The Timing of Physical Therapy for Low Back Pain: Does It Matter in Workers' Compensation?

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Of course, any errors or omissions that remain in the report are the responsibility of the authors.

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EXECUTIVE SUMMARY

Non-invasive and non-pharmacological treatments are often prescribed initially for low back pain (LBP). Physical therapy (PT), as one of the non-invasive and non-pharmacological treatments, is recommended by most treatment guidelines as part of conservative care before considering other invasive procedures, such as injections and surgery. More recently, opioid prescribing guidelines also recommend PT as the first-line non-pharmacological treatment before considering opioid prescriptions.[1] With an increasing number of workers with injuries receiving PT,[2] an important question is, what impact does the PT treatment pattern have on utilization of other medical resources and outcomes? Outside workers' compensation, several studies have reported that for LBP, early PT treatment is associated with lower utilization of medical services and better outcomes.[3] This study is aimed at examining, among workers' compensation claims, the relationship between early and late PT timing and utilization of medical services, medical costs, and duration of temporary disability.[4] Specifically, we look at how different timing of PT initiation may impact the use of magnetic resonance imaging (MRI), opioid prescriptions, pain management injections, and lumbar surgery; the overall medical costs per claim; and the number of weeks of temporary disability benefits per claim.

After accounting for a rich set of factors that might affect both the timing of PT and the outcomes studied, we conclude that for workers with LBP-only injuries[5] for which PT treatment is indicated, early PT within 14 days after injury is likely to be beneficial, associated with a lower utilization of medical services, lower overall medical costs, and shorter temporary disability (TD) duration.[6] To the best of our knowledge, this is the most recent and comprehensive study that addresses PT timing focused on the workers' compensation population.[7] The findings of our study support the value of ordering PT early rather than late, suggesting that clinicians and payors should be encouraged to work proactively to remove barriers to early PT. Nonetheless, our study also underscores the need for high-quality random clinical trial studies so that we may have a more definitive answer to the question regarding PT timing.[8]

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[1] See the American College of Occupational Medicine (ACOEM), ODG, and Washington State opioid guidelines.

[2] Between 2012 and 2017, the percentage of claims receiving PT/occupational therapy services in the typical CompScope™ state increased 7.2 percentage points, and the same figure increased 16.8 percentage points in California (Dolinschi et al., 2020).

[3] Arnold et al. (2019) and Ojha et al. (2016) provide the latest systematic reviews on this topic.

[4] The reader should be reminded that we included some descriptive results for claims without PT treatment as part of the PT care continuum (in the statistical appendix), but studying PT versus no PT treatment requires a statistical analysis, which is beyond the scope of this study.

[5] The LBP-only claims are those that had a low back pain condition that had neither a red flag condition (e.g., tumor, infectious disease, fracture, dislocation, and severe complications of diabetes and psychological conditions) nor nerve involvement (e.g., sciatica, radiculopathy, and radiating leg pain). See Chapter 2 for a more detailed description.

[6] The conclusion on early PT within 14 days of injury was based on the patterns in the results for the adjusted utilization and costs of medical services and TD duration across the five PT timing groups (i.e., within 3 days, 4–7 days, 8–14 days, 15–30 days, and after 30 days postinjury). In this report, we refer to the three earlier PT timing groups (i.e., within 3 days, 4–7 days, and 8–14 day) as *early PT* and the two later PT timing groups (i.e., 15–30 days and after 30 days postinjury) as *late PT*.

[7] Another PT timing study based on workers' compensation data was Zigenfus et al. (2000).

[8] Even though we controlled for various underlying factors, we cannot assert that we have measured a causal effect of early versus late PT, which we discuss later in the report.

MAJOR FINDINGS

Using detailed medical transactions and claims data for workers with low back pain,[9] we find an increased utilization of medical services when PT treatments were initiated more than 14 days after injury (what we refer to as *late PT*). The average payment per claim for all medical services received during the first year of treatment was also higher for claims with late PT, compared with claims with early PT. Late initiation of PT treatment is also associated with a longer duration of temporary disability. These findings hold true after we controlled for a rich set of variables that may affect the timing of PT initiation and the outcomes studied.[10]

- For LBP-only claims with more than seven days of lost time that had 3 or more PT visits during the first year of treatment, we find the following:
  - Workers whose PT treatment started after 30 days of injury were 47 percent more likely to receive MRI and 46 percent more likely to receive opioid prescriptions, compared with those who had PT treatment initiated within 3 days after injury. The differences were 29 percent for pain management injections and 89 percent for low back surgeries, although fewer workers with LBP-only conditions had these procedures (Table A). Workers with PT initiated between 15 and 30 days postinjury also had a higher utilization of these services, but the percent differences were smaller, between 12 and 33 percent depending on the service.
  - The average payment per claim for all medical services received during the first year of treatment was lower for claims with early PT initiation than for those in the late PT groups, especially when compared with the PT after-30-days group. Our adjusted results show that the average medical cost per claim for workers in the PT after-30-days group was 24–28 percent higher than for those who had PT within 3 days and 4–7 days of injury (Table A). Note that the result reflects an association between early versus late PT timing and medical utilization and costs.[11]
  - Later timing of PT initiation (after 14 days of injury) is associated with longer TD duration, when compared with earlier PT groups. The average number of TD weeks per claim in the after-30-days group was 58–69 percent higher than that for claims in the two early PT groups (within 3 days and 4–7 days), and the number of TD weeks for the 15–30 days group was 24 percent higher than for the within-3-days group (Table A). One may be concerned about the potential impact of a longer TD duration on the late timing of PT initiation and how that may affect our findings. Based on our analysis, we believe that late PT is more reflective of different practice patterns than a potential impact of TD duration on the timing of PT initiation.[12]

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[9] The data used for this study are based on claims with injuries arising between October 1, 2015, and March 31, 2017, with detailed medical transactions for the first year of treatment after the date of injury. See the data, methods, and caveats section and Chapter 2 for more details.

[10] The variables we controlled for include worker characteristics (e.g., age, gender, marital status, wage, tenure, and industry); attorney involvement and time to first medical visit; severity (indicated by receiving pre-PT invasive procedures); comorbidities (e.g., obesity, diabetes, alcohol or drug abuse, and psychosocial issues, etc.); health care setting for PT; and several county-level variables (e.g., rural/urban areas, PT supply, level of physical activeness, and unemployment rate). State-specific factors are also controlled through fixed effects. See Chapter 2 and Chapter 4 for more details.

[11] Some providers might use a longer TD duration as an indicator for delayed recovery and order PT later. If true, the result could overstate the impact of late PT on higher medical utilization and costs to the extent that the impact would have been due to a longer TD duration. Based on our sensitivity analysis (see Technical Appendix C), we believe that this potential issue, although it may cause results to overstate the impact of late PT, should not change the major findings.

[12] From a clinical stand point, some providers routinely order PT and provide immediate PT treatment for low back pain while others may take a "watchful waiting" approach believing that the patient may get better over time. It is also possible

Table A Impact of Early PT, Unadjusted and Adjusted Results

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
Unadjusted results					
% of claims receiving MRI	28.8%	27.4%	29.9%	35.6%	47.7%
% of claims receiving opioid prescriptions	28.0%	28.0%	36.3%	42.1%	47.3%
% of claims receiving pain management injections	7.6%	6.4%	7.6%	9.5%	14.3%
% of claims receiving low back surgery	1.0%	0.8%	1.2%	1.4%	3.9%
Average payment per claim for all medical services	$4,098	$3,964	$4,302	$4,414	$5,804
Average weeks of temporary disability per claim	7.4	6.6	7.9	9.7	13.9
Adjusted results					
% of claims receiving MRI	30.0%	30.0%	31.9%	36.2%	44.2%
% of claims receiving opioid prescriptions	30.1%	29.0%	35.8%	40.2%	44.0%
% of claims receiving pain management injections	8.6%	7.4%	8.4%	9.6%	11.1%
% of claims receiving low back surgery	1.5%	1.2%	1.6%	1.7%	2.7%
Average payment per claim for all medical services	$4,306	$4,161	$4,394	$4,547	$5,337
Average weeks of temporary disability per claim	8.2	7.7	8.7	10.2	13.0

Notes: Included are LBP-only claims with more than seven days of lost time, injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the unadjusted results aggregated based on the pooled data of 27 states. The adjusted results in the bottom half of the table are the predicted values from our statistical analysis. Chapter 4 provides full results and a description of the statistical analysis.

Key: LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy.

- Across the five PT timing groups (within 3 days, 4–7 days, 8–14 days, 15–30 days, and after 30 days postinjury), the results of the adjusted outcomes were slightly different between the two early PT groups, but the differences were not statistically significant. For the late PT groups, especially for those in the after-30-days group, both unadjusted and adjusted numbers are significantly higher than the two early PT groups on most measures. While there may be different reasons for receiving late PT,[13] this result may encourage claims adjusters, case managers, and medical providers to pay closer attention to workers who need PT treatments but have not received them two weeks after their injuries.
- Among the workers who started PT treatment more than 30 days after injury, the utilization and costs of medical services were substantially higher compared with those with earlier PT treatment. This group of claims was also associated with a considerably higher percentage of attorney involvement (27 percent versus 13–15 percent among those receiving PT within 14 days of injury) and a longer time to receive medical care (on average 18 days versus 2–3 days for the early PT groups within 7 days of injury). These two variables also had a large and significant impact on the outcomes.

that a provider may consider ordering PT if the worker stayed out of work for a longer period of time, but this potential confounding issue should not be large enough to negate the substantial difference. See Chapter 4 and Technical Appendix C for more detailed discussions on this issue.

[13] Several issues may delay PT treatment, including compensability issues, delayed injury notice to the employer and insurer, access to providers for initial visits, and a delay in seeking care on the part of workers, as well as different PT referral patterns. The major findings highlighted here are based on our statistical adjustments and sensitivity analysis, which can be found in Chapter 4 and Technical Appendix C.

> While the higher rate of attorney involvement may indicate more prevalent issues of pending compensability (i.e., work-relatedness), a longer time to initial medical visits may reflect several issues that delay care, including pending compensability, delayed notice of injury to employers and insurers, access to providers for initial visits, and how soon the worker seeks care.

Readers should be reminded that although the findings from our study provide strong evidence of an association between early timing of PT treatment and lower utilization and costs of medical services and shorter TD duration, association is not causation. We do not measure the causal effect of PT timing on outcomes studied. This is because although we captured some of the factors that might influence both PT timing and outcomes, such as injections and surgery prior to PT (as an indicator for injury severity) and comorbidities, attorney involvement, and timing to first medical visits (as a proxy for possible issues that may prevent workers from getting early PT and lead to worse outcomes), these measures are by no means ideal in terms of capturing injury severity, possible pending compensability, and other issues that might delay care. In addition, there may be unobserved characteristics of workers (e.g., their behavioral response to medical care) that influence the timing of PT treatment and outcomes.

It is worth noting that physical therapy can be considered for most musculoskeletal injuries, for example, LBP with nerve involvement and shoulder sprains and strains. We scoped our study to focus on LBP-only claims with more than seven day of lost time that had 3 or more visits for PT treatment by providers who are not chiropractors.[14] These claims are relatively homogenous, which helps mitigate to some extent differences in the characteristics of the workers, observed or unobserved, who had PT treatment initiated at different points in time. Because of this narrow focus, the results from our analysis are not necessarily generalizable to workers who had low back pain with radiating leg pain and/or nerve findings and/or without lost work time. While it is important to focus on a set of clinically homogenous cases for a study, physical therapy focusing on treatment for other injuries and conditions should be considered for future studies.

DATA, APPROACH, AND CAVEATS

The data used for this study are from the WCRI Detailed Benchmark/Evaluation (DBE) database, which provides us with more than 1.8 million open and closed claims from 27 states,[15] with injuries from October 1, 2015, through March 31, 2017, and detailed medical transactions up through March 31, 2018. The 27 states combined represent two-thirds of the workers' compensation medical benefits in the United States and 37–72 percent of workers' compensation claims in each state.

For this study, we only include a set of low back claims that had low back pain as the primary condition for treatment[16] but did not have red flag (e.g., tumors, infectious diseases, fractures and dislocations) or neurological back or neck conditions. Throughout the report, we use *LBP-only claims* as shorthand for this set of claims. These claims were identified based on the International Classification of Diseases, Tenth Revision

[14] The PT providers in this study are mostly physical therapists, but there may also be a small number of other providers that are not chiropractors. Unfortunately, we are not able to differentiate those other providers from physical therapists.

[15] The 27 states are Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and Wisconsin.

[16] By primary condition, we mean that the payments made for services treating low back conditions represent more than 75 percent of all medical payments for treatments over the initial six-month period. There is a small percentage of claims (up to 5 percent) with degenerative conditions and/or instability of the spine in this set of low back claims.

(ICD-10) codes that were recorded in the detailed transactions for medical services.[17]

To examine the impact of early PT initiation, we only include LBP-only claims that received therapeutic PT treatment, i.e., claims with 3 or more PT visits during the first year of treatment. This is because workers who had 1–2 PT visits might have only received services for evaluation/assessment and/or patient education. We also only include claims with more than seven days of lost time to focus on a relatively homogenous set of low back claims to help ensure the comparability of the results. We compare the results across five PT timing groups (within 3 days, 4–7 days, 8–14 days, 15–30 days, and after 30 days postinjury). Although our analysis of early PT impact focuses on LBP-only claims that had 3 or more PT visits, we report a number of key measures for claims with no PT and claims with 1–2 visits for PT services in the statistical appendix.

We measure the utilization of medical services as the percentage of claims receiving certain types of medical services that are commonly used to treat low back pain. These include MRI, opioid prescriptions, pain management injections, and low back surgery. The average payment per claim measures per-claim costs for all medical services rendered during the first year of treatment. The average duration of TD was computed for individual claims based on the payments for TD benefits evaluated at one year after the date of injury.

In our statistical analysis, we adjust for worker age, gender, marital status, average weekly wage, tenure with preinjury employers, industry, and firm size, which are used for case-mix adjustment in most WCRI studies. We also use attorney involvement to control for potential compensability issues that may delay care. Time to first medical visits may be associated with several possible issues, including pending compensability that may delay care in some states, delayed notice of injury to employers and insurers, access to providers for initial visits, and how soon the worker seeks care. We also include this variable in the controls to address those potential issues. The use of more invasive medical procedures (i.e., injections and surgery) prior to PT treatment provides a proxy for the seriousness of low back pain. For comorbidities, we established a list of ICD-10 comorbidity codes and identified claims that had any of the specified comorbid conditions, including obesity, diabetes, and psychosocial issues within the first year of injury, as well as chronic pain diagnosed within the first three months, indicating a preexisting chronic pain condition.[18] In addition, we obtained two sets of county-level data that have information on the population level of physical activity, supply of providers (including physical therapists), rural versus urban areas, and unemployment rate. These were used to address some of the contextual factors that may influence the timing of PT and outcomes. We carried out several sensitivity analyses to address key data and measurement issues. The adjusted results after controlling for all these variables were used to support the key findings regarding the impact of different timings of PT treatment. Detailed descriptions of the data and approach can be found in Chapter 2 and the technical appendices.

[17] The algorithm used for identifying these claims was originally developed in a previous WCRI study (Wang, Mueller, and Lea, 2019a). In the 2019 study, we had two groups of low back claims: (1) low back claims with radiating leg pain and/or neurological findings, and (2) low back pain only claims. The second group has the uncomplicated low back pain for which PT services are often used for treatment.

[18] Although the prevalence of comorbidities is low in our data, we do see a large variation in the percentage of claims with at least one comorbidity, and having a comorbidity has a large and significant impact on the studied outcomes.

1

INTRODUCTION

Non-invasive and non-pharmacological treatments are often prescribed initially for low back pain (LBP).[1] Thus, physical therapy (PT) is recommended by most treatment guidelines as part of conservative care before considering other invasive procedures such as injections and surgery. More recently, opioid prescribing guidelines also recommend PT as the first-line non-pharmacological treatment before considering opioid prescriptions.[2] With an increasing number of workers with injuries getting PT treatment, it is important to better understand PT patterns and examine which PT patterns make a difference in terms of utilization and costs of medical resources and other outcomes, including return to work. In this study, we examine the relationship between early and late PT timing and utilization of medical services, medical costs, and duration of temporary disability (TD). This is the first in a series of studies as part of our research in the area of physical medicine.

OBJECTIVE AND SCOPE OF THE STUDY

This study aims at examining, among workers' compensation claims, the relationship between early and late PT timing and utilization of medical services, medical costs, and duration of TD. The policy-relevant questions we attempt to answer in this study include the following:

- What are the typical patterns in the timing of PT initiation for workers with LBP-only injuries? How frequently are these patterns observed in practice?
- When PT is prescribed, does early PT initiation help reduce the utilization of other medical services and improve duration of disability? Conversely, does late PT result in higher utilization of medical resources and delayed return to work?
- What factors may have considerable influence on PT timing and outcomes?

This study is focused on the timing of PT initiation when PT is ordered, for workers with LBP-only conditions. Because of the self-limiting nature of LBP, it is possible that some workers with LBP-only conditions will recover without PT treatment. However, more recent studies have suggested that PT treatment, especially when provided early, could help reduce overall health care resource use and shorten disability duration.[3] Our statistical analysis of PT timing is based on LBP-only claims with 3 or more PT visits to capture PT treatment

[1] See Qaseem et al. (2017).

[2] See the American College of Occupational Medicine (ACOEM), ODG, and Washington State opioid guidelines.

[3] See a more detailed discussion later in this chapter that summarizes key findings in the literature.

mostly provided by physical therapists and to estimate the average effect of early versus late PT. Analyzing the outcomes between claims with PT and those without PT requires more rigorous statistical analysis, which is beyond the scope of this study. We only provide a set of descriptive data over the PT continuum, including several measures for claims with no PT visits, 1–2 PT visits, and 3 or more PT visits.

In this study, we see that when PT is prescribed, early PT tends to be associated with lower utilization, lower per-claim medical costs, and shorter TD duration.[4] Recognizing that almost all observational studies are limited regarding true causation analysis, we applied statistical techniques to adjust the data in order to examine the strength of the association. The results of our analysis suggest a strong association between early timing of PT initiation and better outcomes, but we cannot assert that these are a causal effect of early PT.

We scoped our study to focus on LBP-only claims with more than seven days of lost time that had 3 or more PT visits for treatment.[5] This way we have a subset of low back claims for workers with LBP-only conditions that stayed out of work for an extended period of time. These claims are relatively homogenous, which helps mitigate to some extent differences in the characteristics of the workers, observed or unobserved, who had PT treatment initiated at different points in time. Because of this narrow focus, the results from our analysis are not necessarily generalizable to workers who had low back pain with radiating leg pain and/or nerve findings and/or who were without lost work time.

It is worth noting that physical therapy can be considered for most musculoskeletal injuries, for example, LBP with nerve involvement or shoulder sprains and strains. While it is important to focus on a set of clinically homogenous cases for a study, physical medicine treatments used for other injuries and conditions should be considered for future studies.

BACKGROUND

Low back pain was ranked as the leading cause of disability, as measured by years lived with disability in the United States and across the globe (Vos et al., 2016; U.S. Burden of Disease Collaborators, 2013). The estimated total costs associated with low back pain in the United States exceeds $100 billion per year, two-thirds of which are indirect costs, including lost wages and reduced productivity (Katz, 2006). Between 2000 and 2010, many guidelines recommended delay of physical therapy because of the self-limiting nature of back sprains and strains and non-specific pain. More recently, studies either suggested a link between delayed PT and a higher rate of LBP recurrence and likely higher utilization of medical services, or found that PT helped improve functional recovery of patients and was associated with lower utilization of other medical services. As a result, many treatment guidelines shifted to recommend PT as part of initial care. Increasingly, treatment guidelines and opioid prescribing guidelines recommend physical therapy for patients with uncomplicated conditions, such as low back pain, and as the first-line non-pharmacological treatment before considering opioid prescriptions and other invasive procedures.

The latest systematic review, by Arnold et al. (2019), provides the current state of research on this topic. The authors reviewed 11 articles,[6] which were selected out of 1,146 articles, that meet the review criteria. Six

[4] Several other variables are important to measure outcomes of PT treatment, for example, recovery and restoration in functional activity. Unfortunately, we do not have the data to capture these outcomes.

[5] See Chapter 2 for our discussion of claim selection for this study.

[6] The 11 studies included in the systematic review are Childs et al. (2015); Fritz et al. (2012, 2015, 2017); Gelhorn et al. (2012); Karcelas, Rundell, and Friedly (2017); Liu et al. (2018); Nordeman et al. (2006); Rhon Miller, and Fritz (2018); Thackeray et al. (2017); and Zigenfus et al. (2000).

studies compared early PT versus delayed PT, and five studies focused on PT versus no PT (often referred to as *usual care* in the literature). Five of the six studies[7] on timing of PT suggested that early PT was associated with decreased utilization of medical services and better outcomes. The medical services with decreased utilization include advanced imaging studies (Fritz, Wainner, and Flynn, 2012; Childs et al., 2015), spinal injections and lumbar surgery (Gelhorn et al., 2012; Fritz, Wainner, and Flynn, 2012; Childs et al., 2015; Liu et al., 2018), opioid prescriptions (Fritz, Wainner, and Flynn, 2012; Childs et al., 2015; Liu et al., 2018), and physician visits (Zigenfus et al., 2000; Gelhorn et al., 2012; Fritz, Wainner, and Flynn, 2012; Liu et al., 2018). Lower costs of medical services were also reported for cases with early PT at 1-year, 18-month, and 2-year follow ups (Liu et al., 2018; Fritz et al., 2012; and Childs et al., 2015). All five studies reporting positive effects of early PT are retrospective cohort studies, and the sixth study, by Nordeman et al. (2006), was a prospective random controlled trial (RCT) of 60 participants, which reported no significant difference in physician visits after six months. The systematic review concluded that the earlier initiation of PT services for acute low back pain is likely to lead to the reduction of downstream utilization of medical services, and the specific timing and contents of PT services are important to determine the size of the effect.

Although almost all studies reviewed concluded that early PT is associated with better outcomes, the studies vary in terms of how early PT was defined. Among the six studies reviewed (by Arnold et al., 2019), early initiation of PT was defined as 2 days after injury or enrollment (Zigenfus et al., 2000; Nordeman et al., 2006), within 14 days of the index date (Childs et al., 2015; Fritz, Wainner, and Flynn, 2012), and within 30 days of the index date (Gelhorn et al., 2012). Liu et al. (2018) evaluated four timing groups: within 3 days after the index date (immediate), 4 to 14 days (early), 15 to 28 days (delayed), and 29 to 90 days (late).[8] The lack of consistency in defining early PT may lead to confusion for both medical providers and patients in determining the most beneficial time to seek PT services.[9]

Another limitation in the literature is that many studies in the area are observational studies based on administrative data. Without being able to address potential differences in the unobserved characteristics of the low back patients who received PT treatment at different points in time, one cannot establish a causal link between early PT and outcomes of interest. Among possible confounding variables are patient care-seeking behavior, patient response to treatment, and injury/pain severity.

