a federal discharge policy went into effect in 1995 that requires the evaluation of a patient’s needs for post-hospital services and their capacity for self-care if the patient may suffer an adverse health consequence if they are discharged without a plan. This evaluation is consistent with the role of a physical therapist. The policy was expected to mobilize personnel in multiple disciplines who have knowledge in social and physical factors that affect function. However, if this were the sole reason for the increase in physical therapy utilization one would expect a large bump in utilization in the late 1990’s instead of the observed, slow gradual increase over the entire 24 year period. This argument would only hold credence for those discharged to a skilled facility and would not explain the continued increase in physical therapy utilization seen for those discharged to home health. There is further need to understand this correlation since discharges to home health have increased dramatically for all conditions since 2001. A more likely reason for the increase in physical therapy for all patients discharged to places other than home is an overall change in attitudes and beliefs regarding the benefits of inpatient physical therapy. This might be due to physical therapist’s increased role in the hospital discharge process when further therapies are needed. This is supported by Smith et al. who found that patients had a 2.9 times increase in the risk of readmission when therapist’s recommendations were omitted in the discharge plan. Polnaszek et al. also found trends towards poorer patient outcomes and an increased readmission rate when therapists’ recommendations were omitted upon discharge. The overall finding that patients discharged to a place other than home are more likely to utilize physical therapy
again lends support to the idea that the more disabled patients are more readily seen by physical therapists.

A primary concern associated with discharge location affecting physical therapy utilization is that the patients discharged home are less likely to receive inpatient physical therapy. Patients discharged home are at risk of neither receiving physical therapy nor receiving it in a timely manner. Outpatient, post-operative physical therapy typically commences 3 months after a lumbar operation.\textsuperscript{61} Although patients with LBP constitute about 25 percent of outpatient physical therapy caseloads\textsuperscript{29,68} it is known that only about 15 percent of patients with LBP seek care.\textsuperscript{95} For this reason there is concern that patients having low back surgery may not seek a physical therapist and, therefore, will lose the potential benefits of such services as back school,\textsuperscript{58} therapeutic exercises with cognitive-behavior counseling,\textsuperscript{61,113,123} and increased patient activation.\textsuperscript{121,137} An additional concern following a lumbar spinal fusion is that of continued pain from adjacent level degeneration (ALD)\textsuperscript{21} and the acceleration of its demise following the lumbar surgery.\textsuperscript{90} For this population physical therapy could consist of education and prevention measures to slow the progression of ALD which, in turn, could reduce the LBP average reoperation rate of 20.1 percent.\textsuperscript{89}

Surgery and the type of surgery also showed a significant association with seeing an inpatient physical therapist. The longitudinal model from 1992 – 2014 revealed that surgery patients were nearly 2.5 times more likely to receive physical therapy. The second model from 2010 – 2014 further clarified this showing that more invasive surgery (fusions, in this case) were 4.2 times more likely to consume physical therapy services. Lumbar surgeries (specifically fusions) have increased dramatically since Cherkin et al.\textsuperscript{87}
reported an overall surgical rate of 33 percent for those hospitalized with LBP in 1991. The sample findings support the more recent study by Rhee et al.\textsuperscript{116} who reported a surgical rate of around 90 percent in 2015 for those hospitalized with LBP.

**Limitations**

This study only looks at one state and a very specific patient population. Extrapolating the findings from this study to other patient populations must be taken with care. This study also lacks functional measures and outcomes that would be helpful in interpreting the benefits (or lack thereof) of physical therapy. This is a common limitation when using an administrative dataset instead of clinical data. Another limitation is that there was no measure of the intensity of physical therapy. This was addressed by Freburger et al.\textsuperscript{132} when they examined the intensity of physical therapy by its percentage of the total inpatient charges. A third limitation is that this study could neither distinguish between appropriate or inappropriate physical therapy nor between other indicators of evidence-based medicine. It would be interesting to examine the usage of opioids verses other medications, the usage of advanced imaging, and the presence of outpatient physical therapy prior to imaging or other inpatient interventions. The lack of information available in the data made this impossible. Lastly, the slow and steady increase over time resulted in little variability in the most recent years with a large majority of patients receiving physical therapy. If physical therapy continues to see a large majority of patients with LBP in acute care facilities who are discharged to skilled care and home health care the study of factors associated with this population and physical therapy will be of little benefit.
Future Study

Using a variable that identifies the same patient over several encounters over time would allow for examination of readmission rates, further hospitalizations, and further surgeries for this population, as well as how physical therapy may modify these outcomes. Another area of future study would be examining the factors associated with physical therapy for those discharged home. Since this is a population in which intervention may significantly benefit the patient, understanding the variables associated with physical therapy is important as this may be an under-utilized intervention point. A third area of future study could be understanding the costs and benefits associated with inpatient physical therapy as it relates to hospital procedures, discharge location, and further downstream costs.

Conclusion

There are several factors associated with receiving physical therapy as an inpatient procedure for patients suffering from LBP. All of these factors are inherent in the patient’s hospital stay and are weakly related patient factors. One factor strongly associated with receiving physical therapy is being discharged to home health or another skilled care location. Secondly, as length of stay increased the likelihood of receiving physical therapy dramatically multiplies. Thirdly, surgery is significantly associated with physical therapy with those having a more invasive procedure more likely to require physical therapy. Lastly, age had a weak association with receiving physical therapy in one analysis and was not significantly associated in the study from 2010 - 2014. This
study did not show significance in receiving physical therapy based on hospital characteristics.

The significant factors associated with physical therapy utilization for those hospitalized with LBP supports the hypothesis that the more involved (or disabled) patients receive physical therapy. This would encapsulate those with more invasive procedures, those who require a longer length of stay, the aged, and those discharged to a location for further supervised care.
Chapter 4:

Factors Associated with Lengths of Stay Longer than Seven Days for Patients with Low Back Pain Requiring Surgery in the State of Florida from 2010 - 2014

Abstract

Purpose: The purpose was to identify factors associated with a length of stay longer than 7 days for patients with low back pain requiring surgery in Florida hospitals from 2010 – 2014.

Rationale: Patients that require extended hospitalizations incur large costs to themselves and to society. Reducing these occurrences by understanding the factors that contribute to long lengths of stay is valuable.

Methods: The retrospective study used inpatient admission data for patients with low back pain who required surgery and were hospitalized in Florida from 2010 - 2014. A mixed method regression examined the dependent variable of a length of stay longer than 7 days. The regression used patient, hospital, and admitting physician characteristics as well as, the inpatient procedure, to examine length of stay. Patient admissions were restricted to the following: a primary diagnosis of low back pain that resulted in surgery, a length of stay ≥ 1 day, an age between 18 and 84, an elective admission, and a discharge to either home, further skilled care, or home health care. Encounters were further limited to acute care hospitals that had no ownership profit status change within the year.
Results: Length of stay longer than 7 days was associated with patient factors (age, African American race, comorbidities, Medicaid insurance) and inpatient events (surgery type and post-operative complication). Length of stay was minimally but significantly associated with physician factors, and length of stay was not associated with hospital factors.

Conclusion: Length of stay greater than 7 days comprises a small percentage of all patients with low back pain undergoing surgery in Florida. However, this population represents a potential area of significant cost savings to healthcare organizations. Hospitalizations longer than 7 days were best explained by post-operative complications, comorbidity counts, and the invasiveness of the surgical procedure.

Introduction

According to the National and State Summaries of Inpatient Charge Data, Fiscal Year 2014, the Centers for Medicare and Medicaid Services paid an average of $24,394.09 for each unit of Diagnosis-Related Group (DRG) code 460 – a spinal fusion except cervical without major complications or comorbidities. Medicare paid this DRG code 76,752 times in 2014. The end result was Medicare payments for spinal fusions of over $1.87 billion in 2014, accounting for 1.3 percent of the total Medicare part A spending of 137.31 billion dollars in 2014.

In an effort to improve costs in this bundled payment system, healthcare organizations are focusing on drivers of cost such as length of stay. Early in their development, fusion surgeries were understood to increase length of stay by 20 percent and charges by 50 percent compared to other lumbar surgical procedures. One reimbursement practice proposed to reduce costs incorporates pay-for-performance
measures to link patient outcomes to provider reimbursement. As reported by Reis et al.\textsuperscript{142} this measure aims to reduce hospital-acquired conditions and thereby reduce cost. Since costs are driven by length of stay (and length of stay by hospital-acquired conditions) significant cost savings could be realized by healthcare organizations with reduction in these hospital-acquired conditions.\textsuperscript{143} As reported by Gruskay et al. in 2015,\textsuperscript{144} a 1 day increase in length of stay for patients undergoing a spinal fusion resulted in an increased cost of nearly $1,000.

Ninety-seven percent of patients hospitalized for low back pain (LBP) are discharged within 7 days.\textsuperscript{116} The remaining 3 percent have hospitalizations lasting longer than 7 days and represent a population for which significant cost savings can be achieved. Likewise, more lumbar fusions are performed in the southern United States than in any other region in the United States.\textsuperscript{145,146} Since the United States performs these surgeries at a rate 5 times that of England\textsuperscript{46} and other industrial countries, despite similar prevalence,\textsuperscript{85} it is possible that the southern United States performs more lumbar fusions than anywhere else in the world.

This study examines the state of Florida over a 5 year timeframe to establish significant factors associated with a length of stay greater than 7 days for those admitted to a hospital with LBP that required surgery. The hypothesis is that those with comorbidities, more invasive surgeries, and post-operative complications were significantly associated with the adverse outcome of a stay greater than 7 days. A second objective of this study was to investigate hospital and physician factors that might be associated with a length of stay greater than 7 days.
**Background**

Lumbar surgeries have gained national attention in recent few decades due to the introduction of spinal fusions secondary to Federal Drug Administration approval of fusion cages in the early 1990’s,9,84 and the high costs, questionable benefits associated with such procedures. When low back surgery is needed, three types of surgery are often performed – discectomies, laminectomies, and fusions. Discectomies are the least invasive and involve trimming of bulging or herniated disc material that is encroaching on adjacent nerves.76,77 Laminectomies require the removal of the bony lamina of the vertebrae. This procedure removes bony encroachment on the spinal cord and spinal nerves.77,78 Fusions, or arthrodesis, requires the use of instrumentation and/or bony matrix to fixate the joints between adjacent vertebrae frequently using metal implants.76,77,79 Fusions are the most invasive back surgeries. They can involve multiple levels and can incorporate the other surgery types mentioned above. The theories involved around the use of fusions are as follows (adapted from Deyo et al.141):

1) Vertebreal instability is the cause of the patient’s pain and the fusion will reduce symptoms,

2) Surgical alterations (such as a discectomy or laminectomy) may result in reduced stability and a fusion will prevent further back pain,

3) Fusions are indicated when other procedures were “unsuccessful with the reasoning that operative changes may have inadvertently produced instability”141 resulting in persistent pain.

Fusions indicate end-of-the-line treatment for patients with LBP. At least 12 international clinical practice guidelines have been published for the treatment of LBP.44 Briefly, a general overview of clinical practice guidelines for LBP are as follows:
• Routine x-rays are not indicated in the absence of “red flags”.48,49 (Red flags are signs, symptoms, or other findings that indicate that a more serious underlying pathology may exist manifesting as LBP.7)

• Advanced imaging such as magnetic resonance imaging (MRI) or computed tomography (CT) is also not advised.49

• Education should be performed and considered as a primary treatment for LBP.57 Education should include the favorable prognosis for LBP, the need to remain active, progress activities, and limit bed rest.47,48,50,57 The patient should also be educated on the risk factors for developing chronic LBP.50

• Medication should consist of acetaminophen, non-steroidal anti-inflammatory drugs (NSAIDS), or skeletal muscle relaxants.44,59 Opioids should be avoided and only used in select cases with severe, disabling pain.59

• Referrals are recommended to counselling (if the patient exhibits risk factors for developing chronic LBP44,50), to chiropractors or osteopathic physicians (if manipulation is indicated44,48), and to physical therapists (if the patient requires movement retraining, coordination, or muscle strengthening or endurance44,61). Referrals to specialists are not generally recommended unless the patient exhibits red flags or the patient is a surgical candidate.48

• Surgery is indicated only when a diagnosis leads to a specific location that is causing the pain or disability, or when outcomes are unacceptable after 6-12 weeks of other conservative measures.57 Fusions should not take place until conservative care has failed for at least 5 months.57

Despite these strict recommendations, surgery rates for LBP in the United States are 2 – 5 times higher than any other nation.46,49 Fusion rates have also skyrocketed and have increased at least 4-fold in the last 20 years.33 This is despite fusion outcomes that reveal that 15 - 20 percent28 require additional surgery the decade after the fusion, and nearly 5 percent require two or more additional surgeries.89

Back surgical complication rates range from 7 – 32 percent.142,145 Nasser et al.143 in their literature review of spine surgery, reported a large range of complications due to little agreement of what other authors defined as an intra-operative, post-operative, and
medical complication. They found an average lumbar fusion complication rate of 16.4 percent. Many of these complications are understood to increase the length of hospitalization.\textsuperscript{141,144,145,147} One author reports that many studies show that the complication rate associated with fusions far outweigh the benefits.\textsuperscript{146} Other complications, which are not associated with the surgery, but are associated with hospitalization included cognitive decline,\textsuperscript{148} loss of function,\textsuperscript{149} and nosocomial infections. These often affect the older populations.

The purpose of the present analysis was to find associations contributing to lengths of stay longer than 7 days in the surgical LBP population in Florida from the years of 2010 – 2014. Patient, physician, and hospital characteristics as well as, hospital procedures were used to calculate the adverse outcome. The findings may be important as they could improve the patient selection and treatment process thereby, reducing costs to all stakeholders involved in the care of LBP. The hypothesis was that age, surgery type, post-operative complications, and comorbidity count would have significant, direct relationships with having a length of stay longer than 7 days.

**Methods**

A mixed method regression was performed to examine the factors associated with a length of stay greater than 7 days. The Florida Agency for Health Care Administration (AHCA) inpatient data set was used. The Florida AHCA data is part of the nationwide Healthcare Cost and Utilization Project (HCUP), which is the largest collection of longitudinal hospital care data in the United States.\textsuperscript{106} The data includes all inpatient encounters for Florida hospitals and all patient identifying information is removed. The Florida data set contains between 1.77 - 2.74 million encounters per year (referencing the
years of 1991 – 2014). Statistical Analysis System Software 9.4 from the SAS Institute, Cary, NC, was used to perform all data preparation and procedures, as described within this work. To reduce the encounters to only those with chronic low back pain, the *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) codes were used to retrieve the appropriate encounters. These codes were extrapolated using the *ICD-9-CM Diagnosis Code Book*\(^\text{127}\) and based on other studies analyzing procedures consistent with physical therapy and low back pain. (See Appendix 1 for a comparison of ICD-9-CM codes used by this study and other referenced studies.) Only records with the following ICD-9-CM codes as the primary diagnosis were included in this study:

- 721._ _ (30, 42, 50, 60, 70, 80, 90, 91)
- 722._ _ (10, 20, 32, 52, 73, 83, 93)
- 724._ _ (00, 02, 09, 20, 30, 40, 50, 60, 90)
- 729.2
- 737._ _ (20, 21, 22, 29, 30, 39, 80, 90)
- 738._ _ (40, 50)
- 739._ _ (30, 40)
- 756._ _ (10, 11, 12)
- 846._ _ (00, 10, 20, 30, 80, 90)
- 847._ _ (20, 30, 90)
- 922.31

The data were further reduced to only those patients who had a length of stay of at least 1 day. The years examined were 2010 – 2014. These years were chosen as they were the most recent hospital and financial data available for these years. Since the main interest of this study was the care of patients with standard LBP undergoing a lumbar surgery, the admission type was limited to “elective” only. This removed admissions due to trauma or urgent neurological conditions. As a means to further control for possible alternative treatment approaches, any patient who was discharged to a location other
than home, home health, or another skilled treatment center (such as a skilled nursing facility, a long term care hospital, etc.) were removed. This eliminated any patients that were discharged to cancer centers, hospice, law enforcement, psychological centers, or expired during their hospitalization. Furthermore, patients under the age of 18 were excluded due to the possibility of their encounter being related to congenital low back anomalies and not standard LBP. Likewise, those over 84 were also removed from the data since frailty syndrome is present in 25 percent of those 85 years and older. This restriction on age was done as a crude measure to control for frailty syndrome and the possible resultant alternative discharge strategies associated with the frail elderly.

Further exclusions were performed to ensure standard hospitalizations (no long-term care hospitals) and to limit possible procedural changes secondary to a change in hospital ownership. Figure 4.1 provides the selection process and effects on the population from which the sample was drawn.

The following depicts the mixed method regression model used:

\[
\text{Ln Length of stay > 7 days (Y) = } \beta_0 + \beta_1 \text{*gender} + \beta_2 \text{*age} + \beta_3 \text{*African American race} + \beta_4 \text{*other race} + \beta_5 \text{*Hispanic ethnicity} + \beta_6 \text{*comorbidity count} + \beta_7 \text{*discectomy} + \beta_8 \text{*laminectomy} + \beta_9 \text{*fusion 4 – 8 levels} + \beta_{10} \text{*fusion > 8 levels} + \beta_{11} \text{*Medicare insurance} + \beta_{12} \text{*Medicaid insurance} + \beta_{13} \text{*Worker’s Compensation insurance} + \beta_{14} \text{*other insurance} + \beta_{15} \text{*no insurance} + \beta_{16} \text{*government-owned hospital} + \beta_{17} \text{*investor-owned} + \beta_{18} \text{*medium-sized hospital} + \beta_{19} \text{*large-sized hospital} + \beta_{20} \text{*number of LBP cases in hospital} + \beta_{21} \text{*number of LBP admitting physicians} + \beta_{22} \text{*number of physician’s LBP cases} + \beta_{23} \text{*number of hospitals that the physician has privileges} + \beta_{24} \text{*wound complication} + \beta_{25} \text{*medical complication} + \beta_{26} \text{*nervous system complications} + \beta_{27} \text{*bone matrix protein} + \beta_{28-31} \text{*year} + \varepsilon.
\]

A generalized linear mixed model (GLMM) was used. The GLMM allows for non-Gaussian distributions and the logit link function required for the above outlined model. Additionally, this procedure is “mixed” allowing the use of a RANDOM component.
The random component makes allowances for correlated data. The random component in this model was the hospital facility. Using the hospital as the random component allows
for correlations of encounters that occurred in the same facility. This helped to control for institutional differences between each location. The base for this model (for comparison) was a white, non-Hispanic male, who had commercial insurance, had a 1 – 3 level fusion, and was treated in a small, not-for-profit hospital. The year of 2014 was indicated as the base year for yearly comparisons.