While the systematic review by Arnold et al. (2019) focused on the impact of early PT on medical utilization and costs, an earlier systematic review by Ojha et al. (2016) looked at patient outcomes as well as utilization and costs of medical services. Ojha et al. (2016) selected 14[10] out of 3,855 studies for review and concluded that for spinal pain, there was low-quality evidence suggesting that early versus delayed physical therapy was associated with decreased costs and decreased frequency of opioid prescriptions, advanced imaging, and surgeries, without compromising patient-important outcomes. However, all studies in the review consistently showed that early PT was not associated with unfavorable outcomes (i.e., more pain/function/disability, increased utilization and costs). One subgroup analyzed showed improved function/disability with early PT in an occupational health setting. Findings on outcomes of early PT across the studies were summarized, including

[7] The six studies are Childs et al. (2015); Fritz, Wainner, and Flynn (2012); Gelhorn et al. (2012); Liu et al. (2018); Nordeman et al. (2006); and Zigenfus et al. (2000).

[8] Some studies report results of immediate PT initiation. For example, discussed in Liu et al. (2018) is the Virginia Mason Medical Center, which offered patients with uncomplicated LBP same-day access to a PT team that developed and implemented a treatment plan for the patient during the first visit.

[9] See Arnold et al. (2019).

[10] The 14 studies include 4 RCTs, 1 prospective cohort, and 9 retrospective cohort studies.

perceived pain (degree of pain and the number of pain-free days) and function/disability in and outside workers' compensation (workers' compensation outcomes including work days absent, restrictive work days, sick leave days, activity handicap index, and weight-lifting capacity).

The 2018 study by Liu et al. is the most recent study that looked at several categories of timing and applied a statistical approach to addressing confounding factors. Liu et al. (2018) is the first population-based study to demonstrate the benefits for immediate PT initiation for patients with acute LBP, according to the authors. The study included 46,914 patients with acute low back pain in New York State, with new onset LBP between January 1, 2009, and December 31, 2013. Using the Truven Health MarketScan® Commercial Claims and Encounters Databases, the study aimed to examine the impact of receiving PT and the timing of PT initiation on the probability of service use and LBP-related health care costs over a one-year period. Among the 46,914 patients included, only 6,668 patients received PT initiated at different timings. The study concluded that for acute LBP, immediate referral and initiation of PT services (within three days) may lead to lower health care utilization and LBP-related costs.[11] Among the variables controlled for in the study were age, gender, metropolitan statistical area, insurance type, physician specialty at index visits, medical history one year prior to the index date,[12] and medical services prior to the index date.

Liu et al. (2018) also attempted to address the issue of unobserved confounding factors by applying the inverse probability approach, but as the authors pointed out, the study used a non-random sample of the New York State population, without controlling for patient/pain characteristics[13] and functional status.

Based on the data from 27 workers' compensation jurisdictions, this study describes the pattern of PT treatment initiation and associated outcomes, covering a wide range of issues that are relevant to workers' compensation. The other study focused on workers' compensation was Zigenfus et al. (2000). The PT timing groups defined in our study are similar to Liu et al. (2018), with two noteworthy differences. First, we break the PT timing into five groups: PT within 3 days, 4–7 days, 8–14 days, 15–30 days, and after 30 days. This enables us to look at the outcomes in the earlier PT groups. Based on the results of the outcome variables, we concluded that PT within 14 days of injury best demonstrates the benefit of early PT on use of medical resources and disability duration.[14] The second noteworthy difference is that we measure the PT timing as the number of days from injury to first PT visit. This enables us to analyze the impact of delayed medical care on outcomes, which could indicate pending issues that delay care and lead to undesired outcomes. By identifying health care organization structure in terms of PT care and referral, and looking into comorbidities in workers'

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[11] Liu et al. (2018) selected LBP claims based on the initial visit to a physician. To ensure acute onset low back pain, the study also excluded claims with LBP-related payments prior to the index date and claims with comorbidities diagnosed within four weeks of the index date. The study's utilization outcome variables were the annual probability of service use (receiving CT, MRI, opioid prescriptions, spinal injections, specialist visits, ER visits, spinal surgery) and the annual costs for pain medications (NSAIDs, muscle relaxants, and opioids). The study examined outcomes and costs over a one-year period.

[12] Medical history was focused on neck/thoracic pain, mental health, fibromyalgia, diabetes, hypertension, Charlson comorbidity index greater than 1, five or more unique diagnoses, and five or more therapeutic classes of prescription drugs. The study also used opioid prescriptions four weeks prior to the index date to capture medical services prior to the index date. Here the index date is the initial visit during which an LBP diagnosis was mentioned as the condition being treated.

[13] Among the patient/pain characteristics mentioned by Liu et al. (2018) are the Oswestry Disability Index, pain severity, disability, and fear-avoidance.

[14] We saw some differences in the outcomes we examined between the PT within 3 days and 4–7 days groups, but the differences were not statistically significant for most outcome measures. The differences between the 8–14 days group and the two earlier PT groups were also not significant. The two later PT groups (i.e., PT in 15–30 days and after 30 days) showed significant differences, especially the after-30-days group which had substantially higher utilization and costs of medical services and longer TD duration.

compensation claims, this study also provides additional insights into PT care in workers' compensation.

ORGANIZATION OF THIS REPORT

The report is organized into five chapters. Chapter 2 describes the data included for the analysis and our approach to defining PT timing and measuring the impact of early versus late PT timing on utilization and costs of medical services and duration of temporary disability. Chapter 3 describes patterns of PT initiation and compares the key outcomes across different PT timing groups. It also describes the characteristics of the claims and highlights observed differences in those characteristics across PT timing groups. Chapter 4 provides the results from our statistical analysis that controls, as much as we could with the available data, for factors that likely influence the likelihood of workers receiving PT treatment at different times and the outcomes of interest. In Chapter 5, we discuss the implications of the findings and the need for future research.

Technical Appendix A recaps some of the important points in our definition of low back pain, which was initially established in a previous WCRI study (Wang, Mueller, and Lea, 2019a). Technical Appendix B describes in more detail what we did to identify comorbidities in the administrative data. Technical Appendix C includes regression results and the results of several sensitivity analyses that help address certain data and measurement issues in this study. The statistical appendix has several tables showing some results for the states included in the study that had enough claims in each of the PT timing groups. It also provides data over the entire PT continuum.

2

DATA AND METHODS

This chapter describes the data we used for the study and our approach to examining the impact of early PT on medical service utilization, costs, and TD duration. Several elements are essential for our analysis: (1) definition of PT treatment and timing of PT initiation; (2) outcome variables we focus on; (3) claim selection; and (4) statistical adjustment of the data to ensure that the results on early PT impact are not distorted by differences in underlying factors. We describe these at a high level in this chapter, and Technical Appendices A–C provide more details.

THE DATA

The data used for this study are from the WCRI Detailed Benchmark/Evaluation (DBE) database, which provides us with more than 1.8 million open and closed claims from 27 states,[1] with injuries from October 1, 2015, through March 31, 2017, and detailed medical transactions up through March 31, 2018. All except two states have representative data in the DBE database.[2] These states are geographically diverse and represent a wide spectrum of state policies regarding utilization management and practice patterns of medical services. The claims in the DBE database represent approximately 37–72 percent of all workers' compensation claims, depending on the state, for the individual states we studied.[3] The 27 states combined represent two-thirds of the workers' compensation medical benefits in the United States during the study period.

The detailed medical transaction data provide information on the date of service, specific medical procedures or services provided, the amount paid to the provider, and diagnostic codes indicating specific injuries and medical conditions that were treated. Prior to October 15, 2015, the World Health Organization's 9th revision (ICD-9) was used for recorded diagnoses; after that date, the 10th revision (ICD-10) is required to be used for recorded diagnoses. The 10th revision provides much more detailed coding schemes that help capture specific diagnoses by nature and severity. Specifically for low back related diagnoses, the ICD-10 system provides much more detailed codes for low back conditions involving nerve root, compared with the ICD-9 system. Because of this, we chose to use the ICD-10 codes for the identification and classification of low back claims to better align our low back classification with specific low back conditions addressed in medical treatment guidelines. This choice limited us to include claims with injuries occurring on or after October 1,

[1] The 27 states are Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and Wisconsin.

[2] We do not name the individual states because of a confidentiality concern.

[3] One may be concerned about the variable level of representation for claim population across states and whether this affects the findings of the study. We tested whether states with a higher percentage of representation would respond differently from states with a lower representation and did not see material differences (test result not included in report).

2015.[4]

We limited the date of injury up to March 31, 2017, to make sure that we have at least 12 months of data to observe medical treatments. This is because the DBE round 20 database we used for the study covers medical details up to March 31, 2018. When extracting medical details for the analysis, we kept the data for the first 12 months of treatments.

Physical therapy is commonly used for treating most musculoskeletal injuries, including a variety of low back pain cases, complicated or uncomplicated. For this study, we chose to focus on a subset of low back pain only claims. In a previous WCRI study, we developed an algorithm that identifies low back pain claims with no red flag conditions (e.g., tumors, infectious diseases, fractures and dislocations),[5] and classified these claims into two groups: (1) low back claims with radiating leg pain and/or neurological findings, and (2) low back pain only claims.[6] This low back pain classification is consistent with most treatment guidelines that specify three groups of low back conditions (i.e., low back pain with a red flag, low back pain with nerve involvement, and low back pain with neither), which are clinically homogenous.

For this study, we focus on the low back pain claims that had neither red flags nor nerve involvement. This means that if a claim had at least one mention in the ICD-10 codes of a red flag condition or neurological back or neck conditions,[7] the claim was excluded from our analysis. We further excluded from this study the low back pain claims that had other neck conditions, traumatic injuries, comorbid conditions with severe complications,[8] and a few non-low back surgeries. Throughout the report, we use *LBP-only claims* as shorthand for this set of claims that are clinically homogenous in terms of medical severity.

Workers with low back injuries may receive treatment by a chiropractor and the percentage of claims with chiropractic care varies by state. We excluded claims with chiropractic care to simplify our analysis by focusing on PT treatments that are mostly performed by physical therapists in a clinical setting. For this study, we chose to focus on LBP-only claims with more than seven days of lost time.[9]

Table 2.1 provides claim counts in the DBE round 20 database, for claims with more than seven days of lost time, the LBP-only claims identified and selected for the study, and a subset of these low back claims for the PT timing analysis.

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[4] We used the date of injury October 1, 2015, as a cut off, instead of October 15, 2015, as a convenient way to construct the data. The 14-day gap is unlikely to make a material difference in the identification of low back claims. Note that the switch from the ICD-9 to ICD-10 system was immediate. The claims with ICD-9 codes were not included in our data.

[5] We identified a large number of codes in the ICD-10 coding system that are related to signs, symptoms, and conditions indicating potentially serious pathology in patients presenting with back pain. These codes, not included in the report, cover conditions such as tumors, infectious diseases, and fractures and dislocations.

[6] The algorithm used the ICD-10 codes that were recorded in the detailed transactions for medical services, including evaluation and management services, emergency services, hospital/critical care, consultations, physical medicine, surgery, anesthesia, and psychiatric services. A detailed description of the algorithm can be found in Wang, Mueller, and Lea (2019a). Technical Appendix A provides the ICD-10 codes used in the algorithm.

[7] See Technical Appendix A for a description of neurological back and neck conditions and a list of ICD-10 codes indicating these conditions.

[8] The comorbid conditions with serious complications include diabetes with hypoglycemia or ketoacidosis, substance abuse with psychotic disorders, and bipolar disorders. These were identified using an ICD-10 code list we established for comorbidities

[9] We chose to study claims with more than seven days of lost time for several reasons. These claims were relatively more serious and more likely to receive the services we studied, providing an adequate sample for analyzing patterns of practice for the specific services. Although the utilization level of medical services observed in these cases was likely to be higher than that for all cases, the cases with more than seven days of lost time provide a relatively more homogeneous and comparable base for the purpose of interstate comparisons in the patterns of medical practice. In addition, the claims with more than seven days of lost time account for the majority of the workers' compensation medical costs and almost all indemnity benefits and costs for cases with low back injuries, providing an adequate base for future studies analyzing costs to workers' compensation systems and worker outcomes.

Table 2.1 Claims Included in the Study

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NV	NY	PA	SC	TN	TX	VA	WI	27-State Total
Number of claims with 7DLT in DBE database	2,059	76,433	10,372	1,476	27,385	11,914	5,037	21,908	8,364	4,442	6,273	5,204	13,633	8,381	11,812	10,937	7,967	11,772	18,955	3,741	44,647	21,038	7,229	9,498	37,223	8,419	10,840	406,959
LBP-only claims with 7DLT, included in the study[a]																												
LBP-only claims with 7 DLT	150	8,450	1,073	110	2,309	1,072	278	1,651	406	189	399	407	1,430	930	741	936	515	886	1,498	293	2,457	1,493	544	618	3,837	570	754	33,996
LBP-only claims with 7 DLT included in the study[b]	127	6,152	893	72	1,900	920	217	1,289	325	139	316	337	1,097	656	647	581	415	704	1,362	234	1,770	1,123	412	542	2,754	504	467	25,955
% of LBP-only claims with 7DLT that are included in the study	85%	73%	83%	65%	82%	86%	78%	78%	80%	74%	79%	83%	77%	71%	87%	62%	81%	79%	91%	80%	72%	75%	76%	88%	72%	88%	62%	76%
Included claims that had 3 or more PT visits	87	4,280	626	58	1,313	692	145	939	226	102	216	189	591	475	477	310	321	442	1,015	178	1,089	802	276	390	1,762	330	306	17,637
% of included claims that had 3+ PT visits, for PT timing analysis	69%	70%	70%	81%	69%	75%	67%	73%	70%	73%	68%	56%	54%	72%	74%	53%	77%	63%	75%	76%	62%	71%	67%	72%	64%	65%	66%	68%

Notes: Claims included are those with injuries occurring from October 1, 2015, to March 31, 2017, with medical treatments received during the first year after the date of injury. The claims in the DBE database represent approximately 37–72 percent of all workers' compensation claims, depending on the state. See Chapter 2 for more details about the data used for this study.

[a] The low back claims included in this study were those for which medical services were predominantly used to treat low back conditions, and these low back claims did not have more serious red flag conditions or neurological back or neck pain. See Chapter 2 for a more detailed description.

[b] The differences in the claim counts between this line and the line above reflect mostly the exclusions of LBP-only claims with chiropractic care. There were also a small number of claims that were excluded from the study as a result of additional exclusions we discuss in Chapter 2.

Key: 7DLT: claims with more than seven days of lost time; DBE: Detailed Benchmark/Evaluation database; LBP: low back pain; PT: physical therapy.

DEFINING PT TREATMENT AND TIMING OF PT INITIATION

Since the timing of PT treatment is the focus of this study, we need to be explicit on two basic definitions: (1) PT treatment and (2) timing of PT initiation. We define PT treatment as any PT services that are rendered at a PT visit during the first year of treatment.[10] These include evaluation/measurement, functional assessment, passive physical therapies (e.g., modalities, manual therapy, massage, traction, as well as durable medical equipment), and active physical therapies (e.g., therapeutic exercises, PT related education and training, active counseling, and work hardening).[11] The goal of PT treatment is to mitigate pain and facilitate functional recovery and return to work.

For this study, we consider workers who had 3 or more PT visits as having PT treatment, which resulted in the exclusion of an additional 8 percent of LBP-only claims with more than seven days of lost time from our analysis of PT timing. We excluded these claims with 1–2 PT visits because many of them might have only received services for evaluation/assessment and/or patient education. Conceivably, some workers with 1–2 PT visits may have received instructions or training for home exercises. These workers may have carried out home exercises as instructed. However, we do not observe those home exercises if they are not billed and paid under workers' compensation. As a result, we cannot separate these claims from those that had only evaluation/assessment and/or patient education. Because of this, we excluded claims that had 1–2 visits for PT services from the analysis of early PT impact. Also note that 24 percent of the claims included in the study did not have any PT visits. For these claims with no PT or 1–2 PT visits (32 percent of LBP-only claims studied), the treating provider may demonstrate for the workers how to do home exercises, but PT treatment was not done by a skilled physical therapist in a clinical setting.

As mentioned earlier, we did not include claims with chiropractic care in this study.[12] Workers with low back injuries may receive treatment by a chiropractor, or there may be some overlapping in service delivery between chiropractors and physical therapists. We chose to exclude claims that ever involved chiropractic care to limit the variables that have to be considered in the analysis for simplicity. We intend to analyze chiropractic care delivery in a future study.

Regarding timing of PT initiation, there is large variation in the literature as to how to define early versus late or delayed PT treatment. Among the six studies selected in the latest systematic review by Arnold et al. (2019), early initiation of PT was defined as 2 days after injury or enrollment (Zigenfus et al., 2000; Nordeman et al., 2006), within14 days of the index date (Childs et al., 2015; Fritz, Wainner, and Flynn, 2012), and within 30 days of the index date (Gelhorn et al., 2012). Liu et al. (2018) evaluated four PT timing groups: within 3 days after the index date (immediate), 4 to 14 days (early), 15 to 28 days (delayed), and 29 to 90 days (late). The lack

[10] We measure PT visits as unique dates of service where at least one PT service is provided. The number of PT visits is commonly used to count the frequency of PT treatment, and during a PT visit 1–3 services are typically provided. Note that when PT is ordered, a typical PT prescription should include the diagnosis, types of PT services (e.g., modalities, exercises, and manual therapy), frequency (e.g., 2–3 visits per week), and duration (i.e., how many weeks PT treatment should last).

[11] Durable medical equipment is infrequent in our data, but it is considered part of physical therapy. Most services under the durable medical equipment category are for orthotics such as braces and thera-bands that are used to assist movement of the spine and lower extremities. There are a small number of acupuncture services in our sample, which were grouped with passive modalities. These services might be performed by acupuncturists and physical therapists.

[12] Overall across all 27 states, 1.2 percent of the claims with more than seven days of lost time had chiropractic care. The numbers varied by state, ranging from 0.7 to 2.2 percent. For LBP-only claims, however, the percentage of claims with chiropractic care was higher and varied widely by state. The percentage was below 5 percent for 12 states and was the highest in Minnesota (27 percent). The percentage of claims with chiropractic care was also higher in California, Delaware, Louisiana, Maryland, Massachusetts, New York, Pennsylvania, Taxes, and Wisconsin (10–22 percent). We excluded claims with chiropractic care from this study to simplify the analysis. Patterns of chiropractic care may be addressed in future studies.

of consistency defining early PT may create confusion about the impact of early PT that has been reported, and is not helpful for both medical providers and patients in determining the most beneficial time to seek PT services (Arnold et al., 2019).

For this study, we chose to define PT timing in five categories: PT within 3 days, 4–7 days, 8–14 days, 15–30 days, and after 30 days of injury. One may define PT timing by measuring the number of days from onset of injury to the date of first PT visit. Using this variable and its quadratic form in a statistical analysis may help identify optimal PT timing. We explored this option but did not see evidence of a non-linear pattern. We decided to use the five-category definition because it is largely consistent with the literature and this categorical PT timing definition is more meaningful for policymakers, claims administrators, and clinicians treating workers with LBP injuries. Note that our definition of PT timing largely follows the definition in Liu et al. (2018), with two important distinctions. First, instead of four timing categories, we defined five PT timing groups. This way we may see if the data suggest a natural breakpoint between early and late PT based on the outcomes. Second, instead of anchoring the number of days at the index visit (i.e., the first visit during which low back pain is diagnosed), we defined the PT timing as the number of days from injury to the first PT visit. By doing so, we capture the time elapsed from the onset of low back pain (i.e., the date of injury) to the date on which PT treatment was initiated. This definition breaks out the PT timing in two parts: (1) time from injury to initial medical visit (e.g., office or emergency visit), and (2) time from initial medical visit to first visit for PT treatment. These two time intervals reflect different underlying forces. The first one could be reflective of issues arising from the claims administrative process (e.g., timeliness of injury reporting, case management, and pending compensability) as well as access to care and worker's care-seeking behavior.[13] The second part may have to do with PT referral patterns and timeliness of PT treatment once referred.

To provide a whole picture of medical care related to PT treatment, we described a PT continuum based on our data as follows (for low back pain cases):

- Claims with no PT services.
- Claims with 1–2 PT visits. This group of claims may have one of the two following characteristics. First, some claims may be less serious and the PT visits were mostly for evaluation and patient education. Second, some of the workers in this group may have visited a physical therapist for evaluation and home exercise training and instructions. We are not able to observe if these workers continued with therapeutic exercises at home. Although we do not know how many cases are in this group, we do not consider this group of cases as having PT treatment.
- Claims with 3–6 PT visits. This group had relatively brief but therapeutic PT treatment, for which we track PT timing.
- Claims with 7 or more PT visits. We also track PT timing for this group of claims with longer therapeutic PT treatment.

We combined the last two groups as claims with PT treatment, which are the focus of our analysis on the impact of PT timing on utilization and TD duration. Chapter 3 and the statistical appendix provide descriptive statistics based on this design.

[13] Some workers might have low back pain for a while before seeking medical care, especially for those who suffer cumulative injuries. This kind of delay in care may also be reflected in a longer time from the date of injury to the first medical visit.

OUTCOME VARIABLES OF INTEREST

The outcome variables we focused on in this study include the percentage of claims with key medical services (MRI, opioid prescriptions, pain management injections, and low back surgery), the average payment per claim for all medical services, and the average number of weeks (or days) of temporary disability benefits. These measures were constructed for LBP-only claims with more than seven days of lost time.

The utilization of specific medical procedures was measured based on detailed medical transaction data for medical services rendered during the first year of treatment. The specific types of medical services and procedures were identified using the Current Procedure Terminology (CPT) codes.[14] For MRI, injections, and surgery, CPT codes not only specify the type of procedure but also indicate the parts of the body on which the procedures are used. Table 2.2 provides a list of CPT codes for these three types of medical procedures for low back pain.

Table 2.2 CPT-4 Codes for MRI, Pain Management Injections, and Low Back Surgery for LBP-Only Claims

Medical Procedures	CPT-4 Codes
MRI for low back	72148[a]
Pain management injections	Epidural steroidal injections: 62322, 62323, 62326, 62327, 64484 Facet injections: 64493, 64494, 64495, 64635, 0216T, 0217T, 0218T Trigger point: 20552, 20553 Other injections: 62282, 62292, 62303, 62304
Low back surgery	63005, 63011, 63012, 63017, 63030, 63035, 63042, 63044, 63047, 63048, 63056, 63057, 63077, 63081, 63272, 63277; 20931, 20936-7, 22551, 22558, 22585, 22612, 22614, 22630, 22632-4, 22830, 22840, 22842, 22845, 22846, 2285x.