**Variable Selection**

**Dependent Variable**

The dependent variable was a categorical variable indicating a length of stay greater than 7 days. Hospitalization for patients with LBP is usually between 1 - 7 days (96.6 percent of the time) with most patients (51.6 percent) having an inpatient stay of 3 - 7 days. Similar to the study by Rhee et al., the length of hospitalization was categorized at 2 levels: 1 - 7 days and > 7 days.

**Patient Variables**

The following patient specific variables were initially used to examine the research question: gender, age, race, ethnicity, comorbidity count, the presence of a surgical procedure, the insurance type and status, the year of hospitalization, and the dependent variable which was the presence or absence of being hospitalized for more than 7 days. The following section discusses the purpose and rationale regarding each tested variable.

Gender is a risk factor of LBP with females consistently suffering from the condition more often. The increased prevalence of LBP in females is consistent across all age groups, races, and ethnicity. Females have more low back related surgeries, more intense and invasive low back surgeries, poorer low back surgical outcomes, longer hospitalizations, as well as more opioid use for LBP. As gender is a risk factor
for many facets of LBP it was included in this study to examine its effect on lengths of stay longer than 7 days.

Aging is a risk factor for any degenerative musculoskeletal condition including LBP. Specific to LBP, increased age has been linked to LBP chronicity and increased opioid use. Likewise, those receiving low back related surgery at a younger age have a higher rate of reoperation later in life. Since aging is a risk factor for LBP and is associated with declining function, age was included to examine its effect on longer hospitalizations. However, as mentioned previously, only those aged 18 – 84 were included in this analysis.

Race has some influence in the development of LBP with the highest incidence occurring in African Americans and white Caucasians. Most convenience samples in the United States are predominantly white and compose about 85 percent of the studied LBP population. However, when low back surgery is performed on those in the Medicare population, whites have shorter hospitalizations and less surgical complications when compared to non-whites. Since race has an effect in the development of LBP, as well as an effect in the post-surgical outcomes of LBP, a patient’s race was included in the study.

While gender, age, and race all play a role in the incidence of LBP, ethnicity has been less reported in recent LBP literature. Descriptive statistics of most LBP studies reveal that LBP affects more non-Hispanics than Hispanics. The reasons for ethnic differences seen in the LBP population has not yet been theorized. However, ethnicity was included in this examination to assess whether it has an association with hospital length of stay greater than 7 days.
The presence of any comorbidity in the LBP population has been shown to increase back pain related disability, overall health care cost,\textsuperscript{11} and length of hospitalization.\textsuperscript{115} Any comorbidity is present in about 9 percent of patients having low back related surgery.\textsuperscript{89} Despite the concerns of comorbidities on cost, hospitalization, and disability, comorbidities are not significant predictors of further low back surgical procedures.\textsuperscript{89} Since comorbidities increase disability and often increase the length of a hospital stay for patients with LBP, it was included in the model. Comorbidity count was tabulated as recommended by the Agency for Research and Quality (AHRQ) and the associated Elixhauser comorbidity software, version 3.7.\textsuperscript{150} This established the presence of up to 30 comorbidities for each patient. The total count of the comorbidities per encounter was used in the model.

Greater than 90 percent of hospital admissions for LBP result in surgical procedures\textsuperscript{116} with roughly 23 percent involving arthrodesis or spinal fusion.\textsuperscript{89} Re-operation rates in the 10 to 11 years following low back related surgery range between 18 - 23 percent.\textsuperscript{89,113} Higher re-operation rates exist for those having surgery earlier in life with the subsequent surgery demonstrating increased complexity, more resultant complications,\textsuperscript{115} and poorer outcomes.\textsuperscript{114} Recently, the number of complex, multi-level lumbar surgeries have risen dramatically.\textsuperscript{89} Since lumbar surgery can greatly alter function it was used as a predictive variable for length of stay. Surgery was noted to occur if the patient encounter had an *International Classification of Disease, 9th Revision, Clinical Modification* (ICD-9-CM) procedure code\textsuperscript{107} indicating a discectomy (80.51), a spinal decompression (03.09) or a lumbosacral fusion (81.06-81.08 and 81.62-81.64). Only these 3 surgeries were considered. Some studies have shown that lengths of stay
have a direct association with the type of low back surgery with more invasive procedures resulting in longer hospitalizations. Other studies have shown that the number of fused vertebral levels has no effect on lengths of stay. The hypothesis for these variables was that length of stay would increase relative to the invasiveness of the surgery. For comparison, the base level surgery was a 1 – 3 level fusion. Discectomies, laminectomies, fusions of 4 – 8 levels (ICD-9-CM code 81.63) and fusions of more than 8 levels (ICD-9-CM code 81.64) were independent variables. When encounters contained 2 surgical categorical variables the most invasive surgical technique was used as the true surgery category.

Since treatment (especially treatment for LBP) is often influenced by the payer’s medical policy in the United States,31 insurance status and type of insurance was included in the study. Insurance was collapsed to place each admission into 1 of the following 6 mutually exclusive categories: Medicare, Medicaid, Commercial insurance, Worker’s Compensation, Other insurance, and no insurance.

Lastly, since this study was a retrospective, longitudinal study, the effect of time was controlled by using the year of each encounter as an independent variable. Spinal care has substantially changed over the time period examined.37,117 However, Mafi et al.38 showed that physical therapy utilization for LBP was relatively unchanged from 1999 to 2010. Regardless, year was used as a variable to predict length of stay for LBP. Table 1 summarizes the variables included in the model.

**Hospital Variables**

The hospital variables included profit status and hospital size. Since the literature suggests that a hospital’s profit status results in differences in regards to both services
provided and outcomes,\textsuperscript{130,131} profit status was included in the model. Variables indicating profit status were built at 3 levels: not-for-profit, government owned, and investor owned for-profit.

Hospital size (categorized by the number of licensed beds) has shown some differences in health services utilization. Freburger et al.\textsuperscript{132} showed that patients having total joint replacements were more likely to have physical therapy in a large hospital. In the same study, they found no difference in physical therapy utilization based on hospital size for patients having a stroke. Similar to Freburger’s study, categories for hospital size based on the number of licensed beds were created using tertiles for small, medium, and large hospitals.

Since volume has been related to improved outcomes across many fields of healthcare,\textsuperscript{151,152} new variables were created at the hospital and physician level to attempt to capture volume or specialization for this low back sample. The number of low back pain cases were tabulated and used as an independent variable for each surgeon and each hospital. Likewise, the number of physicians treating LBP per each hospital and the number of hospitals each physician utilized over the 5 years. In this manner, four volume/specialization variables were constructed. Hypotheses were than increased LBP cases (per physician and per hospital) and increased LBP physicians per hospital would show improved outcomes (shorter lengths of stay). No hypothesis was made regarding the number of hospital privileges for each physician.