[a] CPT code 72148 is the common code billed for MRI, spinal canal and contents, lumbar, without contrast material. Note that code 72149 (MRI, spinal canal and contents, lumbar, with contrast material) and 72158 (MRI, spinal canal and contents, without contrast material, followed by contrast material and further sequences; lumbar) were less frequent but could indicate a case with existing low back pain and prior lumbar surgery. Less than 1 percent of the LBP-only claims had either of the two codes; these claims were excluded from our analysis.

Key: CPT: Current Procedural Terminology; LBP: low back pain; MRI: magnetic resonance imaging.

Opioid prescriptions are identified based on drug transactions in the DBE database using the therapeutic classification scheme developed by Medi-Span®.[15] These are controlled substances scheduled at the federal level based on their analgesic potency and risk for abuse and dependence.[16]

The medical costs per claim capture payments for all medical services received during the first year of treatment. TD duration is measured as the number of weeks of TD benefits, with benefit payments derived from carriers' transaction data over a one-year period from the date of injury.[17] Because these two measures tend to be skewed in the distribution across all claims, we made log transformation of each variable in our statistical analysis, and for descriptive statistics, we report both mean and median values of each variable. It

[14] Wang, Mueller, and Lea (2019a) provided a list of CPT codes and the mapping of these CPT codes to pre-defined types of medical services for low back pain. CPT® is a trademark of the American Medical Association.

[15] According to Medi-Span®'s Therapeutic Classification System, a hierarchical classification scheme, the first two digits of the 10-digit Generic Product Identifier classifies general drug products. We identified opioid prescriptions based on drug group 65 for opioid analgesics. See Medi-Span® (2005).

[16] See Thumula, Wang, and Liu (2019).

[17] A small number of claims that had missing or unreasonable TD duration are excluded from the analysis. These include claims that did not have TD benefits but received benefits for permanent partial disability, a few claims with negative TD payments after adjusting for credits, and claims that had an unusually large number of weeks beyond one year.

should be noted that in principle, the duration of TD benefits does not exactly reflect the duration of time that workers were away from work. Several scenarios include (1) workers receive TD benefits until reaching maximum medical improvement and start receiving permanent partial disability benefits; (2) some workers may choose to settle their claims; or (3) in some states, temporary disability benefits may be terminated while workers resolve disputes about their ability to return to work.[18] However, for this study that compares outcomes across different PT timing groups, the duration of TD benefits should be a reasonable proxy for return to work. It is worth noting that across states with different system features, there is large variation in the duration of TD benefits. For example, TD durations are much longer in wage-loss states than in a non-wage-loss states, because unlike in a non-wage-loss state, workers in a wage-loss state do not shift to receiving permanent partial disability benefits after reaching maximum medical improvement. This can be addressed by controlling for state fixed effects, which we applied in our statistical analysis.

ADJUSTING FOR UNDERLYING FACTORS INFLUENCING PT TIMING AND OUTCOMES

The objective of this study is to examine the association between early PT and the utilization and costs of medical services and the duration of temporary disability. There are a number of factors, observed and unobserved, that likely affect the comparability of the outcomes across different PT timing groups. It is important to understand how these factors may influence the timing of workers receiving PT treatment, how they contribute to the outcomes of interest, and to what extent these factors may bias the estimated effect of early versus late PT timing on utilization and TD duration.

CASE-MIX VARIABLES

Several observed characteristics of workers likely affect treatment patterns and outcomes. These include worker age, gender, occupation, patient education, and social support. In our statistical analysis, we adjusted for a rich set of variables, including worker age, gender, marital status, industry, average weekly wage, tenure with preinjury employers, firm size, and attorney involvement.[19] Occupation is also an important factor. A worker who needs to lift 70 pounds at work is likely to have a longer period of treatment and recovery, and return to work later, compared with someone with the same low back pain but who works in a clerical job. We do not have data on worker occupation, but the information on industry helps broadly characterize worker occupation. Education is another important factor, which is likely to influence workers' perception of injury and need for medical care as well as their behavioral response to the health care they receive. We do not have data on workers' level of education. Good relationships and social support may also affect behavioral responses to treatment. If a worker has social support (for example, is married and has a good relationship with coworkers and supervisors at work), the worker may be more likely to receive treatment promptly and more motivated to go back to work.[20]

Issues arising from the claims administration process may also affect the timing of receiving treatment and outcomes. In our data, we have variables on both defense and worker attorney involvement, which to a certain

[18] See Savych, Neumark, and Lea (2018) for more discussion.

[19] This is a set of variables we use to adjust for differences in the mix of cases in most WCRI studies.

[20] Oyeleke, Adejumo, and Odole (2019) investigated the role of psychosocial factors on treatment adherence and suggested that social support, along with several other psychosocial factors, helped predict treatment satisfaction and behavioral domains of treatment adherence among low back patients. Two systematic review articles suggest that social support helps facilitate return to work for individuals with work-related injuries (White et al., 2019; Chimenti and Wong, 2019).

extent reflect the existence of these issues. Although worker attorney involvement may better indicate issues in the claims administrative process, the data on worker attorney involvement was not as complete and consistent as for defense attorney involvement. Because of this, we used defense attorney involvement in our analysis, and tested the correlation between defense and worker attorney involvement. We also tested the sensitivity of the results on the early PT impact by running the same analysis based on claims with neither defense nor worker attorney involvement.[21] In addition, we controlled for the number of days from injury to first medical visit, which may reflect, to some extent, issues arising from the administrative process (e.g., delays in case management, pending compensability issues) as well as access to care and workers' care-seeking behavior.

SEVERITY AND COMORBIDITIES

Compared with those receiving early PT, workers who receive PT treatment later may be more likely to have more serious low back pain and/or have certain untreated comorbidities. This may have an effect of delaying care and lead to worse outcomes. On the other hand, if a worker has a comorbidity such as obesity/overweight and mental health issues, a provider may be inclined to order PT early to encourage the patient to stay active. Although severity and comorbidities may be correlated with some of the case-mix variables discussed above,[22] controlling for those case-mix variables may not be enough to adjust away the differences caused by these underlying factors.

Lacking data on injury severity, we used pre-PT pain management injections and pre-PT low back surgery as proxies to adjust for differences in severity across the PT timing groups. This is in addition to our claim selection that yields a set of relatively homogenous and uncomplicated low back pain claims.[23]

For comorbidities, we established a list of ICD-10 codes that indicate comorbidities and identified claims where there was at least one mention of any comorbidity code on the list. We used this comorbidity indicator to adjust for different the comorbidity mix of claims across the PT timing groups. There are seven categories of comorbidities in our definition: alcohol or drug abuse, chronic pain or symptoms within three months postinjury, diabetes, obesity, psychosocial issues, smoking, and other life-style issues (e.g., lack of physical activity). For LBP-only claims with more than seven days of lost time, the percentage of claims with any of these comorbidities appeared to be low, but showed an increased pattern over the PT timing groups, ranging from 2.9 percent in the PT within-3-days group to 7.5 percent for the after-30-days group (Table 3.5).

One concern regarding how well we captured comorbidities in workers' compensation data is that treatments of comorbidities are usually not covered under workers' compensation. Therefore, they may not be listed as diagnoses by the provider. Based on our review of detailed medical data, we believe that some providers do code comorbidities and the comorbidity diagnoses are kept in the detailed medical transaction data, especially for claims where ICD-10 codes are present at the bill level. However, the lack of consistent recording of comorbidities and certain data system issues[24] may result in the understatement of the prevalence of

[21] Technical Appendix D provides some results from our sensitivity analyses.

[22] For example, older workers may be more likely to have other coexisting conditions and certain services may be considered appropriate prior to PT treatment. Older workers may take a longer time to recover. As a result, duration of treatment and temporary disability may be extended. In fact, most treatment guidelines recommend early imaging to rule out cancer if the patient is older than 50 years.

[23] Our study sample includes only claims with more than seven days of lost time that had low back pain diagnoses but did not have red flag conditions or nerve involvement. This set of claims is clinically homogeneous and few of the claims had services indicated for severe low back pain. However, the residual variation in the level of pain and severity may affect the estimation of the early PT effect. We used the utilization of certain medical services prior to PT treatment as an indicator for severity.

[24] Since the treatment of comorbidities is not normally covered under workers' compensation, it is not common to see a comorbidity code being entered as the diagnosis for the service rendered. The ICD-10 codes for comorbidities were

comorbidities. Even if we cannot fully capture comorbidities using the administrative data, we can still use it as an indicator to adjust for the observed differences. Technical Appendix C provides a more detailed discussion on comorbidity identification and related sensitivity tests.

STATE POLICIES AND ENVIRONMENT

Different state policies have direct and indirect impacts on medical treatment and benefits received by workers. If PT is encouraged by state policies and guidelines, and the same states have other policies and system features to promote utilization review and return to work, the difference in state policies, if not adjusted for, may affect the estimated effect of PT timing. For example, states are different in benefit structure. TD duration is much longer in wage-loss states than in non-wage-loss states. If the early PT group has proportionally more claims in non-wage-loss states and the late PT group has proportionally more claims from wage-loss states, the estimated effect of early PT could be biased in favor of early PT. There may be other state-specific factors (e.g., difference in the mix of health care organizations with different delivery patterns and outcomes, economic environment) which affect the estimation of the early PT effect. We adjusted for these state-specific factors by controlling for state fixed effects in our statistical analysis.

SAME-BILLING-ENTITY PT

With an increasing trend of vertical integration in the health care market, many system practitioners agree that having the treating physician and PT providers in an integrated setting makes a difference in terms of PT referral and timeliness of receiving PT treatment. Conceivably, many clinics/centers have organization-level treatment protocols for PT referrals that encourage the use of PT treatment and facilitate patients' quick access to PT services. These organizations may also have other guidelines that promote functional recovery and return to work. To capture this type of health care delivery setting, we developed an algorithm that identifies what we called the *same-billing-entity* health care providers. Specifically, the algorithm compares the unique provider IDs (i.e., encrypted tax ID in this case) between the provider who provided PT services and the provider who saw the patient during an office visit before the first PT visit. If both PT and office visit providers share the same ID, we consider the claim as having same-billing-entity PT treatment.[25]

The same-billing-entity PT may imply one of two things: (1) the treating physician and the physical therapist work in the same clinic or medical center so that the PT treatments are provided in an in-house setting; or (2) both the treating physician and the physical therapist are affiliated with the same health care organization as one billing entity. In the latter case, PT treatments are not done in-house but are referred internally to PT units within the same organization. Regardless of which specific clinical setting PT treatments are provided in, this direct relationship between the referring physicians and physical therapists is likely to be subject to the same organization-level protocols and lead to a higher rate of PT referrals and timely PT treatments. Our intention was to control for the same-billing-entity PT to equalize the impact of different organization-level

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mostly seen in the multiple ICD-10 fields that reflect provider coding practice. Conceivably, if the provider observed comorbid conditions and entered corresponding codes in the bills, the comorbid codes can be kept in the detailed medical transactions. If the detailed medical transaction data consistently have multiple ICD-10 codes kept, one would observe comorbidities.

[25] For some claims, there may be more than one PT provider and more than one treating provider whom the worker saw before the first PT visit. If there is more than one pre-PT office visit provider and one of the providers shares the same ID with the PT provider, we consider the claim as having same-billing-entity PT treatment. A few claims had more than two PT providers. In this case, we checked the provider who provided PT services first.

treatment protocols that may bias the estimated effect of early PT.[26] Note that there is a small percentage of claims that had PT treatment without office visits, which may reflect the direct PT pattern we expected to see in some locations.

Some system practitioners also suggested identifying the type of providers with PT referrals as a way to adjust for differences in individual provider's training and clinical experience. For this study, we did not identify provider specialty for several reasons. First, some of the differences can be captured in the way we control for same-billing-entity providers, which many system practitioners agreed is a more important factor. Second, for controlling provider specialties, it is likely that we have to perform the analysis on a smaller sample of claims due to different levels of details that are available in the data. Third, occupational medicine as a specialty can sometimes be mislabeled or improperly designated in practice, and even if we identified specialties as labeled, the results might not be meaningful.

EXTERNAL COUNTY-LEVEL DATA

In addition to all the factors discussed above, we obtained county-level data, primarily from two external sources that capture geographic differences in many contextual factors. The Area Health Resource File provides a rich set of data on population characteristics, residence in rural versus urban areas,[27] provider supply,[28] and labor market conditions (i.e., unemployment rate[29]).

The Institute for Health Metrics and Evaluation (IHME), affiliated with the University of Washington, also has been collecting health care related data internationally. Among the IHME data files, we used the estimated prevalence of physical activity for the residents by county to examine how that may influence the results.[30]

UNOBSERVED CHARACTERISTICS OF WORKERS

Finally, there are certain things we do not observe that may well influence the timing of receiving PT and outcomes. Inability to measure and control for these characteristics biases the estimated effect of early versus late PT. One possibility in this direction could be that workers who are more active and outgoing are more likely to respond to early PT and fitness in general. These workers may also be more likely to recover faster and return to work sooner. This may be the case for identical workers with the same characteristics that we measured and controlled in this study. If true, this unmeasured personal trait could sort more active workers

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[26] While our intention was to capture clinically and financially integrated health care organizations with organization-level treatment protocols, the same billing entity we identified may also capture some financially integrated organizations that had early PT referrals in response to economic incentives for self-referrals. We were not able to differentiate these two types of vertical integrations.

[27] ZIP code Rural-Urban Commuting Areas (RUCAs) geographic taxonomy, available at https://ruralhealth.und.edu/ruca.

[28] We used the data for 2009 licensed physical therapists and the population estimate to compute the ratio of physical therapists for every 100,000 population at the county level. The data for 2009 licensed physical therapists was from the National Center for the Analysis of Healthcare Data (NCAHD), which was based on the data provided to NCAHD by the state licensure boards.

[29] The county-level unemployment rate is based on U.S. Bureau of Labor Statistics' Local Area Unemployment Statistics (LAUS), available at https://www.bls.gov/lau/.

[30] The county-level physical activity data is based on a state-based random-digit telephone survey that covers the majority of United States counties, conducted by the Behavioral Risk Factor Surveillance System (BRFSS). The survey asked questions about whether the respondent participated in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise in the past month. The prevalence of physical activity was based on self-reported physical activity, expressed in a number between 0 and 100. The survey was conducted annually between 2001 and 2011. The physical activity prevalence data we used for our analysis are based on the 2011 survey. See Dwyer-Lindgren et al. (2013). Although the IHME data are not concurrent with our data in years, it is unlikely that the county-level characteristics would change dramatically over the time span.

in the early PT group, exaggerating the effect of early PT on a short disability duration.

For this study, we explored the same instrumental variable (IV) approach used in Savych, Neumark, and Lea (2018), which is essentially to take advantage of small area variation to create a PT timing variable that mimics a random trial study so that the claims would be exchangeable between the controlled PT timing groups. The instrument we constructed highly predicts the likelihood of having early PT, satisfying the first of the four assumptions for a valid IV. The other assumptions are in general not verifiable, but may be argued for or against based on subjective-matter knowledge, which we discussed in Technical Appendix C. Based on the results from our IV analysis, the effect of early PT on lower utilization and costs of medical services and TD duration could have been larger than what we estimated without the IV. The result was not consistent with our expectation for the hypothetical issues regarding unobserved characteristics of workers. There might be other underlying factors that offset the effect of personal traits, but we do not know what the other sources of variation could be.[31]

For this study, we chose to not include the IV analysis in the final analysis that supports the major findings for two reasons. First, the IV analysis did not provide evidence that our findings would be flawed or biased if we did not address the unobserved characteristics of workers with LBP-only injuries. Second, we are not convinced that the IV we constructed meets all the assumptions for the IV analysis to be valid. By not including the IV analysis, we took a conservative approach to report major findings. See more discussion in Technical Appendix C.

STATISTICAL ANALYSIS AND SENSITIVITY TESTS

For the statistical analysis, we used logistic regressions for the dichotomous utilization variables on the likelihood of receiving MRI, opioid prescriptions, pain management injections, and low back surgery. For medical payments and TD duration, we used ordinary least squares (OLS) with log transformation. To illustrate the impact of different sets of variables on the estimated effect of PT treatment at different timings, we used five model specifications to progressively add additional factors that may change the results, as follows: (1) basic model with no adjustment; (2) adjusting for differences in the mix of cases, such as worker age, gender, marital status, average preinjury weekly wage, tenure with preinjury employer, industry, payroll size, attorney involvement, and time to first medical visit; (3) severity (with pre-PT use of pain management injections and lumbar surgery as a proxy) and comorbidities (including, diabetes, obesity, psychosocial factors, alcohol or drug abuse, chronic pain or symptoms noted within the first three months postinjury, and smoking); (4) same-billing-entity PT care (including in-house PT and PT by providers who share the same billing tax ID with providers for PT referrals); (5) contextual factors based on county-level data from external sources, such as rural versus urban, supply of providers, and unemployment rate.

For simplicity, we present and interpret the results from our statistical analysis based on the predicted values of each outcome variable holding constant the variables included in each model. The adjusted results on the outcome variables, presented in Chapter 4, were created as if the cases across the five PT timing groups had the same characteristics for the variables included in each model. This is different from the descriptive statistics we present in Chapter 3, which are based on a straight-forward aggregation of the actual data.

One may be concerned about a potential link between longer TD duration and late PT timing, which if true and significant, could affect our findings on the impact of PT timing on utilization and costs of medical

[31] We suspected that the instrument might be correlated with certain geographic variations in economic environment and general wellbeing of the local population.

services as well as TD duration. It is a valid concern since some providers may consider ordering PT if the worker stays out of work for an extensive period of time. However, from a clinical stand point, it is more likely that late PT reflects a difference in practice patterns. Some providers routinely order PT and provide immediate PT treatment for low back pain while others may take a "watchful waiting" approach believing that the patient may get better over time. To address this concern, we conducted a sensitivity analysis which is presented in Technical Appendix C. Based on that analysis, we concluded that even if some providers order PT because of longer TD duration, the potential impact of longer TD duration is unlikely to be large enough to negate the substantial differences we found in our analysis. We discuss this in Chapter 4 and Technical Appendix C.

Other concerns may be related to how we deal with certain data and measurement issues (e.g., the presence of multiple ICD-10 codes and our ability to capture comorbid conditions, and the type of defense attorney involvement that may help indicate pending compensability issues). These issues and our sensitivity analyses are also discussed in Technical Appendix C.

LIMITATIONS AND CAVEATS

This study provides evidence of a strong association between early PT treatment and lower utilization and costs of medical services and shorter TD duration. The reader should be reminded that a strong association does not necessarily mean causation. As an observational study based on workers' compensation administrative data, this study shares the same limitation as other observational studies on the same topic. Although our analysis provides evidence of a strong association between PT timing and utilization and costs of medical services and TD duration, we cannot assert that we have measured the causal effect of early versus late PT on the outcomes studied. This is because we cannot rule out the possibility that there may be unobserved characteristics of workers that affect both PT timing and outcomes. However, we controlled for a rich set of variables in our statistical analysis to support our findings on the strong association.

Several other limitations should also be noted. First, our study has a relatively narrow focus of LBP-only claims with more than seven days of lost time. The results may not be generalized for other low back conditions and medical-only claims.

Second, we focus on claims with PT treatment (i.e., 3 or more PT visits). There was a high percentage of LBP-only claims that did not receive PT treatment and some only had 1–2 PT visits. There may be several reasons for claims to be in this no-PT group. At one extreme, low back pain experienced by some workers may be resolved within a month and the workers did not need to have PT. At the other extreme, some workers with low back pain could have low back pain so severe that they cannot comply with a full complement of PT services. These workers may have needed additional diagnostics and other treatments. Some of them may also have attorneys involved for various reasons. A separate study could focus on these claims and explore why they had little or no PT treatment.

Third, we identified a small percentage of claims with at least one of the seven comorbidities we defined for low back pain receiving PT treatment. Although small in number, the percentage of claims with comorbidities varied across the PT timing groups and had a significant impact on outcomes. It is reasonable to believe that comorbidities are under-identified in workers' compensation data since those comorbid conditions are normally not covered under workers' compensation. One would need to better understand the extent of understating comorbidities and, more importantly, investigate whether the understatement affects the observed differences across the PT timing groups.

Lastly, we used defense attorney involvement and the number of days from injury to first medical visit to capture possible issues such as pending compensability, delay in injury notice, access to care, and worker's care-

seeking behavior. Although we validated that defense attorney involvement is highly correlated with worker attorney involvement and did a sensitivity analysis, we did not directly observe whether some workers who received PT late had pending compensability issues that prevented them from receiving PT early. The reader should be cautioned when interpreting the results.

3

Descriptive Findings

This chapter describes observations we made regarding patterns of physical therapy services provided for workers with low back pain. It shows an association between early PT treatment and lower utilization and costs of medical services and shorter duration of temporary disability, based on descriptive results. The strength of the association is discussed in Chapter 4, where we apply statistical techniques to control for a number of factors that likely influence the estimated effect of early PT on outcomes. Chapter 3 also describes differences in the characteristics of workers and other factors across the PT timing groups, highlighting the need for further investigation. In this study, we focus on the low back pain claims with more than seven days of lost time that had neither red flag conditions nor nerve involvement recorded in the detailed medical data. We use the term *LBP-only claims* to describe this set of claims throughout the report.[1]

PT Visits and Timing of Initiation

Figure 3.1 shows the frequency of claims by the number of PT visits for the LBP-only claims that received PT services during the first year of treatment, based on the 27-state pooled data.[2]

Among these LBP-only claims with more than seven days of lost time, 24 percent did not have any PT services.[3] Among the same set of claims, 8 percent received PT services but only had 1–2 visits for PT services. A majority of the claims had 3 or more visits for PT services—21 percent had 3–6 PT visits, and 47 percent received longer therapeutic PT treatment (7 or more PT visits).

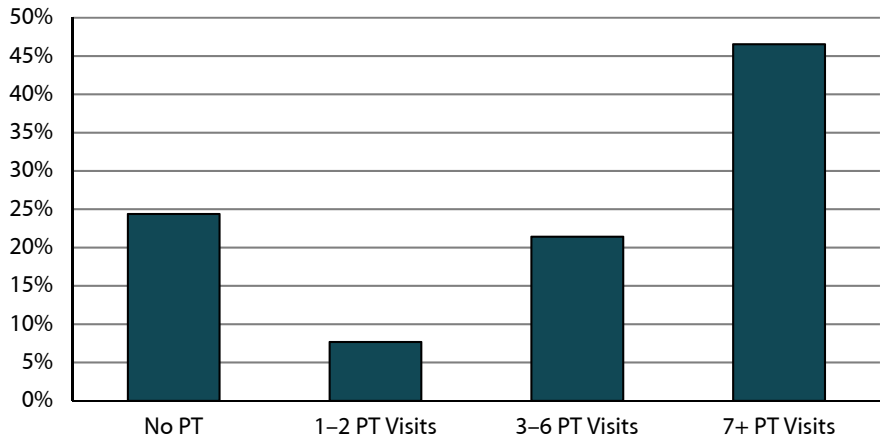
There is large variation across states in the claim frequency of PT visits. Among the 27 states studied, Louisiana and Massachusetts had considerably higher percentages of claims that did not have PT services, while Nevada was on the lower end of the same measure (Table SA.1).

[1] This is a set of claims that have less serious injuries and are clinically homogenous, where PT can be considered as primary treatment. We focused on claims with more than seven days of lost time to make the data more comparable across the 27 states included in the study. See Chapter 2 for a more detailed discussion. The statistical appendix provides results for several key measures, overall and by state for the states that have a large enough number of claims in each of the PT timing groups.

[2] The 27 states are Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and Wisconsin.

[3] These claims had other medical services (e.g., office visits and prescription drugs).

Figure 3.1 Claim Frequency by Number of PT Visits



Notes: Included are 25,955 LBP-only claims with injuries occurring from October 1, 2015, to March 31, 2017, with medical services received during the first year of treatment. These claims had more than seven days of lost time across 27 states.

Key: LBP: low back pain; PT: physical therapy.

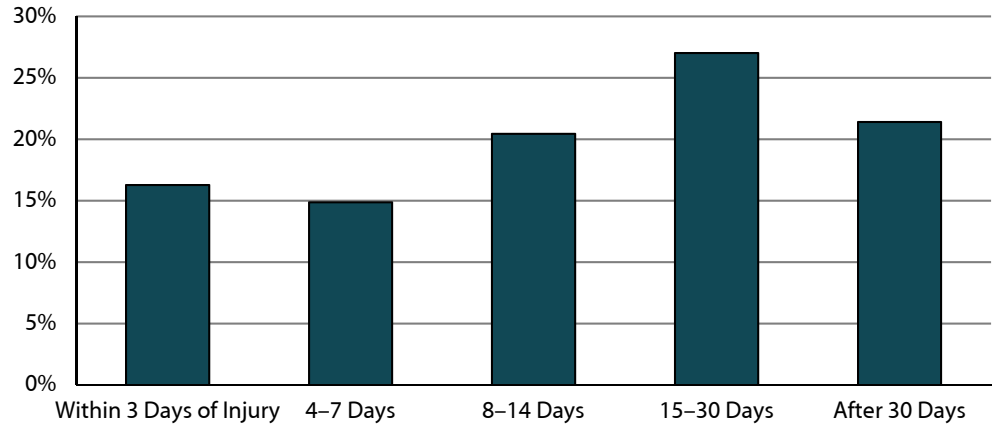
Since the timing of PT treatment is the focus of this study, we defined two important terms used in our report: PT treatment and the timing of PT initiation. By our definition, PT treatment consists of all PT services that were rendered during a PT visit for workers with low back pain who had 3 or more visits for PT services.[4] For PT timing, we defined five categories that are consistent with the definition used in a 2018 study (Liu et al., 2018). Instead of anchoring the PT timing at the first medical visit, we measured PT timing as the number of days from the date of injury to the date of first PT visit. Five categories were designated as PT timing groups in our study: PT treatment that was initiated within 3 days, 4–7 days, 8–14 days, 15–30 days, and after 30 days, from the date of injury. Figure 3.2 provides the percentage of LBP-only claims that received PT treatment by timing of PT initiation, as defined above.

Among the LBP-only claims with more than seven days of lost time that received PT treatment, approximately half of the workers started PT treatment within 14 days after the date of injury (16 percent within 3 days, 15 percent between the 4th and 7th day, and 20 percent between the 8th and 14th day after the date of injury). The results are based on the 27-state pooled data (Figure 3.2).

Among the 27 study states, California and Nevada had considerably higher percentages of claims receiving early PT within 3 days of injury (23 and 28 percent, respectively, compared with 13 percent at the 27-state median). Several other states were also on the higher side of the measure. By contrast, five states had more than 30 percent of claims with PT initiated after 30 days of injury, including Kansas, Louisiana, North Carolina, South Carolina, and Virginia (Table SA.2).

[4] Claims with 1–2 PT visits are not included in this set of claims with PT treatment because when a claim has only 1–2 PT visits, it is likely that the PT visits were for evaluation and assessment. It is also possible that the initial visits were for patient education and instructions as to how to carry out home exercises. Since we cannot separate the claims in these two different scenarios, we decided not to include these claims in the analysis. Chapter 2 has a more detailed discussion.

Figure 3.2 Percentage of Claims by PT Timing Group



Notes: Included are 25,955 LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.

Key: LBP: low back pain; PT: physical therapy.

Since we measure PT timing as the time elapsed from the date of injury to the date of first PT visit, the measure reflects two underlying factors. The time from injury to initial medical attention or first medical service (e.g., first office visit or emergency room visit) may reflect certain issues, for example, pending compensability, delay in injury reporting and insurer notice, and possible delay in case management. The timing of the first medical visit may also reflect certain types of injury (e.g., soft tissue injuries) and specifically how long it takes the worker to realize they have a condition that needs to be treated. The timing from first medical visit to first PT visit would reflect how promptly workers were referred for PT treatment and how fast the PT services were actually delivered. We discuss and provide some results on these measures later in this report.

DESCRIPTIVE RESULTS

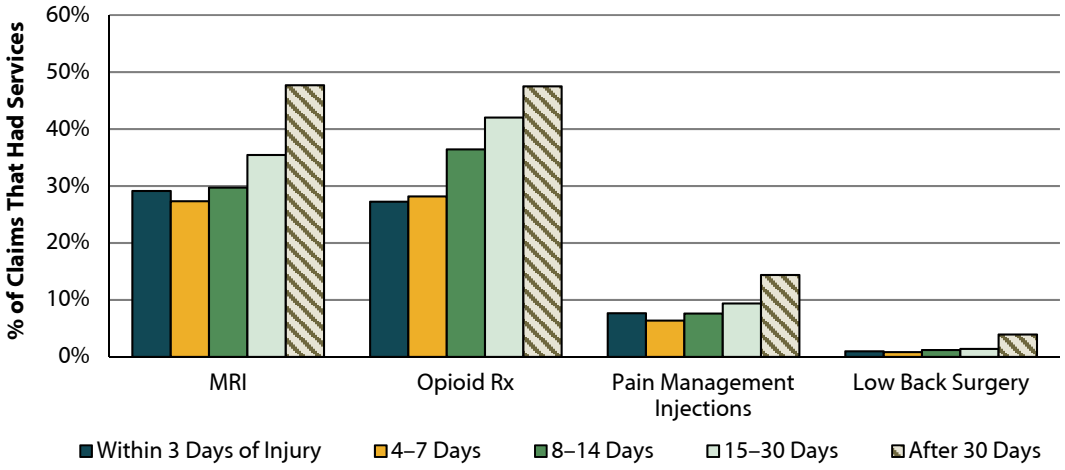
Figure 3.3 shows the percentage of claims receiving certain types of medical services (MRI, opioid prescriptions, pain management injections, and low back surgery) during the first year of treatment, across the five PT timing groups. These are LBP-only claims with more than seven days of lost time that received PT treatment (i.e., 3 or more PT visits).

In general, the data show an increased utilization of medical services and longer TD duration when PT treatment was initiated later, especially for the groups of claims that had PT treatment initiated after 14 days of injury. The percentages were substantially higher for those in the after-30-days group across all four types of medical services (Figure 3.3). Note that the data shown are based on the 27-state pooled data, meaning larger states contribute more observations. We see similar patterns after weighting the data to equalize the influence of individual states due to different sizes (see Technical Appendix C).

In terms of medical costs, Figure 3.4 shows that the average payment per claim for all medical services during the first year of treatment was similar for the within-3-days and 4–7 days groups. The same figure was 43–46 percent higher for claims in the after-30-days group, compared with those in the two early PT groups.

For the group of claims with PT treatment initiated between 8 and 14 days postinjury, the average medical cost per claim was not very different from that of the within-3-days group.[5] The median numbers show a similar pattern.

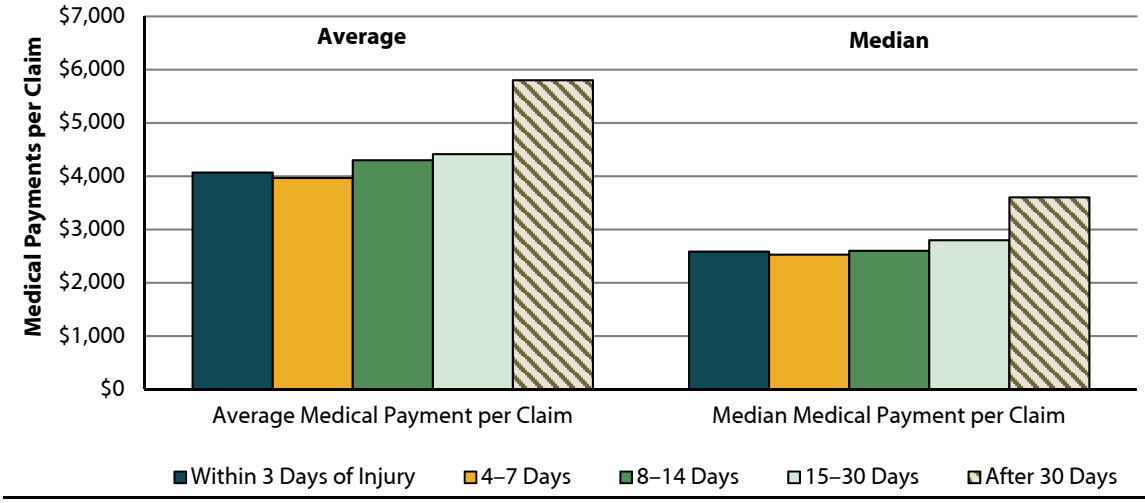
Figure 3.3 Percentage of Claims Receiving MRI, Opioid Rx, Pain Management Injections, and Low Back Surgery, by PT Timing Group



Notes: Included are 25,955 LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.

Key: LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy; Rx: prescriptions.

Figure 3.4 Medical Payments per Claim for all Medical Services by End of First Year, by PT Timing Group



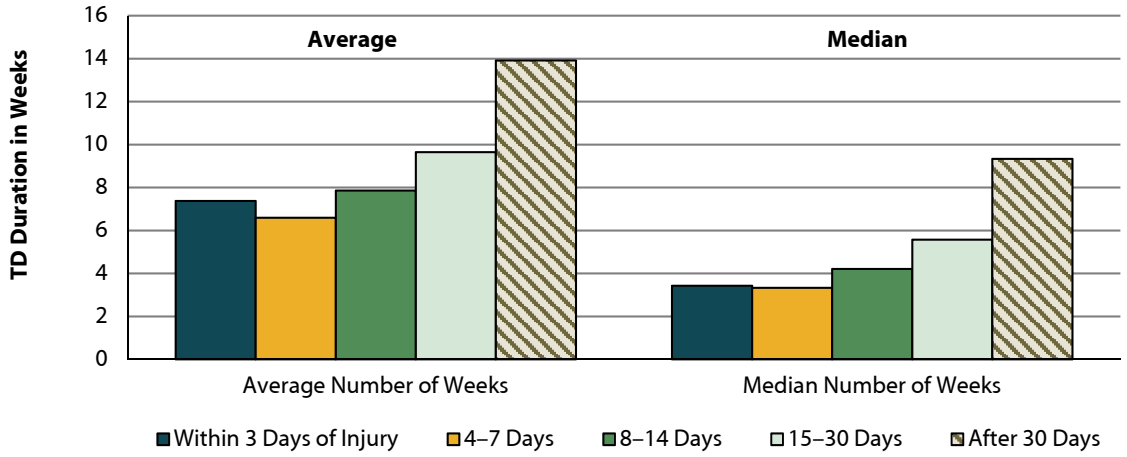
Notes: Included are 25,955 LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.

Key: LBP: low back pain; PT: physical therapy.

[5] The 6 percent difference was not statistically significant at 10 percent.

The impact of PT timing on the duration of TD is also evident based on the descriptive data shown in Figure 3.5. The results suggest a substantially longer TD duration for the workers who received PT treatment after 14 days of injury, compared with the early PT groups (i.e., the within-3-days and 4–7 days groups). This is especially true for the after-30-days group. At 13.9 weeks, the average number of TD weeks per claim for those with PT after 30 days of injury was nearly twice as high as for those that had PT within the first week of injury. The same figure for the 15–30 days group was 9.7 weeks, 31 percent higher than that for the within-3-days group. The middle group (PT in 8–14 days) had a slightly longer TD duration (by 7 percent)[6] than the within-3-days group. The number of TD weeks for typical workers (i.e., the median values of TD duration) across the PT timing groups shows a similar pattern.

Figure 3.5 TD Duration in Weeks per Claim, by PT Timing Group



Notes: Included are 25,955 LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.

Key: LBP: low back pain; PT: physical therapy; TD: temporary disability.

The results on TD duration may reflect, to some extent, differences across the PT timing groups in the mix of states that have different system features influencing TD duration. For example, if proportionally more claims from wage-loss states (e.g., Louisiana, Massachusetts, and Michigan) were in the late PT group, the TD duration could be longer for the average worker in this group.[7] However, within each state, for states with a sufficient sample to support the computation of TD weeks, we see similar trends showing that the earlier initiation of PT treatment is associated with fewer weeks of TD duration (see Table SA.3). Workers with PT treatment initiated after 30 days of injury had a significantly longer TD duration than those in the earlier PT groups.[8]

[6] The difference is small, but statistically significant at 1 percent.

[7] This is because these wage-loss states continue to pay for income benefits as long as the worker is out of work, which is unlike a non-wage-loss state where TD benefits end when the worker reaches maximum medical improvement and shifts to receiving permanent partial disability benefits. We controlled for state-specific factors in our statistical analysis, which is covered in Chapter 4.

[8] We do not report the results for individual states that had fewer than 30 claims in any PT timing category.

Table 3.1 provides descriptive statistics, some of which are underlying data for Figures 3.2 through 3.5. It also includes a number of additional measures in the utilization of other medical services, including PT services, office visits for evaluation and management, and emergency visits. Note that these are descriptive statistics without adjusting for factors that affect the comparability of the claims across PT timing groups, which we will discuss in Chapter 4. We clearly see how each measure progresses across different PT timing groups, and considerable differences are seen between claims in the earlier PT groups (within 3 days, 4–7 days, and 8–14 days) and those in the later PT groups (15–30 days and after 30 days), with the exception of the measures on PT patterns and office visits.[9]

Table 3.1 Descriptive Comparison of Utilization of Medical Services and TD Duration, across PT Timing Groups

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
# of LBP-only claims	2,871	2,621	3,605	4,764	3,776
% of LBP-only claims	16%	15%	20%	27%	21%
PT visits and services					
Number of PT visits by end of first year, mean	12.1	12.2	12.9	13.3	14.0
Number of PT visits by end of first year, median	9	9	9	10	11
% of claims that had > 18 visits for PT services	17%	17%	19%	20%	23%
Average ratio of active versus passive therapy services	3.4	3.6	3.1	3.0	2.9
Time to initial visits, emergency, and office visits for E&M					
Days from injury to first medical visit, mean	2	3	4	6	18
Days from injury to first medical visit, median	1	2	2	3	5
% of claims that had emergency visits	12%	18%	22%	22%	24%
Number of office visits for E&M by end of first year, mean	8	7	7	7	8
Utilization of medical services during the first year of treatment					
% of claims that had MRI	29.1%	27.3%	29.7%	35.4%	47.7%
% of claims that received opioid prescriptions	27.2%	28.2%	36.4%	42.0%	47.5%
% of claims that had pain management injections	7.7%	6.4%	7.6%	9.4%	14.4%
% of claims that had low back surgery	1.0%	0.8%	1.2%	1.4%	3.9%
Medical payments per claim for all medical services rendered during the first year of treatment, mean	$4,069	$3,967	$4,299	$4,414	$5,802
Medical payments per claim for all medical services rendered during the first year of treatment, median	$2,585	$2,528	$2,599	$2,798	$3,603
TD duration by one year after injury					
Number of TD weeks by end of first year, mean	7.4	6.6	7.9	9.7	13.9
Number of TD weeks by end of first year, median	3.4	3.3	4.2	5.6	9.3
Duration of medical treatment by one year after injury					
Number of days for medical treatment during the first year, mean	102	95	109	131	182
Number of days for medical treatment during the first year, median	50	47	59	85	155

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. See Chapter 2 for our definition of LBP-only claims and a list of the 27 states.

Key: E&M: evaluation and management; LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy; TD: temporary disability.

[9] In Chapter 4, we present the adjusted results with statistical significance.

Table 3.1 shows that the utilization patterns of PT services did not vary substantially with the timing of first PT visit. The average number of PT visits was slightly lower among the LBP-only claims with PT treatment initiated earlier. The average number of PT visits was 12.1 per claim for the within-3-days group and 14.0 for those that started PT treatment after 30 days postinjury.[10] Note that a significant percentage of claims had more than 18 PT visits during the first year of treatment—23 percent in the after-30-days group, 5 percentage points higher than that for the two early PT groups. Clinically, we would expect to see PT treatments that are normally prescribed as 2–3 visits per week for 4–6 weeks. The percentages on the 18 PT visits suggest that at least one in five workers with LBP-only conditions had at least 2 visits every week for 9 weeks or 3 visits per week for 6 weeks.[11] Also note that the claims with earlier PT initiation (within the first week) received somewhat more active PT services relative to passive PT services—the average active-passive ratio was 3.4 and 3.6 for claims with PT within 7 days postinjury, and the same figure was 2.9–3.1 for those with PT initiated after 14 days postinjury.[12] We see no significant difference in the number of office visits for evaluation and management across different PT timing groups.

For MRI, opioid prescriptions, pain management injections, and low back surgery, the utilization patterns are clearly correlated with the timing of PT initiation. Claims with PT treatment initiated within the first week of injury tended to have a lower utilization of these services (Table 3.1). For workers with only low back pain who started PT treatment after 30 days postinjury, 47.7 percent had MRI, 47.5 percent received opioid prescriptions, 14.4 percent had pain management injections, and nearly 3.9 percent had low back surgeries, during the first year of treatment. These numbers were more than 50 percent higher to triple those of the same measures for claims with PT within the first week of injury. Similar patterns are seen for medical costs and TD duration. The average medical payment per claim for all medical services during the first year of treatment was $5,802 per claim for those with PT initiated after 30 days postinjury, compared with $4,069 per claim for the within-3-days group and $3,967 per claim for the 4–7 days group. The average worker had 13.9 weeks of temporary disability if their PT treatment started after 30 days postinjury, and the number was 9.7 weeks for those with PT between 15 and 30 days postinjury. By contrast, the same figure was 7.4 and 6.6 weeks for average workers who started PT treatment within 7 days postinjury. Note that the claims in the 4–7 days group had slightly lower utilization and costs of medical services and shorter TD duration than claims in the within-3-days group. We do not know exactly why this was the case, but it might have to do with the mix of cases and providers who had different practice patterns.[13]

Since a significant percentage of LBP-only claims did not have PT treatment or had 1–2 PT visits, the reader may want to compare the utilization and costs of medical services and other measures across the whole continuum of care. In this report, we focus on the impact of early PT timing on outcomes based on claims with PT treatment (i.e., 3 or more PT visits), but we provide some statistics for the set of claims we studied across the PT continuum in the statistical appendix (Table SA.4).

One may be concerned about the comparability of the claims across different PT timing groups. It is possible that some of the workers who had later PT treatment had relatively more serious low back pain and/or had certain comorbidities, compared with those who were treated earlier. It is also possible that some of these

[10] Although the difference is statistically significant at the 1 percent level, the size of the difference is small.

[11] Several states had rules limiting PT visits, including California, Kansas, Louisiana, North Carolina, and Tennessee (Rothkin and Tanabe, 2018).

[12] The difference is statistically significant at the 10 percent level.

[13] The adjusted results after we controlled for various factors also show a similar pattern, but the differences are not statistically significant between the within-3-days and 4–7 days groups. See Chapter 4 for more details.

workers in the late PT group encountered certain issues in the claims administration process, including questions about whether the claim is compensable. Conceivably, more complicated clinical conditions and compensability issues could delay medical treatment and lead to worse outcomes. Not surprisingly, those whose medical attention was delayed had their PT treatment later—the average number of days from injury to the first medical service was 18 days for the claims in the PT after-30-days group compared with 2–6 days for those in the earlier PT groups (Table 3.1). For this late PT group, the much higher average number (18 days compared with a median value of 5 days) may suggest several scenarios. First, some claims with underlying pending compensability issues may contribute to the much higher average waiting time, preventing workers from seeking medical care early. This may be a primary reason, especially when a delayed initial medical visit was coupled with a higher percentage of claims with attorney involvement (27 percent of the claims in the after-30-days group versus 13–14 percent in the two early PT groups). Second, late injury and/or insurer notice may also have the effect of delaying medical care. Third, some workers might wait to see if their LBP conditions might resolve before seeking care. We believe that severity and comorbidities could be of secondary importance since the claims included in our analysis were for workers with low back pain that had neither red flag nor nerve involvement, a set of clinically homogenous cases specified by most treatment guidelines. For this relatively homogenous set of claims, we do not expect to see substantial variation in the level of medical severity across the PT timing groups. Nonetheless, we address these valid concerns in Chapter 4, which examines the strength of the association between PT timing and outcomes by controlling for a number of factors that might affect that association.

CHARACTERISTICS OF CLAIMS ACROSS PT TIMING GROUPS

Since many factors may influence the timing of PT treatment as well as outcomes, whether the claims in early versus late PT groups are comparable is a valid concern. We provide a series of tables in this section to help better understand the similarities and differences, across the five PT timing groups, in the injury and claim characteristics of workers (Tables 3.2 and 3.5), health care delivery settings (Table 3.3), and medical services workers received prior to PT treatment (Table 3.4). Note that these are descriptive statistics. Examining key factors associated with receiving early versus late PT requires a statistical analysis that takes into account various patient and provider factors, state policies, and the organizational structure of health care delivery.

Table 3.2 suggests that workers in the earlier PT groups tended to be male, higher-wage workers who had slightly longer tenure with their preinjury employers. Industry may make some difference since proportionally fewer workers in the earlier PT groups were in manufacturing and construction industries and more were in high-risk industries.

Table 3.2 Claim and Injury Characteristics, by PT Timing Group

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
# of LBP-only claims	2,871	2,621	3,605	4,764	3,776
% of LBP-only claims	16%	15%	20%	27%	21%
Worker characteristics					
Age, mean	41.2	41.9	42.0	41.8	42.2
Age, median	41.0	42.0	42.0	41.0	42.0
% female workers	31%	37%	40%	41%	43%
% married	28%	29%	31%	29%	28%
Preinjury average weekly wage, mean	$809	$813	$784	$763	$721
Tenure with preinjury employer in years, mean	6.8	6.4	6.8	6.4	6.0
% of workers by industry					
Manufacturing	9%	8%	9%	10%	11%
Construction	5%	6%	5%	6%	8%
Clerical and professional	6%	6%	7%	8%	6%
High-risk industry	35%	36%	33%	31%	30%
Trade	19%	17%	18%	18%	20%
Low-risk industry	14%	15%	16%	16%	15%
Other industry	11%	11%	11%	10%	9%
Missing	1%	1%	1%	1%	1%
Attorney involvement					
% of claims with defense attorney involvement	14%	13%	15%	17%	27%

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. See Chapter 2 for our definition of LBP-only claims and a list of the 27 states.