Post-operative complications have been shown to be significantly associated with and increased length of stay in the low back population.\textsuperscript{142,144,145,147} However, intraoperative complications have not been associated with an increase in length of
stay\textsuperscript{144} and were, therefore, not included in the model. Intraoperative complications are corrected during the procedure and while they will increase the operation time, they are directly associated with the invasiveness of the surgery.\textsuperscript{141,144} Post-operative complications were grouped by the following ICD-9-CM diagnostic codes, as described by Cahill et al.\textsuperscript{145}

- Wound related complications: 998.(10 - 13, 30 - 32, 50 – 51, 59, 83); 998.83
- Medical complications: 410.0 – 410.9; 415.1; 997.1 – 997.3
- Central nervous system complications: 997.0 – 997.01; 997.09
- Other unspecified complications: 998.8; 998.89; 998.9; 999.9

Bone morphogenetic protein (BMP) is a protein that can be added to the bone matrix to facilitate bone growth for adequate stabilization during a fusion procedure. The addition of the protein has shown to be significantly associated with post-operative complications and a subsequent increase in length of stay.\textsuperscript{145} A variable for its use was developed using the procedure code 84.52 as described by Cahill et al.\textsuperscript{145}

**Table 4.1 – Model Variables.***

<table>
<thead>
<tr>
<th>Fixed Effect Variables</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of stay &gt; 7 days</td>
<td>Yes – length of stay &gt; 7 days (los = 1)</td>
</tr>
<tr>
<td>(dependent variable)</td>
<td>No – length of stay &lt; 7 days (los = 0)</td>
</tr>
<tr>
<td>Female gender</td>
<td>Male\textsuperscript{*} (gender = 0)</td>
</tr>
<tr>
<td></td>
<td>Female (gender = 1)</td>
</tr>
<tr>
<td>Age</td>
<td>Age in years</td>
</tr>
<tr>
<td>Race</td>
<td>Caucasian/white\textsuperscript{*}</td>
</tr>
<tr>
<td></td>
<td>African American/black (black race = 1)</td>
</tr>
<tr>
<td></td>
<td>Other race (other race = 1)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Non-Hispanic\textsuperscript{*} (ethnicity = 0)</td>
</tr>
<tr>
<td></td>
<td>Hispanic (ethnicity = 1)</td>
</tr>
<tr>
<td>Comorbidity count</td>
<td>Number of comorbidities</td>
</tr>
<tr>
<td>Low back surgery</td>
<td>Discectomy (disc = 1)</td>
</tr>
<tr>
<td></td>
<td>Laminectomy (lamin = 1)</td>
</tr>
<tr>
<td></td>
<td>Fusion 1 – 3 levels\textsuperscript{*}</td>
</tr>
<tr>
<td></td>
<td>Fusion 4 – 8 levels (fusion48 = 1)</td>
</tr>
<tr>
<td></td>
<td>Fusion &gt; 8 levels (fusion9 = 1)</td>
</tr>
</tbody>
</table>
### Fixed Effect Variables

<table>
<thead>
<tr>
<th>Insurance status</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial insurance*</td>
<td>Medicare (Medicare = 1)</td>
</tr>
<tr>
<td></td>
<td>Medicaid (Medicaid = 1)</td>
</tr>
<tr>
<td></td>
<td>Worker’s compensation (Worker’s = 1)</td>
</tr>
<tr>
<td></td>
<td>Other insurance – auto, etc. (other ins = 1)</td>
</tr>
<tr>
<td></td>
<td>No insurance (no ins = 1)</td>
</tr>
<tr>
<td>Hospital profit status</td>
<td>Not-for-profit*</td>
</tr>
<tr>
<td></td>
<td>Government owned (Govern = 1)</td>
</tr>
<tr>
<td></td>
<td>Investor owned (Invest = 1)</td>
</tr>
<tr>
<td>Hospital size based on licensed beds</td>
<td>Small*</td>
</tr>
<tr>
<td></td>
<td>Medium (Med_hosp = 1)</td>
</tr>
<tr>
<td></td>
<td>Large (Large_hosp = 1)</td>
</tr>
<tr>
<td>LBP cases</td>
<td>Number of LBP cases serviced by hospital</td>
</tr>
<tr>
<td>Admitting physicians for LBP</td>
<td>Number of physicians admitting cases per hospital</td>
</tr>
<tr>
<td>Complications</td>
<td>None*</td>
</tr>
<tr>
<td></td>
<td>Wound (wound = 1)</td>
</tr>
<tr>
<td></td>
<td>Medical (medical = 1)</td>
</tr>
<tr>
<td></td>
<td>Nervous system (CNS = 1)</td>
</tr>
<tr>
<td></td>
<td>Other complication (other comp = 1)</td>
</tr>
<tr>
<td>Bone matrix protein</td>
<td>No* (protein = 0)</td>
</tr>
<tr>
<td></td>
<td>Yes (protein = 1)</td>
</tr>
</tbody>
</table>
| Year | Categorical for 2010-2014  
2014 was used as the reference year for comparisons |

**Random Effects Variable**

<table>
<thead>
<tr>
<th>Facility</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All patients grouped by facility</td>
</tr>
</tbody>
</table>

*Base variables are italicized and marked with a “*”.  

## Results

### Descriptive Statistics

In the sample, average length of stay was 3.09 days with 3.74 percent of the sample having a length of stay > 7 days. The sample population was primarily white, non-Hispanic, and most frequently hospitalized for a 1 – 3 level fusion. The sample was slightly more female, had an average age of 60.7, an average comorbidity score of 1.63 with 52 percent utilizing Medicare insurance. Table 4.2 provides the descriptive statistics for the sample.
Table 4.2 – Patient Sample Descriptive Statistics.

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length of stay</strong></td>
<td></td>
</tr>
<tr>
<td>&gt; 7 days</td>
<td>3.74%</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>51.40%</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>88.22%</td>
</tr>
<tr>
<td>African American</td>
<td>6.05%</td>
</tr>
<tr>
<td>Other race</td>
<td>5.73%</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>92.15%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>7.85%</td>
</tr>
<tr>
<td><strong>Surgery Type</strong></td>
<td></td>
</tr>
<tr>
<td>Discectomy</td>
<td>14.50%</td>
</tr>
<tr>
<td>Laminectomy</td>
<td>16.08%</td>
</tr>
<tr>
<td>Fusion 1-3 levels</td>
<td>59.50%</td>
</tr>
<tr>
<td>Fusion 4-8 levels</td>
<td>9.27%</td>
</tr>
<tr>
<td>Fusion &gt; 8 levels</td>
<td>0.66%</td>
</tr>
<tr>
<td><strong>Insurance</strong></td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>52.00%</td>
</tr>
<tr>
<td>Commercial</td>
<td>34.32%</td>
</tr>
<tr>
<td>Medicaid</td>
<td>3.05%</td>
</tr>
<tr>
<td>Worker's Comp</td>
<td>4.13%</td>
</tr>
<tr>
<td>Other insurance</td>
<td>5.24%</td>
</tr>
<tr>
<td>No insurance</td>
<td>1.26%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length of stay</strong></td>
<td>3.09</td>
<td>2.47</td>
<td>3</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>60.7</td>
<td>14.04</td>
<td>63</td>
</tr>
<tr>
<td><strong>Comorbidity count</strong></td>
<td>1.63</td>
<td>1.45</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4.3 provides the hospital, physician, and complication descriptive statistics for the sample. The sample revealed very low complication rates. Most of the surgeries were performed in not-for-profit facilities and were nearly equally split amongst hospital size. The number of surgeries declined yearly since 2010. Bone-morphogenetic protein aided approximately 20 percent of the surgeries. Hospitals, on average, had 1222 LBP surgical patients and employed 24 LBP surgeons. Physicians treated, on average, 353 LBP surgical patients and had privileges at approximately two hospitals over the study period.
### Table 4.3 – Sample Descriptive Statistics for Hospitals, Physicians, and Complications.

<table>
<thead>
<tr>
<th>Hospital Profit Status</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not-for-profit</td>
<td>52.72%</td>
</tr>
<tr>
<td>Government owned</td>
<td>10.90%</td>
</tr>
<tr>
<td>Investor owned</td>
<td>36.38%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>33.26%</td>
</tr>
<tr>
<td>Medium</td>
<td>35.01%</td>
</tr>
<tr>
<td>Large</td>
<td>31.73%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>22.85%</td>
</tr>
<tr>
<td>2011</td>
<td>21.08%</td>
</tr>
<tr>
<td>2012</td>
<td>19.40%</td>
</tr>
<tr>
<td>2013</td>
<td>18.32%</td>
</tr>
<tr>
<td>2014</td>
<td>17.54%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Complications</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wounds</td>
<td>0.93%</td>
</tr>
<tr>
<td>Medical</td>
<td>1.13%</td>
</tr>
<tr>
<td>Nervous system</td>
<td>0.63%</td>
</tr>
<tr>
<td>Other</td>
<td>0.13%</td>
</tr>
<tr>
<td>Bone graft</td>
<td>Protein aided</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBP surgeries per hospital</td>
<td>1222.28</td>
<td>694.8</td>
<td>1092</td>
</tr>
<tr>
<td>Admitting physicians for LBP per hospital</td>
<td>23.95</td>
<td>15.37</td>
<td>19</td>
</tr>
<tr>
<td>Number of LBP surgeries per physician</td>
<td>353.23</td>
<td>248.03</td>
<td>316</td>
</tr>
<tr>
<td>Number of hospital privileges per physician</td>
<td>1.86</td>
<td>0.97</td>
<td>2</td>
</tr>
</tbody>
</table>

**Model Results**

The solution for the initial full generalized linear mixed model is provided in Table 4.4. Significant estimates can be tabulated and interpreted in the following manner: For
example, the comorbidity count estimate is .448. The result of a 1 unit increase in comorbidity count resulted in an increase in the log odds of having a length of stay greater than 7 days of 56 percent ($e^{.448} - 1 = .56$) holding all other variables constant including the random effects of the hospital. In this manner the log odds can be calculated for each variable. However, since this initial model contains over 30 variables and many of them are not significant, the model was reduced to only those variables with a $p$-value of less than .01.

**Table 4.4 – Solution for the Full Model.**

| Effect                  | Estimate | Standard Error | t Value | Pr > |t| |
|-------------------------|----------|----------------|---------|-------|
| Intercept               | -5.681   | 0.218          | -26.09  | <.0001|
| Female                  | 0.006    | 0.042          | 0.14    | 0.891 |
| Age                     | 0.015    | 0.002          | 6.56    | <.0001|
| African American        | 0.418    | 0.075          | 5.56    | <.0001|
| Other race              | 0.099    | 0.093          | 1.07    | 0.284 |
| Hispanic                | 0.037    | 0.086          | 0.44    | 0.662 |
| Comorbidity count       | 0.448    | 0.012          | 36.44   | <.0001|
| Discectomy              | -0.912   | 0.098          | -9.27   | <.0001|
| Laminectomy             | -0.502   | 0.072          | -6.99   | <.0001|
| Fusion 4-8 levels       | 1.014    | 0.051          | 19.91   | <.0001|
| Fusion > 8 levels       | 2.48     | 0.1200         | 20.70   | <.0001|
| Medicare                | -0.031   | 0.058          | -0.54   | 0.590 |
| Medicaid                | 0.481    | 0.111          | 4.33    | <.0001|
| Worker's Comp           | 0.114    | 0.125          | 0.91    | 0.364 |
| Other insurance         | 0.227    | 0.099          | 2.28    | 0.023 |
| No insurance            | 0.240    | 0.208          | 1.15    | 0.249 |
| Government hosp.        | -0.068   | 0.220          | -0.31   | 0.759 |
| Effect                          | Estimate | Standard Error | t Value | Pr > |t| |
|--------------------------------|----------|----------------|---------|------|---|
| Investor hosp.                 | 0.391    | 0.145          | 2.70    | 0.007|
| Medium size hosp.              | 0.248    | 0.136          | 1.82    | 0.068|
| Large size hosp.               | 0.496    | 0.172          | 2.88    | 0.004|
| Number of hosp. cases          | -0.000   | 0.000          | -0.22   | 0.824|
| Number of hosp. surgeons       | 0.001    | 0.005          | 0.24    | 0.810|
| Number of physician cases      | -0.001   | 0.000          | -9.57   | <.0001|
| Number of physician privileges | -0.071   | 0.027          | -2.63   | 0.009|
| Wound complication             | 2.763    | 0.093          | 29.74   | <.0001|
| Medical complication           | 1.808    | 0.089          | 20.21   | <.0001|
| Nervous system complication    | 2.295    | 0.120          | 19.17   | <.0001|
| Other complication             | 1.331    | 0.290          | 4.60    | <.0001|
| Protein aided surgery          | 0.164    | 0.056          | 2.95    | 0.003|
| Year 2010                      | 0.048    | 0.067          | 0.72    | 0.473|
| Year 2011                      | 0.117    | 0.066          | 1.78    | 0.075|
| Year 2012                      | 0.091    | 0.067          | 1.35    | 0.178|
| Year 2013                      | 0.034    | 0.068          | 0.51    | 0.613|

Table 4.5 provides the reduced model Type III output with odds ratios with confidence intervals. Variables were only included if they met the criteria of an alpha level of less than .01 for this reduced model. Using comorbidity count as an example, the odds ratio can be interpreted as follows: Comorbidity count had an odds ratio of 1.56. Holding all other variables constant (including the random effects of hospital) a 1 unit increase in the comorbidity count resulted in a 1.56 times increase in the chance of having a length of stay greater than 7 days. Output from both models revealed an appropriate fit. The model fit from the full to the reduced mode was relatively unchanged at the Akaike's Information Criteria (AIC) and the Pearson Chi-Square/degrees of freedom fit statistics. Model fit statistics for the reduced model are in Appendix B under “Length of Stay Model”.

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Table 4.5 – Output from Reduced Model with Odds Ratios and Confidence Intervals.

<table>
<thead>
<tr>
<th>Effect</th>
<th>F Value</th>
<th>Pr &gt; F</th>
<th>OR</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>35.18</td>
<td>&lt;.0001</td>
<td>1.01</td>
<td>1.01 - 1.02</td>
</tr>
<tr>
<td>African American</td>
<td>19.94</td>
<td>&lt;.0001</td>
<td>1.50</td>
<td>1.26 - 1.79</td>
</tr>
<tr>
<td>Comorbidity count</td>
<td>1218.08</td>
<td>&lt;.0001</td>
<td>1.56</td>
<td>1.52 – 1.60</td>
</tr>
<tr>
<td>Discectomy</td>
<td>44.48</td>
<td>&lt;.0001</td>
<td>.36</td>
<td>.27 - .49</td>
</tr>
<tr>
<td>Laminectomy</td>
<td>37.03</td>
<td>&lt;.0001</td>
<td>.56</td>
<td>.47 - .68</td>
</tr>
<tr>
<td>Fusion 4-8 levels</td>
<td>160.52</td>
<td>&lt;.0001</td>
<td>2.73</td>
<td>2.34 – 3.18</td>
</tr>
<tr>
<td>Fusion &gt; 8 levels</td>
<td>268.04</td>
<td>&lt;.0001</td>
<td>10.10</td>
<td>7.66 – 13.32</td>
</tr>
<tr>
<td>Medicaid</td>
<td>17.74</td>
<td>&lt;.0001</td>
<td>1.63</td>
<td>1.30 – 2.05</td>
</tr>
<tr>
<td>Number of physician cases</td>
<td>16.76</td>
<td>&lt;.0001</td>
<td>.999</td>
<td>.998 - .999</td>
</tr>
<tr>
<td>Wound complication</td>
<td>473.75</td>
<td>&lt;.0001</td>
<td>15.39</td>
<td>12.03 – 19.68</td>
</tr>
<tr>
<td>Medical complication</td>
<td>198.99</td>
<td>&lt;.0001</td>
<td>5.82</td>
<td>4.56 – 7.43</td>
</tr>
<tr>
<td>Nervous system complication</td>
<td>206.27</td>
<td>&lt;.0001</td>
<td>9.38</td>
<td>6.91 – 12.73</td>
</tr>
<tr>
<td>Other complication</td>
<td>18.36</td>
<td>&lt;.0001</td>
<td>3.79</td>
<td>2.06 – 6.96</td>
</tr>
<tr>
<td>Protein aided</td>
<td>8.94</td>
<td>0.0028</td>
<td>1.21</td>
<td>1.07 – 1.37</td>
</tr>
</tbody>
</table>

The patient demographic variables that were significant and directly associated with a length of stay greater than 7 days were age, the African American race, comorbidity count, and Medicaid insurance. Age and the African American race have previously shown an association with an increased length of stay after invasive lumbar procedures.\textsuperscript{36,89,115-117} However, this association has not been shown for patients with Medicaid insurance. The significance of a race variable and an insurance variable may
indicate deeper, undefined variables related to socio-economic status such as education level and income.

The surgery variables found that the more invasive procedures were associated with an increase in the odds of staying longer than 7 days. Likewise, surgeries less invasive than the base variable of a 1 – 3 level fusion showed an inverse, protective effect on having a length of stay greater than 7 days. This study (as opposed to the study by Gruskay et al.\textsuperscript{144}) found an increase in the length of stay by the invasiveness of the procedure. Gruskay et al. addressed this as a limitation to their study since their sample was skewed to single level fusions only. The Florida sample provides results consistent with the theoretically expected results.

The number of cases per surgeon was associated with a slight protective effect. This finding suggests that the more cases a surgeon has reduces the chance of their patients having the adverse outcome. This variable suggests reduction in length of stay is a product of physician specialization. However, the odds ratio is close to 1.0 (.999) so this effect is minimal.

All post-operative complications were strongly and directly associated with an increased length of stay. However, due to the low incidence of complications in the surgical group and the concurrent high comorbidity counts for the same group, there is concern of contamination between these variables. This is discussed in a following section.

Lastly, the use of a bone-morphogenetic protein was also associated with a length of stay greater than 7 days. This finding is in line with research by Cahill et al.\textsuperscript{145} in which the protein was associated with increased length of stay during the first 5 years of its use.
(2002 – 2007). It appears that the protein may still be associated with an increased length of stay. This result may represent an increase in time spent in the operating room as the protein must be placed alongside the bony matrix.

**Discussion**

The Florida sample was similar to another study that showed about 3 percent of the LBP surgical population has a length of stay greater than 7 days. However, the Florida data had a surprisingly low rate of post-operative complications. The rate was well below 7 percent as reported by Cahill et al. and Tang et al. The reduced complication rates may be due to the age restrictions placed on this dataset as compared to the other aforementioned studies. Despite the low rate of the post-operative complications, the complications were strong predictors of an increased length of stay with wound complications having the highest odds ratio for a longer length of stay. This result aligns with the study by Gruskay et al. who found that post-operative complications were strong predictors of an increased length of stay and that intraoperative complications were not associated with an increased length of stay.