Key: LBP: low back pain; PT: physical therapy; TD: temporary disability.

In our data of LBP-only claims with more than seven days of lost time, the average age of workers was quite similar across the PT timing groups at 41–42 years. Later PT groups tended to have proportionally more female workers. For example, the after-30-days group had 43 percent female workers, compared with 31 percent in the within-3-days group. Workers' average weekly wage was also higher on average in the earlier PT groups than in the later PT groups, which may in part be associated with level of education and occupation, among other things. Workers in the within-3-days group tended to have slightly longer tenure with their preinjury employers, compared with those who had PT treatment initiated after 30 days of injury.

With an increasing trend of vertical integration in the health care market, many system practitioners agreed that having the treating physician and PT providers in a clinically integrated setting makes a difference in terms of PT referral and timeliness of receiving PT treatment. This integrated setting may have two different structures: (1) the treating physician and the physical therapist work in the same clinic or medical center so that the PT treatment is provided in house; or (2) both the treating physician and the physical therapist are affiliated with the same health care organization as one billing entity. In the latter case, even if PT services are not provided in the same building, the practice pattern would be similar across providers within the organization, especially for those that have organization-level treatment protocols. Conceivably, many clinics or medical centers that treat workers have organization-level protocols for PT referrals, which creates an environment that helps patients to quickly access PT services. We were motivated to capture this type of health

care delivery setting by developing an algorithm that identifies what we call *same-billing-entity* health care providers.[14] It is worth noting that the way we identify same-billing-entity providers does not differentiate those health care organizations that are clinically integrated primarily for the goal of promoting quality care from those that are integrated financially for the primary purpose of generating self-referrals and additional income.

Table 3.3 provides data that compare the prevalence of same-billing-entity PT treatment across the five PT timing groups. There is a clear trend that more workers in the early PT groups had PT treatment within the same health care organization, compared with those in the later PT timing groups. Among LBP-only claims with more than seven days of lost time that had PT treatment within the first 3 days postinjury, 72 percent received their PT treatment from physical therapists who were affiliated with the same health care organization as the referring physicians. By contrast, 22 percent of workers who started their PT treatment after 30 days postinjury saw physical therapists in the same health care organization.

Table 3.3 Patterns of PT Referrals and Care Setting and Number of Days from Injury to Medical Care and to PT Treatment, by PT Timing Group

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
% of claims where PT treatment and pre-PT office visit were rendered by providers of the same-billing-entity organization	72%	56%	37%	24%	22%
% of claims with no office visits preceding PT treatment (i.e., direct PT)	3%	4%	5%	5%	6%
Number of days from injury to first medical visit, mean	2	3	4	6	18
Number of days from injury to first medical visit, median	1	2	2	3	5
Number of days from first medical visit to first visit for PT treatment, mean	1	4	8	17	51
Number of days from first medical visit to first visit for PT treatment, median	1	4	8	17	38

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. See Chapter 2 for our definition of LBP-only claims and a list of the 27 states.

Key: LBP: low back pain; PT: physical therapy; TD: temporary disability.

It is conceivable that providers affiliated with these clinically and/or financially integrated organizations may refer the patient for PT treatment sooner than providers who do not have such affiliations.[15] This may happen for two competing reasons: (1) same-billing-entity provider networks may have treatment protocols aimed at improving care, and (2) in some circumstances, same billing entities financially integrated in response

[14] The algorithm compares the unique provider IDs (i.e., encrypted tax ID in this case) between the providers who provided PT services and the providers who provided office visits prior to PT treatment. If the PT provider and the office visit provider for a claim had the same unique ID, we consider the claim as having same-billing-entity PT treatment, which may be in-house PT or PT treatment within the same health care organization. See Chapter 2 for a more detailed discussion.

[15] PT referral may also be the result of a provider's medical decision making, which reflects their specialty training and their perception of the patient's need for physical therapy. It may also be influenced by the availability of PT facilities, which may not be a serious concern given the wide availability of PT service providers.

to economic incentives may have a high rate of self-referrals for PT. [16] Without a rigorous analysis and additional data, one cannot isolate the effect of these two different types of PT referrals. Note that there was a small percentage (3–6 percent) of claims where the worker had PT treatment without an office visit, which could be the result of direct PT that we expect to see in the states that allow patients to receive PT treatment without physician referrals.

Table 3.3 also shows, for each PT timing group, how long it took for an average worker to see a medical provider initially and how long it took from the initial visit to the first PT visit. The results suggest two areas of issues that might have delayed PT treatments. For medical care, the average number of days from injury to the first medical service was 18 in the delayed PT group, compared with 2–3 days in the early PT group. The median value for the after-30-days group was 5 days. The large difference between the mean and median values indicates that there was a set of cases with a big delay in seeing the first medical provider. The results suggest that some workers in the late PT group might have issues—such as pending compensability, [17] delayed notice of injury, and access to initial providers—that caused the delay in seeing medical providers.

The second area of issues is related to PT referrals and initiation. As Table 3.3 shows, the average worker in the after-30-days group took 51 days to have PT treatment initiated. The same figure is 17 days for those in the 15–30 days group. Once the worker had an initial visit to a medical provider, a longer wait from the first medical visit to the first PT service may be for several reasons. First, it may reflect differences in provider practice in that some providers may have waited to see if the worker's condition got better before ordering PT, while others may have ordered PT early. Differences in provider practice may also be reflected in different patterns of ordering early imaging studies, surgical referrals, opioid prescribing, patient education, and other pain management strategies. Second, if the worker has an untreated comorbidity, they may need some time to address the underlying comorbid condition before receiving PT treatment. Third, it may take a longer time for a worker to start PT treatment for various reasons,[18] even if the provider ordered PT early. In addition, it is also possible, although should be infrequent, that some workers might have more serious low back pain that needs to be addressed prior to PT referral, but the severe condition was not reflected in the data based on the ICD-10 coding. For these workers, a different path should be followed, including diagnostic testing and specialist consultations. Future studies should investigate key factors that influence PT referrals and timing of PT initiation taking into account patient and provider factors, relevant state policies, and the structure of health care delivery.

Table 3.4 provides data on the utilization of medical services prior to PT treatment. The pattern of use of these services may partially reflect the severity of cases where the services were necessary. It may also reflect

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[16] We did not see clear evidence that same-billing-entity providers are associated with better outcomes. In our statistical analysis, we see that the same billing entities tend to be associated with a higher utilization of MRI and a higher rate of opioid prescribing, with little or no effect on rate of injections and surgery as well as medical costs and TD duration (see Technical Appendix C).

[17] Pending compensability issues often have an effect of delaying care. Workers with pending compensability issues would be more likely to be in a later PT group in our data. This may happen in most workers' compensation jurisdictions except those with pay-without-prejudice. For example, Massachusetts requires 180 days of pay-without-prejudice where workers receive medical and indemnity benefits without the insurer accepting liability. Benefits may or may not terminate after 180 days depending on whether the insurer accepts liability based on compensability rules. Another example is California where the state mandates that up to $10,000 be paid while compensability decisions are pending. Note that it is also possible that medical care was delayed if a worker had a comorbid condition and received treatment that was not paid under workers' compensation and therefore not captured in our data. This may or may not be due to compensability issues.

[18] For example, the worker might not have quick access to a PT facility or might not have the social support needed to attend prescribed PT sessions.

different provider practice patterns. As Table 3.4 shows, proportionally fewer claims in the early PT groups had these medical services prior to PT treatment. Seven percent of cases had emergency visits before PT among those who had PT within 3 days of injury. Among those who had PT initiated after the first week, the emergency visit rate ranged from 20 to 22 percent. We do not consider pre-PT emergency visits as a severity marker because it may partially reflect different levels of access to health care and partially be subjective as some patients believe their level of pain warrants an emergency visit.

Table 3.4 Pre-PT Utilization of Medical Services, by PT Timing Group

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
% of claims that had an emergency visit before PT treatment	7.0%	16.2%	20.1%	20.6%	22.0%
Number of office visits for E&M before PT treatment, mean	1.0	1.2	1.7	2.4	3.4
Number of office visits for E&M before PT treatment, median	1.0	1.0	2.0	2.0	3.0
% of claims that had MRI before PT treatment	0.1%	0.3%	1.2%	4.7%	18.2%
% of claims that received opioid Rx before PT treatment	15.4%	20.4%	28.1%	35.4%	39.3%
% of claims that had pain management injections before PT treatment	0.0%	0.0%	0.1%	0.5%	2.0%
% of claims that had low back surgery before PT treatment	0.0%	0.0%	0.0%	0.0%	0.8%

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. See Chapter 2 for our definition of LBP-only claims and a list of the 27 states.

Key: E&M: evaluation and management; LBP: low back pain; PT: physical therapy; Rx: prescriptions.

More office visits prior to PT treatment could mean several things. It could be that a doctor saw a patient without referring the patient for PT treatment until a later visit, which reflects a "watchful waiting" approach recommended by some clinical guidelines. It could also be that a patient had some form of testing between the visits in an effort to identify the patient's diagnosis. For the PT after-30-days group, 3 visits is consistent with clinical observations, according to a reviewer of the report. It usually takes 2–3 visits to recognize delayed recovery risk factors for low back pain in an occupational health setting, and if these factors could be recognized by the second visit, the worker would likely receive PT earlier.

The after-30-days group had a higher rate of pain management injections and low back surgeries, compared with the earlier PT timing groups. This may suggest that workers with these pre-PT medical procedures had more serious low back pain than those who had PT at earlier times, and they needed more medical attention before PT treatment.[19]

It is also evident that the receipt of MRI and opioid prescriptions was much higher in the later PT timing groups. Table 3.4 shows that 18.2 percent of the claims in the after-30-days group had MRI prior to PT treatment while 0.1–0.3 percent of those with PT within 7 days had pre-PT MRI. For those receiving pre-PT MRI, the imaging study was likely to be the main reason for the delay in PT treatment. In some cases, this could mean that the workers who had pre-PT MRI had more serious low back pain, but ordering MRI could also be

[19] We used pre-PT pain management injections and low back surgery as proxies for injury severity, and we controlled for these factors in our statistical analysis in Chapter 4.

due to provider practice patterns. Because of this, the receipt of pre-PT MRI is not necessarily an indicator for severity. The same argument holds true for the higher percentage of workers in the late PT timing group who received opioid prescriptions compared with those in the earlier PT groups (Table 3.4).

Differences in the prevalence of comorbidities also may compromise the comparability of the claims across the PT timing groups. Table 3.5 shows the percentage of claims in each of the PT timing groups that were identified as having a comorbidity in our data. The identification of the comorbidities was based on an ICD-10 list we established after reviewing the ICD-10 codes and the two widely used comorbidity indexes that are based on ICD-9 or ICD-10 codes (i.e., the Charles Comorbidity Index and the Elixhauser Comorbidity Index). On the ICD-10 list we established, there are nine categories including alcohol or drug abuse, chronic pain and symptoms (within the first three months after injury), diabetes, hypertension, family history of chronic and mental health issues, obesity, psychosocial issues, and smoking. For this study, we do not consider hypertension and family history of chronic and mental health issues as comorbidities for LBP-only claims with PT treatment, and very few claims had lifestyle issues (e.g., lack of physical activity) recorded in the data. The identification and groupings of ICD-10 comorbidities are discussed in Chapter 2.

Table 3.5 Percentage of Claims Identified as Having a Comorbidity, by PT Timing Group

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
Number of LBP-only claims	2,871	2,621	3,605	4,764	3,776
% of LBP-only claims	16%	15%	20%	27%	21%
% of claims with the following identified comorbidity					
Alcohol or drug abuse	0.2%	0.2%	0.3%	0.4%	0.3%
Chronic pain or symptoms within first 3 months	0.7%	0.7%	1.1%	1.1%	1.8%
Diabetes	0.7%	1.1%	1.2%	1.2%	1.7%
Obesity	0.9%	1.0%	1.3%	1.1%	2.0%
Psychosocial issues	0.7%	0.7%	1.7%	1.4%	1.9%
Smoking	0.1%	0.2%	0.7%	0.4%	0.7%
At least one of the above comorbid conditions	2.9%	3.8%	5.7%	5.3%	7.5%

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. See Chapter 2 for our definition of LBP-only claims and a list of the 27 states.

Key: LBP: low back pain; PT: physical therapy.

As Table 3.5 shows, the prevalence of comorbidities was low among the LBP-only claims. However, the data show considerable variation in the same measure across the five PT groups, with the claims in the after-30-days group having higher percentages. Among the claims in the PT after-30-days group, 1.8 percent were identified as having chronic pain and symptoms within the initial three months,[20] 1.7 percent had diabetes, 2.0 percent had obesity, and 1.9 percent had psychosocial issues. These figures are double or triple those for the

[20] Note that chronic pain and symptoms is the only comorbidity category to which we applied the three-month cutoff. When we looked at claims with ICD-10 codes indicating chronic pain and symptoms during the first year of treatment, the percentage was from 1.8 to 5.3 percent across the five PT timing groups. However, we do not use this to identify claims with chronic pain as a comorbidity because such a diagnosis, if present later than 90 days after injury, would be most likely an outcome rather than a comorbidity.

claims in the earlier PT groups. Clinically, patients with psychosocial issues should be referred for PT earlier, especially for those with more than one psychosocial issue. The trend shown in Table 3.5 likely reflects provider practice. Claims having any of the seven comorbidities accounted for 7.5 percent in the after-30-days PT group and 2.9 percent in the within-3-days group. Note that the percentage of claims with any comorbidity for the after-30-days group was significantly higher than that for the other four PT groups. The percentage for the 15–30 days group was also significantly higher than that for the within-3-days and 4–7 days groups. For the 8–14 days group, the same figure was higher than that for the 15–30 days group, but the difference is not statistically significant.

In all, we observed increased utilization and costs of medical services when PT treatments were provided later than 14 days postinjury, especially for the group of workers whose PT treatment started after 30 days postinjury. Later PT treatments were also correlated with a longer duration of temporary disability. However, our data also show that the claims in the earlier PT timing groups are significantly different from those in the late PT group (the 15–30 days and after-30-days groups) in a number of variables we have on worker and injury characteristics and other factors. It is important to understand what factors are important in influencing PT timing and outcomes and find a way to adjust for them so that the comparisons of these cost and utilization measures and TD duration across the PT timing groups are "apples-to-apples."

4

FINDINGS FROM STATISTICAL ANALYSIS

In the previous chapter, we provided the descriptive data suggesting that early PT treatment may be associated with a lower utilization of medical services, lower medical costs, and shorter TD duration. We also illustrated considerable differences across the PT timing groups in a number of covariates and underlying factors, including gender, wage, tenure with preinjury employers, pre-PT use of medical services, and frequency of identified comorbidities, as well as attorney involvement and time to first medical visits. The reader may question the results in Chapter 3 since they were not adjusted for possible factors affecting the comparability of the results across different PT timing groups.

This chapter describes our statistical analysis that examined the strength of the association between the timing of PT initiation and outcomes of interest. Based on our statistical analysis, we found that the differences in the utilization and costs of medical services and TD duration (presented in Chapter 3) across the PT timing groups were reduced after we controlled for a rich set of factors that may affect those outcome variables, but early PT timing remained significantly associated with lower utilization of medical services, lower overall medical costs per claim, and shorter duration of temporary disability. We discuss factors that likely affect the estimated effect of early PT on the outcome measures we studied and present the results from our statistical analysis. At the end of this chapter, we summarize the key findings of this study.

FACTORS INFLUENCING PT REFERRAL/TIMING AND OUTCOMES

Table 4.1 lists all the key factors we considered and the statistical models we tested in our analysis.

There are several important characteristics of workers that may influence the treatment they received and timing of receiving it. These include worker age, gender, industry/occupation,[1] and level of education, which may be partially reflected in wages, relationships, and social support (e.g., marital status, tenure with preinjury employer, and firm size). These characteristics may also influence workers' perception and behavioral response to the health care they receive. For example, older workers may be more likely to have other coexisting conditions and certain services may be considered appropriate prior to PT treatment.[2] Older workers may take a longer time to recover. As a result, duration of treatment and temporary disability may be extended. As to industry and occupation, a worker who needs to lift 70 pounds at work would probably have a longer period of treatment and return to work later, compared with someone with an identical injury but who works at a professional job. For social support, if the worker is married or has a longer tenure with the preinjury employer,

[1] Occupation is one of the key factors influencing clinical decisions, recovery, and return to work. Without directly observing workers' occupation, we used WCRI's industry grouping to capture some of the differences in workers' occupation.

[2] In fact, most treatment guidelines recommend early imaging to rule out cancer if the patient is older than 50 years.

this may imply better social support to help with the treatment and recovery. We adjust these individual factors in our statistical analysis to see by how much these factors may account for the differences in the outcomes (or, technically, by how much these factors may bias the estimated effect of early versus late PT timing on utilization and TD duration).

Table 4.1 Controlling Factors Affecting the Estimated Effect of Early versus Late PT Timing

	Model 1	Model 2	Model 3	Model 4	Model 5
Characteristics of workers and claims					
Age		X	X	X	X
Gender		X	X	X	X
Marital status		X	X	X	X
Average weekly wage		X	X	X	X
Tenure with preinjury employer		X	X	X	X
Industry group		X	X	X	X
Firm size		X	X	X	X
State-specific factors (including state policies and other environmental factors)		X	X	X	X
Attorney involvement		X	X	X	X
Days from injury to first medical visit		X	X	X	X
Indicators for severity and comorbidities					
Did the worker receive pre-PT injections or surgery (used as a proxy for severity)			X	X	X
Did the worker have any comorbidities recorded in the detailed medical transactions (used as a comorbidity indicator)			X	X	X
PT referring pattern and care setting					
Internal PT referral (i.e., same-billing-entity PT)				X	X
Direct PT				X	X
External county-level data					
Rural versus urban area					X
Physical activity level (i.e., prevalence of physical activity)					X
Unemployment rate					X
Provider supply (# of PTs per 100,000 population)					X

Notes: The grouping of the variables and the order in which the groups of variables were introduced to our statistical analysis were guided by a framework we established that made clinical and practical sense. We did not rely on the R squares to determine inclusion of difference variables. We also tried a step-wise approach at an early stage of the study to see what might work in terms of grouping and inclusion of the variables, but that exercise did not provide us with a useful guide.

Key: LBP: low back pain; PT: physical therapy.

Differences in injury severity and comorbidities are also important factors influencing speed of recovery and medical decision making as to what treatments and tests would be needed. One may have concerns that although severity and comorbidity may be correlated with some of the case-mix variables (e.g., worker age, gender, and industry/occupation), controlling only for those case-mix variables may not be enough to adjust away the difference caused by these underlying factors. For severity, we used pre-PT utilization of injections

and surgery as a proxy.[3] This is in addition to the relatively homogenous set of claims we selected for the study.[4] For comorbidities, we established a list of ICD-10 comorbidity codes and identified claims that had at least one of the comorbidity codes. This comorbidity indicator was included in our statistical analysis to at least partially control for the impact of comorbidities on the estimated effect of PT timing.[5] We also controlled for attorney involvement and time to first medical visit. These variables may in part be reflective of several possible underlying issues, including pending compensability, delayed notice of injury to employers and insurers, and access to providers for initial visits. It is also possible that some workers did not seek care until a later time. Several county-level variables were also considered in our analysis, including rural versus urban area, level of physical activity, unemployment rate, and availability of PT providers. Table 4.1 describes different model specifications based on several groups of variables, starting with a basic unadjusted model to a full model with all the factors we measure.

Differences in state policies may also affect timing of PT initiation and outcomes. For example, states with employer choice of medical provider may have more provider networks and large clinics or medical centers that treat workers with injuries. These large health care organizations may have different practice patterns, compared with providers that have a limited focus on workers' compensation health care, which has implications for health services utilization and outcomes. Different benefit structures for temporary disability may also affect timing of medical care and return to work. We adjusted the data to mitigate the impact of differences in state policies and other state-specific factors by controlling for state fixed effects, that is, by including state dummies in the regressions to absorb the state-level differences so that the PT timing variables are more likely to reflect the effect of different timing. We also controlled for same-billing-entity PT to capture differences in the delivery of PT services and organization-level protocols. This was measured in the way we described in the previous chapter.

Several external data sources provide county-level data that help characterize certain contextual factors. We used the International Health Metrics and Evaluation data to control for level of physical activity at the county level.[6] We also controlled for the potential impact of rural versus urban areas, unemployment rate, and availability of providers.[7]

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[3] Unlike MRI, opioid prescriptions, emergency visits, and office visits, injections and surgery are invasive procedures. If provided, they could be a marker for injury severity. See Chapter 2 for a more detailed discussion.

[4] Our study sample includes only claims with more than seven days of lost time that had LBP diagnoses but did not have red flag conditions or nerve involvement. This set of claims are clinically homogeneous and few of them had services indicated for severe low back pain. However, the residual variation in the level of pain and severity may affect the estimation of the early PT effect. We used the utilization of certain medical services prior to PT treatment as an indicator for severity. Chapter 2 provides more details.

[5] Since treatment of comorbidities is normally not covered by workers' compensation, we do not expect that the workers' compensation data would systematically record comorbidities for workers. However, we do see claims that have detailed medical transaction data with ICD-10 codes for some specific comorbidities, especially in the detailed medical data that had multiple ICD-10 codes recorded. This encouraged us to establish an ICD-10 list of comorbidities and conduct a sensitivity analysis, which is described in Technical Appendix C.

[6] The IHME Global Heath Data Exchange (GHDx) provides a wide range of data collected including surveys, censuses, vital statistics, and other health-related data, available at http://ghdx.healthdata.org/.

[7] The Health Resources and Services Administration (HRSA), an agency of the U.S. Department of Health and Human Services, provides health care data on health care professions, health facilities, population characteristics, and other health-related data at the county, state, and national levels. They are available at https://data.hrsa.gov/topics/health-workforce/ahrf.

IMPACT OF EARLY PT ON UTILIZATION AND COSTS OF MEDICAL SERVICES AND TD DURATION

For the statistical analysis, we used logistic regressions for the dichotomous utilization variables on the likelihood of receiving MRI, opioid prescriptions, pain management injections, and low back surgery. For medical payments and TD duration, we used OLS with log transformation.[8] The statistical analysis was focused on estimating the average treatment effect by keeping the within-3-days group as a reference and using the dummy variables for the other four PT timing groups in the equation.[9] For simplicity, we present and interpret the results from our statistical analysis based on predicted values of the outcome variables, adjusting for differences across the PT timing groups in the variables we control for. In other words, we computed each outcome measure based on the estimated effect of PT timings as if each PT timing group had the same claim characteristics. Tables 4.2 through 4.7 provide the results in the order of increasing inclusion of control variables as specified in Table 4.1.