Overall, the sample also revealed that the year was not a significant predictor for length of stay (see Table 4.4). Back surgeries declined over the period examined (see Table 4.2). Again, this could be due to the age restrictions placed on this sample. Interpretation of this finding should be made cautiously as it is known that the average age for LBP surgery has risen and surgeries for those over 84 years old were removed from this study. The lack of significance of the year contributing to an increased length of stay suggests that surgical techniques are stable and have not significantly changed over the 5 year period.
Discharge location has been shown to be a predictor of length of stay,\textsuperscript{140,144} and discharges to skilled facilities have been associated with lumbar fusions.\textsuperscript{141,146} However, cause and effect is unclear regarding this variable.\textsuperscript{144} For example, does the patient’s predisposition for a skilled nursing facility result in an increased length of stay or is discharge to a skilled facility the result of factors associated with an increased length of stay. Since cause and effect could be assessed, discharge location was not used in the prediction model. Regardless, significant differences exist between the long length of stay group and the normal length of stay group. Some of the differences are shown in Table 4.6. The discharge location switches from primarily home to primarily skilled care as length of stay jumps past 7 days. Costs and physical therapy utilization also show significant jumps as length of stay increases. This result is expected as length of stay is directly associated with cost\textsuperscript{140} and physical therapy utilization is required as function declines from increased length of stay.\textsuperscript{149}

Comorbidity count which was associated with an adverse outcome shows interesting results (Table 4.6). Using a threshold of 3 for the comorbidity count shows that those with 4 or more comorbidities have a normal length of stay approximately 20 percent of the time and have an extended length of stay nearly 80 percent of the time. To examine this, further a logistic regression was performed using a length of stay greater than 7 days as the dependent variable with the independent variables being all 30 of the individual comorbidities. The result is in Table 4.7. Some of the associated comorbidities in order of strength were as follows: weight loss, pulmonary circulation disorders, and electrolyte imbalance.
Table 4.6 – Some Differences between the Length of Stay Groups.

<table>
<thead>
<tr>
<th>Length of Stay</th>
<th>1 -7 days</th>
<th>&gt; 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charges</td>
<td>$99,598.43</td>
<td>$240,580.97</td>
</tr>
<tr>
<td>Physical therapy</td>
<td>89.46%</td>
<td>99.14%</td>
</tr>
<tr>
<td>Discharge location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>53.47%</td>
<td>18.31%</td>
</tr>
<tr>
<td>Home health</td>
<td>32.40%</td>
<td>30.39%</td>
</tr>
<tr>
<td>Skilled facility</td>
<td>14.12%</td>
<td>51.30%</td>
</tr>
<tr>
<td>Comorbidity Count</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>26.01%</td>
<td>7.64%</td>
</tr>
<tr>
<td>1</td>
<td>26.01%</td>
<td>14.01%</td>
</tr>
<tr>
<td>2</td>
<td>23.03%</td>
<td>19.93%</td>
</tr>
<tr>
<td>3</td>
<td>12.98%</td>
<td>19.84%</td>
</tr>
<tr>
<td>4</td>
<td>6.12%</td>
<td>15.65%</td>
</tr>
<tr>
<td>5</td>
<td>2.36%</td>
<td>11.31%</td>
</tr>
<tr>
<td>6</td>
<td>0.83%</td>
<td>6.43%</td>
</tr>
<tr>
<td>7</td>
<td>0.27%</td>
<td>2.92%</td>
</tr>
<tr>
<td>8</td>
<td>0.06%</td>
<td>1.52%</td>
</tr>
<tr>
<td>9</td>
<td>0.01%</td>
<td>0.60%</td>
</tr>
<tr>
<td>10</td>
<td>0.01%</td>
<td>0.16%</td>
</tr>
</tbody>
</table>

Table 4.7 – Results of Logistic Regression Examining Comorbidities and a Length of Stay Longer than 7 Days.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Point Estimate</th>
<th>95% Wald Confidence Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight loss</td>
<td>5.975</td>
<td>4.601 - 7.759</td>
</tr>
<tr>
<td>Pulmonary circulation disorder</td>
<td>4.907</td>
<td>3.856 - 6.246</td>
</tr>
<tr>
<td>Electrolyte disorders</td>
<td>4.865</td>
<td>4.461 - 5.305</td>
</tr>
<tr>
<td>Paralysis</td>
<td>3.945</td>
<td>3.152 - 4.938</td>
</tr>
<tr>
<td>Liver Disease</td>
<td>3.064</td>
<td>1.037 - 9.048</td>
</tr>
<tr>
<td>AIDS/HIV</td>
<td>2.823</td>
<td>1.207 - 6.601</td>
</tr>
<tr>
<td>Blood loss anemia</td>
<td>2.715</td>
<td>2.089 - 3.528</td>
</tr>
<tr>
<td>Drug abuse</td>
<td>2.500</td>
<td>1.997 - 3.129</td>
</tr>
<tr>
<td>Effect</td>
<td>Point Estimate</td>
<td>95% Wald Confidence Limits</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>2.447</td>
<td>2.045 - 2.928</td>
</tr>
<tr>
<td>Coagulation deficiency</td>
<td>2.350</td>
<td>2.009 - 2.748</td>
</tr>
<tr>
<td>Metastatic cancer</td>
<td>2.304</td>
<td>0.975 - 5.443</td>
</tr>
<tr>
<td>Deficiency anemia</td>
<td>2.155</td>
<td>1.960 - 2.369</td>
</tr>
<tr>
<td>Peptic ulcer</td>
<td>2.103</td>
<td>1.447 - 3.057</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>2.059</td>
<td>1.580 - 2.684</td>
</tr>
<tr>
<td>Psychosis</td>
<td>1.956</td>
<td>1.641 - 2.330</td>
</tr>
<tr>
<td>Neurologic disorders</td>
<td>1.869</td>
<td>1.495 - 2.337</td>
</tr>
<tr>
<td>Complicated diabetes</td>
<td>1.562</td>
<td>1.253 - 1.948</td>
</tr>
<tr>
<td>Obesity</td>
<td>1.511</td>
<td>1.373 - 1.663</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>1.455</td>
<td>1.244 - 1.702</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>1.408</td>
<td>1.204 - 1.647</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>1.407</td>
<td>1.190 - 1.664</td>
</tr>
<tr>
<td>Cancer tumor</td>
<td>1.308</td>
<td>0.846 - 2.022</td>
</tr>
<tr>
<td>Chronic lung disease</td>
<td>1.290</td>
<td>1.174 - 1.417</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>1.193</td>
<td>1.076 - 1.323</td>
</tr>
<tr>
<td>Depression</td>
<td>1.151</td>
<td>1.042 - 1.271</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>1.146</td>
<td>1.054 - 1.246</td>
</tr>
<tr>
<td>Valvular disease</td>
<td>1.134</td>
<td>0.937 - 1.373</td>
</tr>
<tr>
<td>Uncomplicated diabetes</td>
<td>1.106</td>
<td>1.006 - 1.215</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>0.474</td>
<td>0.183 - 1.230</td>
</tr>
</tbody>
</table>

Lastly, new variables were examined based on the volume of patients (for both the hospital and the physician) and the number of LBP physicians per hospital as well as, the number of hospital privileges afforded a physician. These variables had little effect on the model. In fact, all hospital variables (new and established) fell out of the final model.
while the 2 new physician variables appear to be of little clinical value (see Table 5). This suggest that lengths of stay are primarily determined by patient factors and inpatient procedures but not by physician and hospital characteristics.

**Limitations**

Despite using all post-operative complications as described by Cahill et al.\textsuperscript{145} the data showed a very low percentage of post-operative complications. While there were no ICD-9-CM codes that were duplicative in describing a post-operative condition and a comorbidity, there is concern that coding during hospitalization was not equivalent to the methods described within this work. This may have led to an increased comorbidity count and a decreased rate of reported post-operative complications for the subjects contained within this study. Therefore, using the results found in this study may not be accurate for making predictions based on comorbidity count alone as the study may have over-estimated comorbidities and under-estimated complications. For example, a patient suffering from post-operative complications of a wound and a deep vein thrombosis could have received ICD-9-CM diagnostic codes indicating the presence of peripheral vascular disease and a pulmonary/circulatory disorder. This would have increased the patient comorbidity count by two. Only the performance of a chart review (or performing a new prospective study) could limit this confounding factor. Regardless, the use of comorbidity count and the complication variables are significantly associated with a length of stay greater than 7 days. These variables should be used in conjunction.

A second limitation of this study is the inability to create a variable based on the patient’s function. This is often a limitation when using administrative data instead of clinical data. With the observed rate increase in physical therapy utilization and skilled
location discharge for those hospitalized longer than 7 days a reduction in function could be theoretically argued. The addition of a functional index at admission and at discharge could be enlightening regarding the patient’s status change while hospitalized.

Another limitation was the inability to use the American Society of Anesthesiologists’ (ASA) score. This score has been associated with an increased length of stay for this population.\textsuperscript{144,147} The ASA score was not available in the dataset and was, therefore, excluded. The variable may have improved the proposed model.