The top halves of the tables provide the adjusted results (that is, results holding the controls constant) for each PT timing group. Since the adjusted values for the within-3-days group are slightly different with different model specifications, we indexed the results against the adjusted values for the PT within-3-days group, which is the ratio between the adjusted value of the group and that of the within-3-days group. By doing so, we show comparatively how each set of controls of the covariates and confounding factors may change the results on the impact of early PT on the outcomes. We present these numbers in the bottom half of the tables. For example, Table 4.5 shows that the full model had 1.89 for the after-30-days group, which means that the surgery rate for claims in the late PT group was 89 percent higher than for the within-3-days group. The same ratio was 3.72 when there was no adjustment for the data.

We summarize the key findings for each outcome variable on the following pages.

[8] For the analysis that involves county-level external data for contextual variables, we also tried to use multilevel regression to capture cross-county geographic variation and variation across individuals within the same county.

[9] We tested a possible non-linear relationship between PT timing and outcomes using a quadratic form of the number of days from injury to first PT, and we did not see evidence suggesting a non-linear response. We also explored the variable treatment effect, which we discuss in the summary section of this chapter.

- MRI: Without adjusting for any underlying variables, the workers in the PT after-30-days group were 66 percent more likely to receive MRI than those in the PT within-3-days group (Table 4.2). The same figure was 24 percent for the cases in the 15–30 days group. The differences are statistically significant at the 1 percent level. For the three PT timing groups within 14 days of injury, the difference in the percentage of claims with MRI was not statistically significant across the three groups. After adjusting for a rich set of variables, the gap between the later PT groups (15–30 days and after 30 days postinjury) and the within-3-days group was smaller—47 percent higher for the after-30-days group (reduced from 66 percent higher) and 20 percent higher for the 15–30 days group (reduced from 24 percent higher), still statistically significant at the 1 percent level.

Table 4.2 Percentage of Claims Receiving MRI—Estimated Results by PT Timing

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days*	15–30 Days	After 30 Days
% of LBP-only claims that received MRI, by PT timing, 7DLT claims with PT treatment					
Unadjusted (model 1)	28.8%	27.4%	29.9%	35.6%	47.7%
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	29.9%	29.7%	31.3%	35.3%	44.1%
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	30.2%	29.9%	31.3%	35.4%	43.7%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	29.4%	29.5%	31.3%	35.7%	44.1%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	30.0%	30.0%	31.9%	36.2%	44.2%
Use of MRI across PT timing groups, indexed to the use of MRI for the within-3-days group					
Unadjusted (model 1)	1.00	0.95	1.04	1.24***	1.66***
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	1.00	0.99	1.05	1.18***	1.48***
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	1.00	0.99	1.04	1.17***	1.45***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	1.00	1.00	1.06*	1.21***	1.50***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	1.00	1.00	1.06*	1.20***	1.47***

Notes: Included in the analysis are LBP-only claims with more than seven days of lost time. These claims had injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the adjusted results holding constant the variables included in each model corresponding to the models listed in Table 4.1. The numbers presented in the bottom half of the table are the results indexed against the adjusted values for the PT within-3-days group.

The adjusted results are statistically significant at 1 percent (***), 5 percent (**), and 10 percent (*).

Key: 7DLT: more than seven days of lost time; LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy.

- Opioid prescriptions: The size of the effect of different PT timing was reduced after controlling for the same sets of variables, but the percentage of claims receiving opioid prescriptions was still significantly higher for claims in the later PT timing groups, compared with those with PT initiated within 3 days of injury (Table 4.3). After adjustment, the claims in the later PT timing groups (after 30 days and 15–30 days) were, respectively, 46 and 33 percent more likely to receive opioids than the claims in the within-3-days group. Adjusting for controls does narrow the range of opioid receipt across the different PT timing groups. The ratios were reduced from 1.69 to 1.46 for the after-30-days group, from 1.50 to 1.33 for the 15–30 days group, and from 1.30 to 1.19 for the 8–14 days group—all statistically significant at 1 percent.

Table 4.3 Percentage of Claims Receiving Opioid Prescriptions—Estimated Results by PT Timing

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
% of LBP-only claims that received opioid Rx, by PT timing, 7DLT claims with PT treatment					
Unadjusted (model 1)	28.0%	28.0%	36.3%	42.1%	47.3%
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	29.2%	28.1%	35.7%	40.8%	45.9%
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	29.6%	28.4%	35.8%	40.7%	44.9%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	30.4%	28.9%	35.8%	40.4%	44.4%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	30.1%	29.0%	35.8%	40.2%	44.0%
Rate of receiving opioid Rx across PT timing groups, indexed to the rate of receiving opioids Rx for the within-3-days group					
Unadjusted (model 1)	1.00	1.00	1.30***	1.50***	1.69***
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	1.00	0.96	1.22***	1.40***	1.57***
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	1.00	0.96	1.21***	1.38***	1.52***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	1.00	0.95	1.18***	1.33***	1.46***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	1.00	0.96	1.19***	1.33***	1.46***

Notes: Included in the analysis are LBP-only claims with more than seven days of lost time. These claims had injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the adjusted results holding constant the variables included in each model corresponding to the models listed in Table 4.1. The numbers presented in the bottom half of the table are the results indexed against the adjusted values for the PT within-3-days group.

The adjusted results are statistically significant at 1 percent (***), 5 percent (**), and 10 percent (*).

Key: 7DLT: more than seven days of lost time; LBP: low back pain; PT: physical therapy.

- Pain management injections: The use of injections among workers in the after-30-days group was significantly higher compared with the same measure for the early PT group within 3 days of injury. The fully-adjusted difference was 29 percent, decreased from 88 percent for the unadjusted number (Table 4.4). The percentage of claims with pain management injections across the first three PT groups (within 3 days, 4–7 days, and 8–14 days) were similar, although the 4–7 days group had a slightly lower rate of injections.[10] Note that the ratios between the after-30-days and 15–30 days groups and the within-3-days group decreased from 1.88 to 1.29 and from 1.25 to 1.12, respectively, after controlling for a series of factors.

Table 4.4 Percentage of Claims Receiving Pain Management Injections—Estimated Results by PT Timing

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
% of LBP-only claims that received pain management injections, by PT timing, 7DLT claims with PT treatment					
Unadjusted (model 1)	7.6%	6.4%	7.6%	9.5%	14.3%
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	8.4%	7.1%	8.0%	9.5%	12.2%
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	9.0%	7.7%	8.5%	9.6%	10.9%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	8.6%	7.6%	8.5%	9.8%	11.2%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	8.6%	7.4%	8.4%	9.6%	11.1%
Rate of receiving pain management injections across PT timing groups, indexed to the rate of receiving injections for the within-3-days group					
Unadjusted (model 1)	1.00	0.84*	1.01	1.25***	1.88***
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	1.00	0.85*	0.96	1.13	1.45***
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	1.00	0.86*	0.94	1.06	1.21**
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	1.00	0.87	0.98	1.13	1.29***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	1.00	0.87	0.98	1.12	1.29***

Notes: Included in the analysis are LBP-only claims with more than seven days of lost time. These claims had injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the adjusted results holding constant the variables included in each model corresponding to the models listed in Table 4.1. The numbers presented in the bottom half of the table are the results indexed against the adjusted values for the PT within-3-days group.

The adjusted results are statistically significant at 1 percent (***), 5 percent (**), and 10 percent (*).

Key: 7DLT: more than seven days of lost time; LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy.

[10] The difference was statistically significant at 10 percent for the unadjusted results, but not statistically significant for the fully adjusted results.

- Low back surgery: After adjusting for all specified factors, the percentage of LBP-only claims with surgery for the after-30-days group was estimated at 2.7 percent, still significantly higher than the surgery rate for the within-3-days group at 1.5 percent (Table 4.5).[11] Note that for low back surgery, a much larger reduction was seen after controlling for the whole set of variables.

Table 4.5 Percentage of Claims Receiving Low Back Surgery—Estimated Results by PT Timing

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
% of LBP-only claims that had low back surgery, by PT timing, 7DLT claims with PT treatment					
Unadjusted (model 1)	1.0%	0.8%	1.2%	1.4%	3.9%
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	1.3%	1.0%	1.3%	1.4%	3.0%
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	1.5%	1.2%	1.5%	1.6%	2.5%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	1.4%	1.1%	1.5%	1.6%	2.6%
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	1.5%	1.2%	1.6%	1.7%	2.7%
Rate of low back surgery across PT timing groups, indexed to the rate of low back surgery for the within-3-days group					
Unadjusted (model 1)	1.00	0.80	1.16	1.32	3.72***
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	1.00	0.76	1.05	1.11	2.35***
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	1.00	0.78	0.99	1.06	1.66***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	1.00	0.80	1.05	1.15	1.83***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	1.00	0.83	1.09	1.19	1.89***

Notes: Included in the analysis are LBP-only claims with more than seven days of lost time. These claims had injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the adjusted results holding constant the variables included in each model corresponding to the models listed in Table 4.1. The numbers presented in the bottom half of the table are the results indexed against the adjusted values for the PT within-3-days group.

The adjusted results are statistically significant at 1 percent (***), 5 percent (**), and 10 percent (*).

Key: 7DLT: more than seven days of lost time; LBP: low back pain; PT: physical therapy.

[11] The adjusted results for the 8–14 days and 15–30 days groups were similar to the results for the within-3-days group. Note that for some reason, the surgery rate was slightly lower for the 4–7 days group, but the difference was not statistically significant.

- The average total medical payment per claim for the first year of treatment ranged from $4,306 to $5,337 after controlling for all the factors we specified for the final statistical analysis (Table 4.6). The average per-claim medical cost was 24 percent higher for the after-30-days group than for the within-3-days group (statistically significant at the 1 percent level). The same figure was 6 percent higher for claims in the 15–30 days group. This was the result after adjusting for all factors, which reduced the difference from 42 to 24 percent for the after-30-days group.

Table 4.6 Average Medical Payment per Claim—Estimated Results by PT Timing

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
Average medical payment per claim, by PT timing, 7DLT claims with PT treatment					
Unadjusted (model 1)	$4,098	$3,964	$4,302	$4,414	$5,804
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	$4,300	$4,141	$4,333	$4,432	$5,465
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	$4,392	$4,220	$4,358	$4,463	$5,273
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	$4,283	$4,151	$4,354	$4,515	$5,349
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	$4,306	$4,161	$4,394	$4,547	$5,337
Average medical payment per claim across PT timing groups, indexed to that for the within-3-days group					
Unadjusted (model 1)	1.00	0.97**	1.05	1.08	1.42***
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	1.00	0.96	1.01	1.03	1.27***
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	1.00	0.96	0.99*	1.02	1.20***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	1.00	0.97	1.02	1.05**	1.25***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	1.00	0.97	1.02	1.06*	1.24***

Notes: Included in the analysis are LBP-only claims with more than seven days of lost time. These claims had injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the adjusted results holding constant the variables included in each model corresponding to the models listed in Table 4.1. The log transformation of medical payment was used in the ordinary least squares regression. The numbers presented in the bottom half of the table are the results indexed against the adjusted values for the PT within-3-days group.

The adjusted results are statistically significant at 1 percent (***), 5 percent (**), and 10 percent (*).

Key: 7DLT: more than seven days of lost time; LBP: low back pain; PT: physical therapy.

- The average TD duration per claim after the adjustments was still much longer (by 58 percent) for the after-30-days group when compared with the within-3-days group (statistically significant at the 1 percent level). See Tables 4.7 and 4.8. Claims in the 15–30 days group had 24 percent longer TD duration per claim than those in the within-3-days group. Although the difference was statistically significant, the average TD duration for workers in the 8–14 days group was slightly longer than that for the within-3-days PT group.

Table 4.7 Average Number TD Weeks per Claim—Estimated Results by PT Timing

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days*	15–30 Days*	After 30 Days*
Average number of TD weeks per claim, by PT timing, 7DLT claims with PT treatment					
Unadjusted (model 1)	7.4	6.6	7.9	9.7	13.9
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	8.1	7.5	8.5	10.0	13.0
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	8.2	7.5	8.6	10.1	12.9
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	8.1	7.5	8.6	10.1	12.9
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	8.2	7.7	8.7	10.2	13.0
Average number of TD weeks per claim, indexed to that for the within-3-days group					
Unadjusted (model 1)	1.00	0.90	1.07***	1.32***	1.89***
Adjusted for differences in individual worker characteristics and state-specific factors (model 2)	1.00	0.92	1.06***	1.24***	1.61***
Adjusted for case-mix factors, plus severity and comorbidities (model 3)	1.00	0.92	1.05***	1.23***	1.58***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT (model 4)	1.00	0.92	1.06***	1.25***	1.59***
Adjusted for case-mix factors, plus severity and comorbidities, same-billing-entity PT, county-level factors (model 5)	1.00	0.93	1.06***	1.24***	1.58***

Notes: Included in the analysis are LBP-only claims with more than seven days of lost time. These claims had injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the adjusted results holding constant the variables included in each model corresponding to the models listed in Table 4.1. The log transformation of TD duration in weeks was used in the ordinary least squares regression. The numbers presented in the bottom half of the table are the results indexed against the adjusted values for the PT within-3-days group.

The adjusted results are statistically significant at 1 percent (***), 5 percent (**), and 10 percent (*).

Key: 7DLT: more than seven days of lost time; LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy; TD: temporary disability.

One may be concerned about the potential impact of a longer TD duration on the late timing of PT initiation and how that may affect the estimated results for TD duration and for utilization and costs of medical services. From a clinical stand point, it is more likely that the late PT reflects a difference in practice patterns. Some providers routinely order PT and provide immediate PT treatment for low back pain, while others may take a "watchful waiting" approach, believing that the patient may get better over time. It is also possible that a provider may consider ordering PT if the worker stayed out of work longer. Based on our sensitivity analysis (see Technical Appendix C), we conclude that even if some providers order PT because of a longer TD duration, the impact of longer TD duration would not be large enough to negate the substantial difference.

It is worth noting that several variables appear to be significantly associated with late PT initiation and worse outcomes. These variables include attorney involvement, time to first medical visit, and presence of comorbidities (see Tables 3.2, 3.5, and Tables TA.C1 through TA.C6).

Comorbidities have a low prevalence in our data, but it varies substantially across the PT timing groups. In our data, it appears that the common comorbidities are associated with a clinically meaningful delay in PT and had a significant impact on the delivery of other services as well as medical costs and duration of temporary disability. The results may be less intuitive from a clinical point of view since, normally, a clinician would want to order PT sooner for the patient who has a known comorbidity that tends to lengthen recovery time. However, several other factors may also be at work. It is possible that some workers are less likely to follow through with PT treatment even when it is ordered. Insurance companies are less likely to agree to cover a claim when there are comorbidities present that they believe might affect the work-related nature of the injury. Insurance companies may ear-mark these claims for further investigation and thus delay acceptance of the claim and treatment for the condition. Lastly, in the situation where a comorbid condition is not fully treated, the worker may be referred to the patient's primary care to treat that condition before proceeding with PT treatment.

For the reader who is interested in statistical analysis and the estimated effect of early PT treatment, Technical Appendix C provides the point estimates of the effect of PT timing and factors we captured and controlled in the statistical analysis.[12] A high-level discussion of the statistical techniques and factors we controlled for can be found in Chapter 2.

SUMMARY: ADJUSTED EFFECT OF EARLY PT SMALLER THAN UNADJUSTED BUT SIGNIFICANT

In our statistical analysis, we controlled for a rich set of variables that help capture worker characteristics; injury severity and comorbidities; practice settings for PT treatment; potential issues that may delay care and PT treatment; and county-level data that reflect rural/urban area, supply of PT providers, unemployment rate, and physical activity level of the residents across counties. Based on the fully-adjusted results, we found that the utilization of selected medical services, overall medical costs per claim, and TD duration were significantly lower or shorter for claims in the earlier PT groups (within 3 days of injury and 4–7 days) compared with those in the later PT groups, especially the group with PT after 30 days postinjury. The statistical adjustment reduced the size of the estimated effect of early PT on outcomes we studied, but the direction remains the same. Table 4.8 summarizes the finding of our statistical analysis for the outcomes we studied. It also compares the adjusted results with the unadjusted results to illustrate the impact of the adjustment.

[12] Technical Appendix C also discusses several technical issues we encountered in the analysis and how we addressed those issues in our sensitivity analyses. We ran these sensitivity tests to address certain data and measurement issues. These sensitivity analyses were based on a smaller and narrowly-defined sample to test the impact of certain issues on the estimated effect of PT timing.

Table 4.8 Unadjusted and Adjusted Effect of PT Timing on Utilization and Costs of Medical Services and TD Duration

	Timing of PT Initiation Postinjury					Percentage (point) Difference Relative to the PT within-3-Days Group			
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
% of claims receiving MRI									
Unadjusted	29%	27%	30%	36%	48%	-1.4%	1.2%	6.8%	19.0%
Adjusted[a]	30%	30%	32%	36%	44%	-0.1%	1.9%	6.1% ***	14.1% ***
% of claims receiving opioid prescriptions									
Unadjusted	28%	28%	36%	42%	47%	0.0%	8.3%	14.1%	19.3%
Adjusted[a]	30%	29%	36%	40%	44%	-1.2%	5.7% ***	10.1% ***	13.8% ***
% of claims receiving pain management injections									
Unadjusted	7.6%	6.4%	7.6%	9.5%	14.3%	-1.2%	0.0%	1.9%	6.7%
Adjusted[a]	8.6%	7.4%	8.4%	9.6%	11.1%	-1.2%	-0.2%	1.0%	2.5% ***
% of claims receiving low back surgery									
Unadjusted	1.0%	0.8%	1.2%	1.4%	3.9%	-0.2%	0.2%	0.3%	2.9%
Adjusted[a]	1.5%	1.2%	1.6%	1.7%	2.7%	-0.2%	0.1%	0.3%	1.3% ***
Average payment per claim for all medical services									
Unadjusted	$4,098	$3,964	$4,302	$4,414	$5,804	-3%	5%	8%	42%
Adjusted[a]	$4,306	$4,161	$4,394	$4,547	$5,337	-3%	2%	6%	24% ***
Average number of weeks of TD duration per claim									
Unadjusted	7.4	6.6	7.9	9.7	13.9	-10%	7%	32%	89%
Adjusted[a]	8.2	7.7	8.7	10.2	13.0	-7%	6% ***	24% ***	58% ***

Notes: Included are LBP-only claims with more than seven days of lost time. These claims had injuries arising from October 1, 2015, to March 31, 2017, with medical services during the first year of treatment. The numbers in the top half of the table are the unadjusted results aggregated based on the pooled data of 27 states. The adjusted results in the bottom half of the table are the predicted values from our statistical analysis. Chapter 4 provides full results and a description of the statistical analysis.

[a] The adjusted results are based on the full model specification of our statistical analysis (see Table 4.1 for variables included in the adjustment).

The adjusted results are statically significant at 1 percent (***), 5 percent (**), and 10 percent (*).

Key: LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy; TD: temporary disability.

The first five columns of the data in the table show for each outcome variable the unadjusted and adjusted numbers; the adjusted numbers are based on the final model specified that includes all factors. The next four columns of the data present the percentage or percentage point difference between claims in a given PT timing group and those with PT within 3 days of injury. For example, among LBP-only claims with more than seven days of lost time that had 3 or more PT visits during the first year of treatment, the percentage of claims receiving pain management injections was 7.6 percent for those with PT within 3 days of injury, 9.5 percent if PT started between 15 and 30 days postinjury, and 14.3 percent if PT was initiated after 30 days. After the adjustment, the same figures are 8.6, 9.6, and 11.1 percent, respectively. The difference in the percentage of claims with injections between the after-30-days group and the within-3-days group is 6.7 percentage points unadjusted, which is reduced to 2.5 percentage points after the adjustment. Similar patterns can be seen for the other utilization measures. The adjusted average medical payment per claim for the PT after-30-days group was 24 percent higher than that for the within-3-days group, which was reduced from a difference of 42 percent in the unadjusted results. These adjusted numbers are statistically significant at the level indicated.

As mentioned previously, the results from our statistical analysis presented in this chapter show the average effect of different PT timing groups. One may be concerned about possible differences in the response to early PT between older and younger workers, male and female workers, and states with different policies. In our additional analysis, we tested the variable effect of early PT (within 7 days or within 14 days postinjury) for age, gender, and states. The results suggested that male workers may respond better on average to early PT in terms of TD duration. The estimated coefficient was -0.248 for early PT and -0.100 for the interaction of early PT and male worker, using the 7-day early PT definition. The same figures were -0.262 and -0.166 for the 14-day early PT definition. The estimated coefficients were all statistically significant at 1 percent. The results were mixed for medical payments—gender was not significant for the 7-day early PT definition, but it was significant for the 14-day early PT definition. We did not see evidence suggesting a different response to early PT between older (55 years of age or older) and younger (35 years of age or younger) workers with LBP-only injuries in terms of TD duration. For medical payments, the result shows that older workers with early PT might have been associated with lower costs, statistically significant at 10 percent. Separate estimations for individual states with substantially large sample sizes support the major findings that early PT is associated with lower medical utilization and costs and shorter TD duration, although the response to early PT may vary by state. Further investigations in this direction may be needed, especially in the context of different state policies governing the use of medical treatment guidelines, fee schedules, and utilization review (including preauthorization).

5

IMPLICATIONS

After accounting for various factors that might affect both the timing of PT and the outcomes studied, we found that for injured workers with LBP conditions for which PT treatment is indicated, early PT within 14 days after injury is likely to be beneficial, associated with lower utilization of medical services, lower overall medical costs, and shorter TD duration. Conversely, late PT initiation is associated with an increased utilization of medical services, increased medical costs, and prolonged disability.[1] The findings of our study support the value of ordering PT early rather than late, suggesting that clinicians and payors should be encouraged to work proactively to remove barriers to early PT. To address the potential concern about unobserved characteristics of workers and their impact on the study findings, we explored a more advanced statistical technique in our additional investigation.[2] Although this investigation did not provide us with a convincing way to address the issue, it helped underscore the need for high-quality randomized clinical trial studies so that we may have a more definitive answer to the question regarding the impact of PT timing. This is particularly important since current treatment guidelines rarely address the timing of PT and such studies could assist guideline development in this area.

There is large variation in the definition of timing for PT initiation in the literature. Without a standard definition, research findings on the impact of early PT timing are less informative for policymakers, stakeholders, and practitioners. Our study does not address optimal PT timing, but the results from our analysis across the five PT timing groups shed some light onto what exact timing may make a difference. For example, we found that the utilization of MRI, opioid prescriptions, pain management injections, and low back surgery was fairly similar for claims in the PT within-3-days and 4–7 days groups. The results on medical costs per claim and TD duration were similar for claims with PT initiated within 14 days postinjury. For claims with PT initiated after 14 days, the 15–30 days group had, on average, higher utilization of medical services, higher medical costs per claim, and longer TD duration, compared with the three earlier PT groups (within 3 days, 4–7 days, and 8–14 days).[3] These results imply that 14 days may be a practically effective threshold to alert claims adjusters, case management nurses, and medical providers to pay a closer attention to workers for whom PT treatment is indicated but has not been initiated within two weeks after injury. Medical treatment guidelines are variable and at times non-specific on the timing of PT services. The findings from our study may add clarity to the guidelines on this topic. The results of our statistical analysis could also assist payors in the development

[1] Controlling for a rich set of factors resulted in a considerable reduction in the size of the early PT effect, but the gaps in the utilization of medical services, costs of medical services, and TD duration were still substantially large for claims with PT initiated after 14 days of injury, especially those with PT after 30 days postinjury.

[2] The additional analysis was to explore the instrumental variable approach that was established in Savych, Neumark, and Lea (2018). We discuss this in Chapter 2 and Technical Appendix C.

[3] The results are summarized in Table 4.8.

of their predictive models that help improve medical care and outcomes. The information could also be used to help educate patients in the shared decision-making process.

Our data show that the same set of outcome measures were substantially higher for claims with PT initiated after 30 days of injury. Compared with those with earlier PT timing, claims in this group had a much higher rate of attorney involvement and a longer amount of time from injury to first medical visit.[4] The higher rate of attorney involvement may indicate more prevalent issues for pending compensability. A longer time to initial medical visit may be for several reasons including compensability issues that may delay care in some states, delayed notice of injury to employers and insurers, access to providers for initial visits, and how soon the worker seeks care. To some extent, both attorney involvement and the number of days from injury to first medical visit may reflect some of these issues that potentially delay care, resulting in a greater use of medical resources and delayed return to work. Our data also show that there was a longer time elapsed from first medical visit to first PT visit for claims in the later PT groups when compared with those in the earlier PT groups,[5] which may suggest some differences across providers in PT referral patterns and provider practice in terms of prescribing other services (e.g., imaging studies, opioids, injections, and surgery) for managing low back pain. State policies and treatment guidelines may be helpful to influence providers' practice patterns to avoid delays in PT treatment. Future studies should investigate key factors that influence PT referrals and timing of PT initiation, taking into account patient and provider factors, relevant state policies, and organizational structures of health care delivery.

CLOSING REMARK

Several observational studies in the literature have reported that early PT treatment is associated with a lower utilization of medical services, better recovery, and shorter duration of disability. The findings from these studies have been limited to association, rather than measuring a causal relationship. Recognizing the limitations of the administrative data, our ability to measure the causal effect of early PT treatment is also bounded by the same limitations. However, we were able to use a rich set of variables, which is among the most comprehensive controls, to provide several new insights in this area of research. Our study focused on a set of relatively homogenous low back claims, and we measured and controlled for severity (indicated by the receipt of invasive procedures prior to PT treatment) and comorbidities (including obesity, diabetes, psychosocial issues, alcohol and drug abuse, chronic conditions mentioned within three months of initial care, and smoking). Our results on attorney involvement and time to first PT visit suggest potential issues that may delay care, and we encourage system practitioners to pay closer attention to workers with uncomplicated low back conditions who have not returned to work and have not received PT services within two weeks of injury. We identified a prevalent health care setting for PT treatment (i.e., same-billing-entity PT care and the impact of organization-level treatment protocols), and examined the impact of such a structure on early PT and outcomes.

This study is the first in a series of planned physical medicine studies. It was designed to examine the

[4] Among the LBP-only claims in the PT after-30-days group, 27 percent involved attorney which is much higher than 13–14 percent for those with PT within the first week of injury (Table 3.2). The average number of days from injury to the first medical visit was 18 days for claims receiving PT after 30 days (Table 3.3).

[5] The average number of days from first medical visit to first PT visit was 51 days for claims in the after-30-days group. By contrast, it only took 1–4 days on average for workers with PT within the first week of injury to receive PT treatment after their initial medical visits; it took 8 days for those in the 8–14 days group (Table 3.3).

relationship between PT timing and outcomes studied, based on a set of uncomplicated LBP-claims that had more than seven days of lost time. This report will undoubtedly raise more questions than we were able to answer within the scope of this study. For example, how different are the outcomes between workers who received PT treatment and those who did not? What are the characteristics of claims with 1–2 PT visits, and why do they tend to have lower utilization of certain medical services even compared with those without PT treatment? What are common PT patterns of care—taking into account types of PT services, frequency, and intensity—and how are these PT patterns associated with health care utilization and outcomes? What are the key characteristics of workers with injuries and how do these characteristics influence the timing of their PT treatment? Do workers with different characteristics response to early PT differently? Can physical medicine be used more often to decrease the frequency of opioid dispensing? What are the practice patterns before and after low back surgery? What is the role of chiropractic care, and how do practice patterns of chiropractors differ from physical therapists?[6] Some of these questions will be addressed in our future studies in this area.

[6] For clarity, we excluded claims with chiropractic care from the analysis. However, we acknowledge that chiropractic care has been a significant part of workers' compensation health care. We will include chiropractic care in a subsequent study on patterns of physical medicine and their impact on outcomes.

STATISTICAL APPENDIX

This statistical appendix provides several tables that show interstate variations in utilization of PT services and state results on utilization and TD duration across different PT timing groups.

In the main report, we focused on claims with more than seven days of lost time to describe our findings. We chose to use this set of claims because they are relatively more serious and represent a large proportion of medical services utilized and costs. We provide underlying data in this appendix. We also provide the results for all claims regardless of whether the claims incurred at least seven days of lost time.

Table SA.1 Claim Distribution by PT Visits

	No PT	2 PT Visits	3–6 PT Visits	7+ PT Visits
AR	32%	3%	35%	30%
CA	21%	13%	28%	38%
CT	25%	8%	22%	45%
DE	17%	3%	16%	64%
FL	27%	10%	22%	42%
GA	22%	7%	27%	44%
IA	26%	11%	23%	40%
IL	25%	6%	22%	48%
IN	27%	8%	23%	41%
KY	31%	5%	21%	43%
KS	24%	8%	31%	37%
LA	49%	6%	15%	29%
MA	46%	6%	15%	34%
MD	25%	6%	19%	51%
MI	25%	4%	29%	42%
MN	40%	11%	23%	27%
MO	18%	7%	31%	45%
NC	41%	5%	19%	36%
NJ	20%	7%	23%	49%
NV	10%	16%	33%	41%
NY	37%	7%	13%	43%
PA	25%	6%	18%	52%
SC	38%	5%	17%	40%
TN	26%	6%	33%	34%
TX	30%	9%	31%	30%
VA	37%	6%	16%	41%
WI	28%	9%	27%	36%

Note: Included are LBP-only claims with more than seven days of lost time. These claims had injuries occurring from October 1, 2015, to March 31, 2017, with medical services received during the first year of treatment.

Key: LBP: low back pain; PT: physical therapy.

Table SA.A2 Claim Distribution by PT Timing Group

	Timing of PT Initiation Postinjury				
	Within 3 Days	**4–7 Days**	**8–14 Days**	**15–30 Days**	**After 30 Days**
AR	11%	9%	24%	37%	18%
CA	23%	14%	17%	24%	22%
CT	16%	20%	22%	26%	16%
DE	10%	17%	26%	40%	7%
FL	18%	10%	15%	29%	28%
GA	17%	17%	19%	23%	24%
IA	10%	14%	31%	23%	22%
IL	15%	15%	22%	27%	20%
IN	15%	8%	21%	33%	23%
KY	10%	9%	28%	30%	23%
KS	6%	13%	22%	27%	32%
LA	5%	7%	11%	34%	43%
MA	5%	10%	25%	37%	24%
MD	18%	22%	25%	22%	14%
MI	16%	18%	22%	26%	17%
MN	8%	15%	26%	32%	20%
MO	17%	17%	29%	22%	15%
NC	10%	8%	16%	29%	38%
NJ	20%	16%	22%	29%	14%
NV	28%	19%	22%	16%	15%
NY	5%	12%	24%	33%	25%
PA	14%	18%	29%	27%	11%
SC	1%	3%	12%	41%	43%
TN	13%	14%	17%	31%	26%
TX	19%	23%	20%	23%	15%
VA	4%	11%	18%	32%	35%
WI	13%	14%	32%	28%	13%

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more PT visits during the first year of treatment. These claims had injuries occurring from October 1, 2015, to March 31, 2017, with medical services received during the first year of treatment.

Key: LBP: low back pain; PT: physical therapy.

Table SA.3 TD Duration in Weeks per Claim by PT Timing Group

	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
CA	9.8	8.6	9.4	10.8	15.1
CT	5.6	6.6	7.5	11.5	14.8
FL	6.2	5.7	7.9	9.7	11.5
GA	10.6	9.2	12.2	13.0	20.4
IL	7.6	5.9	7.8	10.2	13.3
MD	6.9	5.6	7.6	11.0	12.4
MI	5.9	4.9	7.2	7.6	11.5
MO	4.4	7.2	6.0	6.2	10.4
NC	8.8	11.1	11.5	12.7	18.0
NJ	5.8	5.1	7.0	6.8	11.1
NY	8.4	8.3	8.5	8.9	11.8
PA	5.7	6.2	7.5	8.1	14.0
TN	4.6	4.9	7.0	7.3	10.7
TX	4.4	4.8	5.2	7.3	12.2
WI	3.5	5.7	6.3	5.3	8.1

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more PT visits during the first year of treatment. These claims had injuries occurring from October 1, 2015, to March 31, 2017, with medical services received during the first year of treatment. States included are those that had at least 30 claims in each PT timing group.

Key: LBP: low back pain; PT: physical therapy; TD: temporary disability.

In the main report, we focused on the impact of early PT timing on outcomes based on claims with PT treatment (i.e., 3 or more PT visits). For the reader who would like to see a whole picture of PT care, we provide some statistics for the set of claims we studied across the PT continuum (Table SA.4). Our design of the PT continuum breaks out the LBP-only claims into no PT, claims with 1–2 PT visits, claims with 3–6 PT visits, and claims with 7 or more PT visits. For the last two subsets of claims, we further break it out by the five PT timing groups. The data on these measures for individual states are available but not included in this report.

While the progressive patterns of the association between PT timing and outcomes studied were similar for the two PT treatment groups (i.e., claims with 3–6 PT visits and claims with 7 or more PT visits), claims with 7+ PT visits had considerably higher utilization and costs of medical services. TD duration was longer overall for the 7+ PT visit claims. Another noteworthy pattern is that the percentage of claims with opioid prescriptions was considerably lower for the claims that had 3–6 PT visits and had PT initiated within 7 days of injury, at 17–21 percent, compared with claims with little or no PT (35 percent for claims with no PT and 30 percent for claims with 1–2 PT visits). This suggests that for workers with LBP-only injuries, early PT visits may help reduce opioid prescriptions, which may be examined further in a future study. It should be noted that the data presented are descriptive statistics without any adjustment for differences in the underlying factors. The reader should not make any conclusions based on the simple comparison of the results presented in Table SA.4.

Table SA.4 Utilization and Costs of Medical Services and TD Duration over PT Continuum, Descriptive Data without Controlling for Underlying Factors

Measure	No PT	2 PT Visits	3–6 PT Visits within 3 Days	3–6 PT Visits 4–7 Days	3–6 PT Visits 8–14 Days	3–6 PT Visits 15–30 Days	3–6 PT Visits after 30 Days	7+ PT Visits within 3 Days	7+ PT Visits 4–7 Days	7+ PT Visits 8–14 Days	7+ PT Visits 15–30 Days	7+ PT Visits after 30 Days
# of LBP-only claims	6,328	1,990	916	983	1,199	1,490	971	1,955	1,638	2,406	3,274	2,805
% of LBP-only claims	24%	8%	4%	4%	5%	6%	4%	8%	6%	9%	13%	11%
PT and other medical visits by end of first year												
Number of PT visits, mean	0.0	1.4	4.8	4.9	4.9	4.9	4.9	15.5	16.6	16.9	17.1	17.2
Number of PT visits, median	0.0	1.0	5.0	5.0	5.0	5.0	5.0	12.0	12.0	12.0	13.0	13.0
% of claims that had > 18 visits for PT services	0%	0%	0%	0%	0%	0%	0%	25%	27%	29%	29%	31%
Active to passive ratio, mean	0.0	1.3	3.0	3.3	2.5	2.2	2.1	3.6	3.8	3.3	3.2	3.2
% of claims with emergency visits	24%	18%	9%	16%	19%	19%	22%	13%	20%	23%	23%	24%
Number of office visits for E&M, mean	3	4	5	4	5	5	6	9	9	8	8	9
Days from injury to first medical visit, mean	7	7	2	3	4	6	16	2	3	4	6	18
Days from injury to first medical visit, median	2	2	1	2	2	3	5	1	2	2	2	4
Utilization of medical services during the first year of treatment												
% of claims that had MRI	7%	12%	10%	10%	11%	17%	32%	38%	38%	39%	44%	53%
% of claims that received opioid Rx	35%	30%	17%	21%	32%	35%	37%	32%	32%	39%	45%	51%
% of claims that had pain management injections	2%	3%	2%	1%	2%	3%	7%	11%	10%	10%	12%	17%
% of claims that had low back surgery	0.4%	0.7%	0.0%	0.1%	0.4%	0.4%	1.2%	1.4%	1.3%	1.6%	1.9%	4.8%
Costs for all medical services by end of first year after injury												
Medical payments per claim, mean	$941	$1,654	$1,838	$1,836	$2,023	$1,961	$2,728	$5,114	$5,246	$5,433	$5,531	$6,867
Medical payments per claim, median	$503	$926	$1,527	$1,571	$1,541	$1,524	$1,913	$3,421	$3,623	$3,624	$3,705	$4,479
TD duration by end of first year after injury												
TD weeks per claim, mean	3.4	4.7	3.4	3.0	4.0	5.3	9.2	9.3	8.8	9.8	11.8	15.6
TD weeks per claim, median	2.0	2.3	2.0	2.1	2.8	3.8	5.9	4.7	5.0	5.8	7.6	11.0

Note: Included are LBP-only claims with more than seven days of lost time, injuries occurring from October 1, 2015, to March 31, 2017, with medical services received during the first year of treatment.

Key: E&M: evaluation and management; LBP: low back pain: MRI: magnetic resonance imaging; PT: physical therapy; Rx: prescriptions; TD: temporary disability.

TECHNICAL APPENDIX A

LOW BACK PAIN ONLY CLAIMS

The algorithm we developed in the 2019 study (Wang, Mueller, and Lea, 2019a) identified two groups of low back claims: (1) low back pain with neurological findings and/or radiating leg pain, and (2) low back pain claims without nerve involvement. These are claims that had low back pain diagnoses as primary conditions for medical treatments (i.e., medical services for low back pain accounting for 75 percent of all medical payments) and that did not have any red flag conditions or neurological neck pain. The claims we used for this study are from the second group, the low back pain only claims. For this study, we further excluded a small number of claims that had ICD-10 codes indicating comorbid conditions with complications. Workers with these more serious comorbid conditions are not indicated for PT treatment in general (Table TA.A4). While a more detailed description of the algorithm can be found in Wang, Mueller, and Lea (2019a), we provide several lists of ICD-10 codes that may help the reader to better understand what these claims are.

Table TA.A1 provides a list ICD-10 codes indicating various low back diagnoses with no mention of nerve involvement, and Table TA.A2 lists codes that have nerve involvement or codes that may indicate nerve involvement when combined with other codes. For example, spondylolisthesis or spondylolysis with neurological findings are considered low back pain with nerve involvement. Spondylolisthesis without neurological findings is considered as instability. Spondylolysis without neurological findings and without spondylolothesis are considered non-specific low back. In these two tables, the ICD-10 codes are grouped by type, including low back conditions with nerve involvement (e.g., sciatica, radiculopathy, myelopathy, and other neurological conditions), spinal stenosis, spondylolysis and spondylolisthesis, disc disorder with no mention of neurological finding, instability, sacroiliac joint sprains, degenerative conditions without neurological findings, and non-specific low back pain.

Table TA.A1 ICD-10 Codes for Low Back Only Conditions

ICD-10 Code	Description
Disc disorder with no mention of neurological finding	
M5125	Other intervertebral disc displacement, thoracolumbar region
M5126	Other intervertebral disc displacement, lumbar region
M5127	Other intervertebral disc displacement, lumbosacral region
M5135	Other intervertebral disc degeneration, thoracolumbar region
M5136	Other intervertebral disc degeneration, lumbar region
M5137	Other intervertebral disc degeneration, lumbosacral region
M5185	Other intervertebral disc disorders, thoracolumbar region
M5186	Other intervertebral disc disorders, lumbar region
M5187	Other intervertebral disc disorders, lumbosacral region
M519	Unspecified thoracic, thoracolumbar and lumbosacral intervertebral disc disorder
Sacroiliac joint sprains	
S336XXA	Sprain of sacroiliac joint, initial encounter
S336XXD	Sprain of sacroiliac joint, subsequent encounter
S336XXS	Sprain of sacroiliac joint, sequela

continued

Table TA.A1 ICD-10 Codes for Low Back Only Conditions (continued)

ICD-10 Code	Description
Degenerative conditions without neurological findings	
M47815	Spondylosis without myelopathy or radiculopathy, thoracolumbar region
M47816	Spondylosis without myelopathy or radiculopathy, lumbar region
M47817	Spondylosis without myelopathy or radiculopathy, lumbosacral region
M47818	Spondylosis without myelopathy or radiculopathy, sacral and sacrococcygeal region
M47819	Spondylosis without myelopathy or radiculopathy, site unspecified
M47895	Other spondylosis, thoracolumbar region
M47896	Other spondylosis, lumbar region
M47897	Other spondylosis, lumbosacral region
M4826	Kissing spine, lumbar region
M4827	Kissing spine, lumbosacral region
M488X5	Other specified spondylopathies, thoracolumbar region
M488X6	Other specified spondylopathies, lumbar region
M488X7	Other specified spondylopathies, lumbosacral region
M489	Spondylopathy, unspecified
M4986	Spondylopathy in diseases classified elsewhere, lumbar region
M4987	Spondylopathy in diseases classified elsewhere, lumbosacral region
Non-specific back diagnoses	
F454	Pain disorders related to psychological factors
F4541	Pain disorder exclusively related to psychological factors
F4542	Pain disorder with related psychological factors
M4040	Postural lordosis, site unspecified
M4045	Postural lordosis, thoracolumbar region
M4046	Postural lordosis, lumbar region
M4047	Postural lordosis, lumbosacral region
M4050	Lordosis, unspecified, site unspecified
M4055	Lordosis, unspecified, thoracolumbar region
M4056	Lordosis, unspecified, lumbar region
M4057	Lordosis, unspecified, lumbosacral region
M438X5	Other specified deforming dorsopathies, thoracolumbar region
M438X6	Other specified deforming dorsopathies, lumbar region
M438X7	Other specified deforming dorsopathies, lumbosacral region
M438X8	Other specified deforming dorsopathies, sacral and sacrococcygeal region
M438X9	Other specified deforming dorsopathies, site unspecified
S335	Sprain of ligaments of lumbar spine
S335XXA	Sprain of ligaments of lumbar spine, initial encounter
S335XXD	Sprain of ligaments of lumbar spine, subsequent encounter
S335XXS	Sprain of ligaments of lumbar spine, sequela
S338	Sprain of other parts of lumbar spine and pelvis
S338XXA	Sprain of other parts of lumbar spine and pelvis, initial encounter
S338XXD	Sprain of other parts of lumbar spine and pelvis, subsequent encounter
S338XXS	Sprain of other parts of lumbar spine and pelvis, sequela
S339	Sprain of unspecified parts of lumbar spine and pelvis
S339XXA	Sprain of unspecified parts of lumbar spine and pelvis, initial encounter
S339XXD	Sprain of unspecified parts of lumbar spine and pelvis, subsequent encounter
S339XXS	Sprain of unspecified parts of lumbar spine and pelvis, sequela
S3900	Unspecified injury of muscle, fascia and tendon of abdomen, lower back and pelvis
S39002	Unspecified injury of muscle, fascia and tendon of lower back
S39002A	Unspecified injury of muscle, fascia and tendon of lower back, initial encounter

continued

Table TA.A1 ICD-10 Codes for Low Back Only Conditions (continued)

ICD-10 Code	Description
S39002D	Unspecified injury of muscle, fascia and tendon of lower back, subsequent encounter
S39002S	Unspecified injury of muscle, fascia and tendon of lower back, sequela
S3901	Strain of muscle, fascia and tendon of abdomen, lower back and pelvis
S39012	Strain of muscle, fascia and tendon of lower back
S39012A	Strain of muscle, fascia and tendon of lower back, initial encounter
S39012D	Strain of muscle, fascia and tendon of lower back, subsequent encounter
S39012S	Strain of muscle, fascia and tendon of lower back, sequela
S3909	Other injury of muscle, fascia and tendon of abdomen, lower back and pelvis
S39092	Other injury of muscle, fascia and tendon of lower back
S39092A	Other injury of muscle, fascia and tendon of lower back, initial encounter
S39092D	Other injury of muscle, fascia and tendon of lower back, subsequent encounter
S39092S	Other injury of muscle, fascia and tendon of lower back, sequela
M5145	Schmorl's nodes, thoracolumbar region
M5146	Schmorl's nodes, lumbar region
M5147	Schmorl's nodes, lumbosacral region
M5380	Other specified dorsopathies, site unspecified
M5385	Other specified dorsopathies, thoracolumbar region
M5386	Other specified dorsopathies, lumbar region
M5387	Other specified dorsopathies, lumbosacral region
M5388	Other specified dorsopathies, sacral and sacrococcygeal region
M539	Dorsopathy, unspecified
M545	Low back pain
M5489	Other dorsalgia
M549	Dorsalgia, unspecified
M62830	Muscle spasm of back
M791	Myalgia
M9903	Segmental and somatic dysfunction of lumbar region
M9904	Segmental and somatic dysfunction of sacral region
M9983	Other biomechanical lesions of lumbar region

Note: See Chapter 2 for a description of how we identified low back claims.

Key: ICD: International Classification of Diseases.