\textbf{Conclusion}

In conclusion, this study found several variables that were significantly associated with having a length of stay greater than 7 days for patients hospitalized with LBP requiring surgery in Florida between the years of 2010 – 2014. Increased comorbidity count, more invasive surgical procedures, and the presence of a post-operative complication appeared to have the strongest association with a longer length of stay. Hospital and physician characteristics had little effect on a length of stay greater than 7 days for this sample.
Chapter 5:

Conclusion

Recently new non-invasive clinical practice guidelines have been issued for chronic low back pain (LBP). These new guidelines are an update of guidelines published 10 years ago. In general, guidelines continue to recommend movement and activity, including some form of exercise. Guidelines also generally recommend against invasive treatments, including surgery, as well as, routine or advanced imaging unless a specific location of pain can be found that suggests a clinical etiology. The new guidelines also recommend against the use of opioids and narcotic prescriptions for LBP in favor of non-steroidal anti-inflammatory drugs (NSAIDS) and in select cases the use of tramadol. Despite similar recommendations being in pace for more than 10 years, the current state of LBP management reveals that clinical management is deviating from guidelines with an increase in opioid use, routine and advanced imaging, and invasive LBP treatment.

According to the *National and State Summaries of Inpatient Charge Data, Fiscal Year 2014*, the Centers for Medicare and Medicaid Services paid an average of $24,394.09 for each unit of Diagnosis-Related Group (DRG) code 460 – a spinal fusion except cervical without major complications or comorbidities. Medicare paid the DRG code 76,752 times in 2014. The end result was Medicare payments for spinal fusions of
over 1.87 billion dollars in 2014. In this manner, spinal fusions accounted for 1.3 percent of the total Medicare part A spending of $137.31 billion dollars in 2014.\textsuperscript{139}

LBP invasive treatments can be lucrative for hospitals and the surgeons that perform them. Since clinicians have not responded to LBP clinical practice guidelines,\textsuperscript{15} and because policy often drives healthcare in the United States,\textsuperscript{31} policy alterations may be required to bring about substantial changes in the LBP treatment. This study examined different facets of inpatient LBP treatment in Florida over several time periods with several different aims. The 3 purposes of these studies were as follows:

\begin{itemize}
  \item Purpose 1 – To examine the utilization of inpatient physical therapy for patients in Florida with LBP and Medicare insurance surrounding a federal discharge policy that began in 1995.
  \item Purpose 2 – To examine and describe the factors associated with inpatient physical therapy utilization for over 2 decades of encounters for patients with LBP in Florida
  \item Purpose 3 – To find and describe associations with the adverse outcome of an increased length of stay for patients having low back surgery
\end{itemize}

These purposes and their respective findings are reviewed in the following sections.

**Purpose 1**

The care of LBP has been slow to change despite the development of generally accepted clinical practice guidelines.\textsuperscript{15} This is often the case when treatments are not universally successful and when a myriad of opinions and alternative treatments exist.\textsuperscript{43} However, in the United States, public policy often influences care practices and reimbursement and often advances treatment based on “medical necessity,” which can be based generally on clinical practice guidelines.\textsuperscript{31} This study examined a federal discharge policy\textsuperscript{102} that was written to improve the hospital discharge process for patients
discharged to further skilled care or for those who might have an adverse outcome if a discharge plan was not in place. This policy was written for Medicare participants (patients and practitioners) and went into effect in 1995. Three years prior to implementation (1992 - 1994) and 3 years post implementation (1996 – 1998) were examined for a change in practice behavior regarding inpatient physical therapy utilization among patients with low back pain in Florida. The hypothesis was that physical therapy utilization increased after the public policy implementation due to the new role of physical therapists in the discharge process. Examining a population, which has been resistant to change, as well as, using a population for which physical therapists commonly treat was necessary to see if the policy resulted in changed behavior. The result was that policy did, in fact, increase physical therapy utilization for the LBP population with a possible halo-effect or carryover-effect to patients being discharged to home. The importance of this finding is that the policy was associated with changed behavior in the use of physical therapy prior to discharge. Other factors significantly associated with having inpatient physical therapy for LBP were having a surgery, longer length of stay, and the discharge location.

**Purpose 2**

This study had 2 objectives. The first objective was to describe the hospitalized LBP population in Florida over a 25 year period. The second objective was to identify the factors associated with inpatient physical therapy utilization for patients with LBP over the timeframe of the data (1992 – 2014). A subset of this objective was to examine hospital characteristics and perform a more in-depth look at physical therapy utilization for the years of 2010 – 2014. Findings from this analysis included an increase
in physical therapy utilization, skilled discharges, and lumbar fusion surgeries over time with a reduction in both home discharge and length of hospitalization. The findings from this study also found that age, length of hospitalization, discharge location, and surgery (specifically, more invasive surgeries) were the primary factors associated with inpatient physical therapy. This study identified an area along the treatment pathway for further education and intervention as the group not receiving physical therapy were those discharged home. It has been reported that this group typically does not receive outpatient exercise instructions until three months post-operatively. The importance of this finding is that it may provide an intervention point in which to educate the patient to keep them from future surgeries.

**Purpose 3**

The last study examined length of stay in the Florida LBP surgical population from 2010 – 2014. A length of stay greater than 1 week was the dependent variable. Since payment for inpatient services typically are bundled under the Diagnosis-Related Groups (DRG) codes, excessive lengths of stay represent areas of improvement for cost savings and are typically administrative intervention points. A length of stay greater than 7 days was identified as the adverse outcome since 97 percent of patients having low back surgery should be discharged within this timeframe. The factors most associated with a length of stay greater than 7 days were age, the African American race, Medicaid insurance, comorbidity counts, post-operative complications, and the invasiveness of the surgery. Those who had longer lengths of stay were commonly discharged to skilled care facilities and had on average charges that were more than double the charges of a patient with a length of stay of less than 1 week. This study identified the need for pre-operative
screening to identify patients with a high risk of the adverse outcome, and the need to reduce any post-operative complications. This study supports previously released clinical practice guidelines in that surgery should only be performed on a carefully selected group of patients.  

Summary of Findings and Implications

The results from the federal discharge policy paper supports others research indicating that policy often drives health care in the United States. The findings from this paper contribute new evidence that a broad policy can effect health care specialty utilization for specific patient populations. This study showed altered care for a patient population that historically has not been affected by published clinical practice guidelines.

The paper on physical therapy utilization was consistent with the literature in that low back fusion surgeries have been on the rise with an increase in resulting skilled discharges. This study did go against evidence in that the size of the physical therapy workforce did not predict physical therapy utilization. An explanation for this discrepancy may be as a result of using the discharge variable. This variable was missing in the referenced study but was a strongly associated in the current study. It may have overshadowed other variables including the size of the physical therapy workforce. The overall finding is that inpatient physical therapy is utilized on patients who may be more disabled – those who are older, hospitalized longer, discharged to further skilled facilities, and have more invasive procedures. This implies that physical therapy is not being utilized in other patient populations that may benefit from education on home exercises and body mechanics.
The results of the study regarding length of stay was consistent with literature showing that about 97 percent of patients with LBP are discharged from the hospital within a week. The study also agreed with literature in that post-operative complications increased length of stay. The study also showed that length of stay is related to the invasiveness of the surgery. This finding is inconsistent in the literature. Lastly, the post-operative complications were far lower in this study than previously reported. Overall, this study supports the clinical practice guideline that emphasizes the need of careful consideration for appropriate patient selection regarding invasive procedures for LBP. This study gives new evidence that using comorbidity count may be beneficial in assisting patient selection to minimize adverse outcomes.

Limitations

Overall, a limitation of this study was that it contained no indicators of function. Function is often a determinant in the need of physical therapy and is often inherent to the clinical decision making process that is not contained within an administrative database. A second overall limitation of this study was the inherent selection bias. Since the encounters analyzed were based on an “elective” hospital admission there is the potential of selection bias. If either self-selection or physician selection took place the result could be a hospitalized population with LBP that is different than the true population of those with LBP. This is a limitation of all administrative data as it compares to clinical data. Each study also had limitations of their own.

The primary limitation of the study surrounding the federal discharge policy was that of the policy variable. The variable was based on time only and may have represented many other activities that took place during the same timeframe. The
variable could easily have been confounded by other factors happening during the same timeframe.

The primary limitation regarding the study of factors affecting physical therapy utilization may have been the discharge variable. This variable can be argued as having a cause-effect issue with physical therapy. For example, was the patient in need of physical therapy because they were discharged to a skilled location or was the patient discharged to a skilled location because they needed physical therapy? By including the discharge variable other less powerful variables may have been overlooked.

The primary limitation of the length of stay study was the possible contamination of the diagnostic variables that indicated comorbidity counts and post-operative complications. Since the comorbidity counts were higher in the long stay group and post-operative complications were surprisingly low there is concern that diagnostic coding of post-operative complications may have ended up in comorbidity counts.

Future direction

Surgery for LBP generates large societal costs with controversial benefits. Any research that contribute to lowering the surgical rate for LBP would result in cost saving to Medicare and other providers, as well as a reduction in harms to patients. One method for future direction would be the use of a patient identifier variable, such as with the Agency for Health Care Administration (AHCA) dataset, which would allow following LBP patients over time. Use this approach would allow for demonstrating the effectiveness of the treatment, related complications, need for further care, including subsequent surgeries, and the overall costs of care for LBP surgical patients.
Another approach would be to utilize geographical information systems via ArcGIS by esri\textsuperscript{156} to visualize and examine patterns of utilization of health care for LBP. This tool can be very powerful in depicting and visualizing clusters of practice differences. See Figure 5.1 and 5.2 for examples of ArcGIS output. Both examples use some of data contained within this body of work. Figure 5.1 shows hospitals that had an average lengths of stay beyond 7 days for patients with LBP more than 5 percent of the time between the years 2010 - 2014. Figure 2 depicts central Florida and the percent of physical therapy utilization and home discharges by hospital and the patients' zip codes for patients with LBP in 2013.

Using GIS with counties or zip codes relative to the patient’s home address allows the attachment of other factors available from the United States’ Census Bureau that is not available in the AHCA administrative dataset. One of the most powerful factors of health care utilization could be that of socio-economic status which could be captured via variables representing the mean area education level and income. This was discussed in Chapter 4 in which both the African American race and Medicaid insurance were found to be significantly associated with an increased length of stay. This finding may indicate an undefined socio-economic status variable that could be pulled in using ArcGIS.

**Conclusion**

This analysis was undertaken to partially complete the requirements of a Doctor of Philosophy (PhD) degree in Public Health and Health Services Research. The studies completed focused on patients hospitalized with LBP in the state of Florida from 1991 – 2014. Using mixed method procedures associations were found identifying intervention points. Among the three papers, intervention points included 1) a public policy that is
Figure 5.1 – A Depiction of LBP Surgical Discharges Beyond 7 days in Florida Using ArcGIS.
associated with increased inpatient physical therapy utilization for LBP patients, 2) a direct patient care point identified for education to patients with LBP after surgery using inpatient physical therapy, and 3) a cost reduction strategy for medical facilities by using factors associated with adverse outcomes to determine the appropriateness of surgery for the LBP population.

All of these studies have their own limitations but shed further light on a medical practice that is controversial\cite{9,43,79} and has been practiced so long that despite sound evidence is seen as standard care.\cite{74} As this type of practice continues a research agenda focused on outcomes beneficial to many stakeholders and should serve as a firm foundation for further research.

Figure 5.2 – Inpatient Physical Therapy and Home Discharge for Patients Hospitalized with LBP in Florida, 2013.
Disclosure

This analysis received no funding for the work contained within. However, the author is a physical therapist, recognizing physical therapists treat LBP patients conservatively. This may be viewed by some as a bias relative to the analyses conducted.
References


98. Dickey D. *Ideas and examples in generalized linear mixed methods*. SAS Global Forum; 2010; Seattle, WA.
101. Moser EB. *Repeated measures modeling with PROC MIXED*. SAS Users Group International Conference 29; May 9-12, 2004; Montreal, Canada.
111. Schabenberger O. *Mixed model influence diagnostics*. SAS Users Group International Conference 29; May 9-12, 2004; Montreal, Canada.
118. Hamlett A, Ryan L, Wolfinger R. *On the use of PROC MIXED to estimate correlation in the presence of repeated measures*. SAS Users Group International Conference 29; May 9-12, 2004; Montreal, Canada.


## Appendices

### Appendix A – Studies Using CBT and Physical Therapy for the LBP Population.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Population</th>
<th>Program</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archer et al.</td>
<td>Randomized Controlled Trial</td>
<td>86 adults undergoing laminectomy with or without fusion for lumbar degeneration</td>
<td>Cognitive-Behavioral-Based Physical Therapy</td>
<td>Weekly 30 minute phone session with a physical therapist focusing on behavior, self-management, problem solving, cognitive restructuring, and relaxation training</td>
<td>CBT group had significantly better decrease in pain/disability and an increase in general health and physical performance when compared to control group</td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kamper et al.</td>
<td>Systematic Review and Meta-analysis</td>
<td>Compared 41 randomized controlled trials</td>
<td>Multi-disciplinary biopsychosocial rehabilitation</td>
<td>Programs had to involve a combination of physical, psychological, education and/or work related components delivered by a team of health care providers</td>
<td>Moderate quality evidence that MBR more effective for long term pain and disability reduction compared to usual care; low quality evidence MBR more effective than physical treatment in long term for reduced disability; low quality evidence MBR no different outcomes compared to surgery, however, MBR group more likely to be working 1 year later</td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Study design</td>
<td>Population</td>
<td>Program</td>
<td>Description</td>
<td>Results</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
<td>-------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mayer et al.</td>
<td>Prospective</td>
<td>563 patients with worker’s claims 4 months from</td>
<td>Continuum of care; interdisciplinary</td>
<td>Combination of directed exercise progression with the following: CBT to</td>
<td>No difference in fusion, non-fusion, or control group; return to work</td>
</tr>
<tr>
<td>2014</td>
<td>Cohort</td>
<td>injury and failed non-surgical care, unable to</td>
<td>functional restoration program</td>
<td>promote coping skills; medical case management to facilitate vocational</td>
<td>2-3 fold higher for all groups compared to previous studies; opioid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>return to work, having either lumbar fusion or</td>
<td></td>
<td>reintegration; biofeedback and relaxation to assist in stress management;</td>
<td>dependence was risk factor for adverse outcome</td>
</tr>
<tr>
<td></td>
<td></td>
<td>non-fusion surgery</td>
<td></td>
<td>education to improve knowledge of musculoskeletal disorder and encourage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>health/fitness</td>
<td></td>
</tr>
<tr>
<td>Archer et al.</td>
<td>Case Series</td>
<td>8 patients undergoing surgery for lumbar</td>
<td>Cognitive-Behavioral-Based Physical Therapy</td>
<td>Weekly in person (1) and phone meetings with a physical therapist for</td>
<td>7 patients had significant reduction of pain. All 8 patients had</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td>degeneration</td>
<td></td>
<td>behavioral self-management, problem solving, cognitive restructuring, and</td>
<td>a significant reduction of disability at 6 months. 5 patients had</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>relaxation strategies</td>
<td>significant increases in performance-based outcomes</td>
</tr>
<tr>
<td>Skolasky et al.</td>
<td>Prospective</td>
<td>65 patients undergoing spine surgery</td>
<td>Patient Activation and Functional Recovery</td>
<td>Patient activation testing. (Activation defined as an individual’s</td>
<td>Higher patient activation was associated with better recovery from</td>
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<tr>
<td>2011</td>
<td>Cohort</td>
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<td></td>
<td>propensity to engage in positive health behaviors.)</td>
<td>surgery including a decrease in pain and disability and an increase in</td>
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<td>physical health.</td>
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<td>Skolasky et al.</td>
<td>Prospective</td>
<td>65 patients with surgical treatment of</td>
<td>Patient Activation</td>
<td>Patient activation testing. (Activation defined as an individual’s</td>
<td>Increased patient activation was correlated with increased participation</td>
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<td>2008</td>
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<td>propensity to engage in positive health behaviors.)</td>
<td>and engagement in physical therapy.</td>
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<td>Study</td>
<td>Study design</td>
<td>Population</td>
<td>Program</td>
<td>Description</td>
<td>Results</td>
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<td>Di Fabio</td>
<td>Meta-analysis</td>
<td>19 randomized controlled trials</td>
<td>Back school versus comprehensive rehabilitation</td>
<td>Back school – education. Comprehensive rehabilitation coupled back school one of the following: work site visit, operant conditioning, cognitive-behavioral group therapy, intensive physical training</td>
<td>Comprehensive rehabilitation with back schools larger effect size than back school alone. Back school alone outcome equal to control group.</td>
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### Appendix B – Goodness of Fit Measures

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<th>Estimation Technique</th>
<th>Policy Model</th>
<th>Physical Therapy Utilization Model #1</th>
<th>Physical Therapy Utilization Model #2</th>
<th>Length of Stay Model</th>
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<td>Deviance</td>
<td>Residual Maximal Likelihood</td>
<td>Residual Maximal Pseudo Likelihood</td>
<td>Maximal Likelihood with Laplace Approximation</td>
<td>Maximal Likelihood with Laplace Approximation</td>
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<td>Aikaike Information Criterion</td>
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<td>(Pseudo) 35,266.75</td>
<td>3,189.91</td>
<td>19,988.05</td>
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<td>Bayesian Information Criterion</td>
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<td>Iterations</td>
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</table>
Appendix C – Comorbidity Count Diagnoses

1. Myocardial Infarction
2. Congestive Heart Failure
3. Peripheral Vascular Disease
4. Cerebrovascular Disease
5. Chronic Pulmonary Disease
6. Connective Tissue Disease
7. Rheumatic Disease
8. Peptic Ulcer Disease
9. Mild Liver Disease
10. Diabetes without complications
11. Diabetes with complications
12. Paraplegia or Hemiplegia
13. Renal Disease
14. Cancer
15. Moderate/Severe Liver Disease
16. Metastatic Carcinoma
17. AIDS/HIV