Table TA.A2 ICD-10 Codes for Low Back Conditions That May Have Nerve Involvement

ICD-10 Code	Description
Low back conditions with nerve involvement (e.g., sciatica, radiculopathy, myelopathy, and other neurological conditions)	
M5410	Radiculopathy, site unspecified
M5415	Radiculopathy, thoracolumbar region
M5416	Radiculopathy, lumbar region
M5417	Radiculopathy, lumbosacral region
M5418	Radiculopathy, sacral and sacrococcygeal region
M5430	Sciatica, unspecified side
M5431	Sciatica, right side
M5432	Sciatica, left side
M544	Lumbago with sciatica
M5440	Lumbago with sciatica, unspecified side
M5441	Lumbago with sciatica, right side
M5442	Lumbago with sciatica, left side
M4710	Other spondylosis with myelopathy, site unspecified

continued

Table TA.A2 ICD-10 Codes for Low Back Conditions That May Have Nerve Involvement (continued)

ICD-10 Code	Description
M4715	Other spondylosis with myelopathy, thoracolumbar region
M4716	Other spondylosis with myelopathy, lumbar region
M4720	Other spondylosis with radiculopathy, site unspecified
M4725	Other spondylosis with radiculopathy, thoracolumbar region
M4726	Other spondylosis with radiculopathy, lumbar region
M4727	Other spondylosis with radiculopathy, lumbosacral region
M4728	Other spondylosis with radiculopathy, sacral and sacrococcygeal region
M5105	Intervertebral disc disorders with myelopathy, thoracolumbar region
M5106	Intervertebral disc disorders with myelopathy, lumbar region
M5115	Intervertebral disc disorders with radiculopathy, thoracolumbar region
M5116	Intervertebral disc disorders with radiculopathy, lumbar region
M5117	Intervertebral disc disorders with radiculopathy, lumbosacral region
M792	Neuralgia and neuritis, unspecified
Spinal stenosis	
M4800	Spinal stenosis, site unspecified
M4801	Spinal stenosis, occipito-atlanto-axial region
M4802	Spinal stenosis, cervical region
M4803	Spinal stenosis, cervicothoracic region
M4804	Spinal stenosis, thoracic region
M4805	Spinal stenosis, thoracolumbar region
M4806	Spinal stenosis, lumbar region
M4807	Spinal stenosis, lumbosacral region
M4808	Spinal stenosis, sacral and sacrococcygeal region
M9923	Subluxation stenosis of neural canal of lumbar region
M9933	Osseous stenosis of neural canal of lumbar region
M9943	Connective tissue stenosis of neural canal of lumbar region
M9953	Intervertebral disc stenosis of neural canal of lumbar region
M9963	Osseous and subluxation stenosis of intervertebral foramina of lumbar region
M9973	Connective tissue and disc stenosis of intervertebral foramina of lumbar region
Spondylolysis and spondylolisthesis[a]	
M4300	Spondylolysis, site unspecified
M4305	Spondylolysis, thoracolumbar region
M4306	Spondylolysis, lumbar region
M4307	Spondylolysis, lumbosacral region
M4309	Spondylolysis, multiple sites in spine
M4310	Spondylolisthesis, site unspecified
M4315	Spondylolisthesis, thoracolumbar region
M4316	Spondylolisthesis, lumbar region
M4317	Spondylolisthesis, lumbosacral region
M4319	Spondylolisthesis, multiple sites in spine
Instability	
M532X5	Spinal instabilities, thoracolumbar region
M532X6	Spinal instabilities, lumbar region
M532X7	Spinal instabilities, lumbosacral region
M532X8	Spinal instabilities, sacral and sacrococcygeal region

Note: See Chapter 2 for a description of how we identified low back claims.

[a] The spondylolisthesis or spondylolysis codes were treated differently. Spondylolisthesis or spondylolysis with neuro findings are considered low back pain with nerve involvement. Spondylolisthesis without neuro findings is considered as instability. Spondylolysis without neuro and without spondylolothesis are considered non-specific low back.

Key: ICD: International Classification of Diseases.

The LBP-only claims are mostly those that had non-specific back diagnoses, disc disorders with no mention of neurological findings, and less frequently, degenerative conditions without neurological findings (Table TA.A1). If a LBP claim had any ICD-10 codes in the "low back conditions with nerve involvement" category, the claim is not considered an LBP-only claim.

Table TA.A3 provides a short list of ICD-10 codes indicating neurological neck conditions. Any low back pain claims that had any of these neurological neck conditions were excluded. There are also a large number of ICD-10 codes that are related to signs, symptoms, and conditions indicating potentially serious pathology in patients presenting with back pain. These ICD-10 codes, which are not listed in the report, cover conditions such as tumor, infectious disease, and fracture and dislocation.

Table TA.A3 Red Flag Conditions and Neck Conditions with Neurological Findings

ICD-10 Code	Description
Neck conditions with neurological findings	
M4712	Other spondylosis with myelopathy, cervical region
M4713	Other spondylosis with myelopathy, cervicothoracic region
M4722	Other spondylosis with radiculopathy, cervical region
M4723	Other spondylosis with radiculopathy, cervicothoracic region
M500	Cervical disc disorder with myelopathy
M5000	Cervical disc disorder with myelopathy, unspecified cervical region
M5001	Cervical disc disorder with myelopathy, high cervical region
M5002	Cervical disc disorder with myelopathy, mid-cervical region
M5003	Cervical disc disorder with myelopathy, cervicothoracic region
M5012	Cervical disc disorder with radiculopathy, mid-cervical region
M5412	Radiculopathy, cervical region

Note: A large number of red flag diagnostic codes were used for identifying claims with more serious conditions. These codes are available but not presented in the report.

Key: ICD: International Classification of Diseases.

In addition to the red flag conditions and neurological neck and back diagnoses, we identified a list of ICD-10 codes for comorbidities with serious complications and excluded the low back claims that had any of these ICD-10 codes, because workers with these diagnoses are not considered as clinically appropriate candidates for PT treatment. Table TA.A4 lists these ICD-10 codes.

Table TA.A4 ICD-10 Codes for Comorbidities with Complications

Conditions	ICD-10 Codes
Diabetes with hyperosmolarity, ketoacidosis, or hypoglycemia with or without coma	E0800, E0801, E081, E0810, E0811, E0864, E08641, E08649, E0900, E0901, E091, E0910, E0911, E0964, E09641, E09649, E101, E1010, E1011, E1064, E10641, E10649, E1101, E1164, E11641, E11649, E1300, E1301, E131, E1310, E1311, E1364, E13641, E13649, E232
Psychotic disorders or severe psychotic symptoms	F060, F062, F23, F24, F28, F3013, F302
Psychotic disorders, with alcohol, drug, and substance abuse and dependence	F1015, F1025, F1095, F1115, F1125, F1195, F1215, F1225, F1295, F1315, F1325, F1395, F1415, F1425, F1495, F1515, F1525, F1595, F1615, F1625, F1695, F1815, F1825, F1895
Intoxication, withdrawal, or psychotic disorders involving other psychoactive substance abuse and dependence	F1912, F19120, F19121, F19122, F19129, F1915, F19150, F19151, F19159, F1922, F19220, F19221, F19222, F19229, F1923, F19230, F19231, F19232, F19239, F1925, F19250, F19251, F19259, F1992, F19920, F19921, F19922, F19929, F1993, F19930, F19931, F19932, F19939, F1995, F19950, F19951, F19959
Bipolar disorders	F3113, F312, F314, F315, F3163, F3164
Major depressive disorders, with psychotic features	F322, F332, F333

Note: The ICD-10 codes indicate comorbidities with serious complications. Claims with any of the ICD-10 codes on this list were excluded from the early PT analysis.

Key: ICD: International Classification of Diseases.

TECHNICAL APPENDIX B

SEVERITY AND COMORBIDITIES

One of the challenges for a study that examines the effect of an intervention on outcomes based on observational data is the lack of control for differences in severity and comorbidities of the conditions across different groups of interest. Workers with injuries who are referred to PT services at a later stage of treatment may have more serious conditions or comorbidities that need to be addressed before PT treatment to facilitate recovery and restore functioning. This may include diagnostic tests or imaging studies that help rule in or rule out a suspected serious condition or, in some cases, treatments for more severe comorbidities before the patient is ready for PT. Although administrative data may not have all the information that is needed to control for the differences in the severity of low back pain and comorbidities, one can assess from the available data how much the potential bias, or the lack of controlling for these factors, may affect the results.

For this study, we tried to control for severity in two ways. First, we selected a set of relatively homogeneous claims that had only LBP conditions without red flags or nerve involvement. For these uncomplicated low back claims, PT treatment would most likely be the primary mode of medical care. We observed, although infrequently, some claims that had pain management injections and low back surgery prior to receiving PT treatment. Although this may reflect a practice pattern that may not be in accordance with evidence-based medicine, it is conceivable that a number of such claims may represent more serious LBP that was not properly coded in the administrative data. We used these pre-PT invasive procedures as a proxy for severity. By doing so, we erred on the conservative side in the estimation of the impact of early versus delayed PT.[1]

For comorbidities, we developed an ICD-10 comorbidity list specific to this study after reviewing the comorbidity instruments in the literature.[2] Table TA.B1 provides the ICD-10 codes we used to create a comorbidity indicator for workers who received PT treatments.

[1] It is possible that some workers might receive an invasive procedure due to practice patterns instead of medical necessity. If this happens, the late PT is not because of the severity as indicated by an appropriate invasive procedure, and therefore, the use of an invasive procedure to indicate severity would have an effect of exaggerating the severity, downplaying the true effect of late PT. Wang, Mueller, and Lea (2019a) provided the CPT codes we identified for pain management injections and low back surgery.

[2] Among several comorbidity indexes we reviewed, the Charlson comorbidity index (CCI) (Charlson et al., 1987) and the Elixhauser comorbidity index (ECI) (Elixhauser et al., 1998) were based on the International Classification of Diseases diagnosis codes recorded in the administrative data. The CCI has 17 categories including heart disease, pulmonary disease, diabetes with or without chronic complications, tumor and malignancy, AIDS/HIV, etc. The ECI originally had 30 categories, used primarily for predicting hospital resource use and mortality. Quan et al. (2005) established ICD-9 and ICD-10 list for 31 categories of the ECI. In addition to several more serious diseases and conditions found in the CCI, it also includes several conditions relevant to our study, including obesity, alcohol and drug abuse, psychoses, and depression. The ICD-10 comorbidity list we established partially reflects these categories.

Table TA.B1 ICD-10 List of Comorbidities for LBP-Only Claims with PT Treatment

Comorbidity Type	ICD-10 Coding Description
Alcohol or drug abuse[a]	Alcohol abuse: F10.x, E52, G62.1, I42.6, K29.2x, K70.x, T51.x, Z50.2, Z71.4x; Drug abuse: F11.x - F16.x, F18.x, F19.x, F55.x, Z71.5x, Z72.2
Chronic pain	G4422, G4432, G892, G8921, G8922, G8928, G8929, G894, and R5382 (ICD-10 codes indicating chronic pain or symptom within 3 months of injury)
Diabetes*	Diabetes due to underlying condition: E08,x; Drug or chemical induced diabetes: E09,x; Type 1 diabetes: E10.x; Type 2 diabetes: E11.x
Obesity	Obesity: E66, E66.0, E66.01, E66.09, E66.1, E66.2; Overweight: E66.3, E66.8, E66.9
Psychosocial issues[a]	Anxiety and depression: F31.3x, F32.x - F34.x, F41.x, F43.x, F48.1, F48.8, and F48.9; Psychoses: F20.x, F22 - F25, F28.x, F29.x, F30.1x, F30.2, F31.1x; Pain or problem related with psychosocial factors: F454, F4541, F4542, Z658, Z659; Adult psychological abuse: T74.3x, T76.3x; Anti-social: Z72.81x
Smoking	Tobacco use: Z72.0
Lifestyle issue	(Other than smoking): Z72.x Lack of physical exercise: Z72.3

Notes: The ICD-10 comorbidity list we developed was partially based on the ICD-10 codes selected for the CCI (Charlson et al., 1987) and ECI (Elixhauser, 1998; Quan et al., 2005).

[a] In these comorbidity categories (alcohol or drug abuse, diabetes, and psychosocial issues), we identified more than 100 ICD-10 codes that indicate serious conditions or complications (e.g., diabetes with hypoglycemia or ketoacidosis, substance abuse with psychotic disorders, and bipolar disorders). These conditions, if present in the patient's record, are not suitable for PT treatment. We further excluded a small number of claims with these conditions from the study.

Family history and hypertension are not considered comorbidities in our study.

Key: CCI: Charlson comorbidity index; ECI: Elixhauser comorbidity index; ICD: International Classification of Diseases; LBP: low back pain; PT: physical therapy.

The major comorbidity categories we identified include alcohol or drug abuse, diabetes, obesity, psychosocial factors, and smoking. We also identified a list of ICD-10 codes indicating chronic pain conditions (e.g., chronic pain syndrome, G894; unspecified chronic fatigue, R5382; and chronic tension-type headache, G4422). If a claim had any of the chronic conditions listed above that were mentioned in the medical services data for the initial three months of treatment after the onset of low back pain, the claim is considered as having comorbid chronic pain. We use the three-month time window to make sure that the chronic pain mentioned was likely due to a preexisting condition, rather than chronic pain arising late in the treatment. For the LBP-only claims included in our study, Table TA.B2 shows the frequency of claims that ever had at least one of these comorbid conditions.

Table TA.B2 Identifying Comorbidities Using ICD-10 Codes

Type of Comorbidity	LBP Claims with Nerve Involvement with > 7 DLT	LBP Claims with Nerve Involvement with ≤ 7 DLT	LBP-Only Claims with > 7 DLT	LBP-Only Claims with ≤ 7 DLT
% of claims with ICD-10 codes indicating the following comorbid conditions				
Alcohol or drug abuse[a]	1.0%	0.3%	0.2%	0.1%
Chronic pain within first 3 months	3.3%	1.9%	1.0%	0.6%
Diabetes[a]	2.7%	1.1%	1.1%	0.6%
Lifestyle issues (e.g., lack of physical exercise)	0.0%	0.0%	0.0%	0.0%
Obesity	3.3%	1.1%	1.1%	0.3%
Psychosocial issues[a]	3.6%	1.1%	1.2%	0.5%
Smoking	1.2%	0.5%	0.5%	0.3%
At least one of the above	**12.9%**	**5.5%**	**4.7%**	**2.2%**

Notes: We do not consider hypertension and family history to be comorbidities since these are less likely to make a difference for PT treatment. The percentages of claims with each type of identified comorbidity do not add up to the percentage of claims with comorbidities because the claims with types of comorbidities are not mutually exclusive.

[a] In these comorbidity categories (alcohol or drug abuse, diabetes, and psychosocial issues), we identified more than 100 ICD-10 codes that indicate serious conditions or complications (e.g., diabetes with hypoglycemia or ketoacidosis, substance abuse with psychotic disorders, and bipolar disorders). These conditions, if present in the patient's record, are not suitable for PT treatment. We further excluded a small number of claims with these conditions from the study.

Key: DLT: days of lost time; ICD: International Classification of Diseases; LBP: low back pain; PT: physical therapy.

It is a valid concern that the comorbidities may be under-identified for the workers receiving care under workers' compensation. Since the treatment of comorbidities is normally not covered by workers' compensation, there is no economic incentive for a provider to code and for a carrier to keep ICD-10 codes indicating comorbidities for the workers. However, we do see a considerable number of claims that have detailed medical transactions where ICD-10 codes are kept for some specific comorbid conditions, especially when the ICD-10 codes are kept for multiple diagnoses on the bill. Based on these observations, we established a list of ICD-10 codes indicating comorbidities that could be considered by medical providers when making decisions for PT treatment for LBP patients. Table TA.B3 provides the same frequency measure but is based on claims that had at least an office visit for which we have multiple ICD-10 codes populated in the detailed medical transaction data used for the study.

It should be noted that even with the comorbidity list, comorbidities may likely be under-identified to the extent that not every provider recorded diagnoses they observed and certain conditions were not observed or coded. For this reason, we likely understate the prevalence of comorbidities even if we use the data that have multiple ICD-10 codes recorded. We do not know exactly how much such an understatement may affect the estimated effect of early versus delayed PT. However, the measured prevalence of comorbidities varies across the PT timing groups in our data (Table 3.5), and the impact of the measured comorbidities on the outcomes we studied are large and significant (Tables TA.C1 through TA.C6). This may imply that at least some of the most important comorbidities are captured in our data. At the same time, it highlights the need for improvement in coding and data collection.

Table TA.B3 Frequency of LBP-Only Claims with Comorbidities Identified, Claims with Multiple ICD-10 Codes

Type of Comorbidity	LBP Claims with Nerve Involvement with > 7 DLT	LBP Claims with Nerve Involvement with ≤ 7 DLT	LBP-Only Claims with > 7 DLT	LBP-Only Claims with ≤ 7 DLT
% of claims with ICD-10 codes indicating the following comorbid conditions				
Alcohol or drug abuse[a]	1.1%	0.3%	0.3%	0.2%
Chronic pain within first 3 months	3.8%	2.3%	1.5%	1.0%
Diabetes[a]	3.1%	1.3%	1.6%	1.1%
Lifestyle issues (e.g., lack of physical exercise)	0.1%	0.0%	0.0%	0.0%
Obesity	3.8%	1.4%	1.5%	0.6%
Psychosocial issues[a]	4.0%	1.4%	1.7%	0.8%
Smoking	1.4%	0.6%	0.7%	0.5%
At least one of the above	**14.5%**	**6.7%**	**6.7%**	**3.8%**

Notes: We do not consider hypertension and family history to be comorbidities since these are less likely to make a difference for PT treatment. The percentages of claims with each type of identified comorbidity do not add up to the percentage of claims with comorbidities because the claims with types of comorbidities are not mutually exclusive.

[a] In these comorbidity categories (alcohol or drug abuse, diabetes, and psychosocial issues), we identified more than 100 ICD-10 codes that indicate serious conditions or complications (e.g., diabetes with hypoglycemia or ketoacidosis, substance abuse with psychotic disorders, and bipolar disorders). These conditions, if present in the patient's record, are not suitable for PT treatment. We further excluded a small number of claims with these conditions from the study.

Key: DLT: days of lost time; ICD: International Classification of Diseases; LBP: low back pain; PT: physical therapy.

Technical Appendix C

Statistical and Sensitivity Analyses

The results presented in Chapter 4 are based on our statistical analysis that examined the impact of early PT on outcomes of interest, controlling for factors that influence the timing of PT initiation and are associated with outcomes. Instead of reporting coefficient estimates of the PT timing variables and other variables included in the regression, we interpret these estimates by computing the predicted values of the given outcome variable holding constant all other variables in the statistical model. In this technical appendix, we provide the estimated results for each outcome variable we studied. We also describe several sensitivity analyses that were aimed at addressing certain data and measurement issues arising in our analysis.

Tables TA.C1 through C6 provide the coefficient estimates of the PT timing groups and other control variables across five model specifications for each of the outcomes we studied. We started with the basic model, which yielded results that are very close to what we reported in the Chapter 3 descriptive analysis. The specification was expanded to include a set of case-mix adjustment variables that are typically controlled for in many WCRI studies. Variables that approximate severity and identify comorbidities were added to the third model specification, and in the fourth model, we added the two variables we created that characterize the medical service setting where PT referring physicians and PT providers share the same unique provider ID or are affiliated with the same health care organization. This captures health care organization structure and serves as a proxy for organization-level treatment protocols. And in the final specification we added several county-level variables to capture geographic variation that could be correlated with both PT timing and outcomes. We used logistic regressions for the likelihood of receiving MRI, opioid prescriptions, pain management injections, and low back surgery, and OLS was used for the per-claim medical payments and TD duration. There is one table for each outcome variable and five columns in each table corresponding to the five model specifications.

Table TA.C1 Coefficient Estimates of Logistic Regression—Likelihood of Receiving MRI during First Year of Treatment

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	-0.906 ***	-1.496 ***	-1.524 ***	-1.602 ***	-0.626
PT timing (reference: PT initiated within 3 days of injury)					
4–7 days	-0.069	-0.010	-0.014	0.001	-0.003
8–14 days	0.056	0.071	0.058	0.098 *	0.098 *
15–30 days	0.314 ***	0.273 ***	0.260 ***	0.316 ***	0.309 ***
After 30 days	0.815 ***	0.676 ***	0.645 ***	0.703 ***	0.680 ***
Controlling for state-specific factors (reference: MI)					
AR		0.544 **	0.553 **	0.540 **	0.463 *
CA		0.179	0.193 *	0.148	0.176
CT		-0.259 *	-0.246 *	-0.262 *	-0.268 *
DE		0.281	0.315	0.331	0.332
FL		1.120 ***	1.146 ***	1.129 ***	1.121 ***
GA		0.688 ***	0.706 ***	0.698 ***	0.683 ***
IA		-0.159	-0.173	-0.180	-0.138
IL		-0.116	-0.104	-0.105	-0.155
IN		0.167	0.176	0.167	0.158
KS		0.166	0.152	0.149	0.148
KY		0.738 ***	0.736 ***	0.730 ***	0.636 ***
LA		0.210	0.202	0.197	0.087
MA		-0.518 ***	-0.529 ***	-0.515 ***	-0.470 ***
MD		-0.431 ***	-0.418 ***	-0.425 ***	-0.399 **
MN		-0.016	-0.027	-0.053	0.071
MO		-0.254	-0.237	-0.239	-0.260
NC		0.284 *	0.288 *	0.284 *	0.274 *
NJ		0.167	0.173	0.169	0.126
NV		0.472 **	0.469 **	0.440 **	0.409 **
NY		0.470 ***	0.480 ***	0.468 ***	0.418 ***
PA		0.027	0.036	0.051	0.029
SC		0.336 **	0.359 **	0.373 **	0.357 **
TN		0.514 ***	0.508 ***	0.499 ***	0.417 ***
TX		-0.355 ***	-0.337 ***	-0.373 ***	-0.376 ***
VA		0.010	0.017	0.018	0.050
WI		-0.694 ***	-0.722 ***	-0.753 ***	-0.707 ***
Worker's age (reference: 35–44 years of age)					
Younger than 25 years old		-0.320 ***	-0.307 ***	-0.304 ***	-0.299 ***
25–34 years of age		-0.148 ***	-0.143 ***	-0.140 ***	-0.145 ***
45–54 years of age		-0.060	-0.065	-0.063	-0.063
55 years or older		-0.153 ***	-0.159 ***	-0.154 ***	-0.149 ***
Missing data on age		-0.053	-0.060	-0.039	-0.026
Worker's gender (reference: female)					
Male		-0.052	-0.051	-0.054	-0.001
Missing data on gender		0.216 *	0.224 *	0.215 *	0.000
Worker's marital status (reference: single)					
Married		0.022	0.024	0.028	0.028
Other		-0.003	0.003	0.012	0.011
Missing data on marital status		0.016	0.015	0.017	0.004
Worker's average weekly wage		0.044 ***	0.042 ***	0.042 ***	0.043 ***
Worker's tenure with preinjury employer (reference: from 2 to 5 years)					
Shorter than 2 years		0.045	0.043	0.040	0.035
From 5 up to 10 years		0.032	0.029	0.027	0.020
From 10 up to 20 years		0.057	0.048	0.047	0.039
Longer than 20 years		0.042	0.042	0.042	0.043
Missing data on tenure		0.179 ***	0.188 ***	0.193 ***	0.172 ***
Industry (reference: clerical and professional)					
Manufacturing		0.294 ***	0.315 ***	0.319 ***	0.299 ***
Construction		0.157	0.172 *	0.171 *	0.157
High-risk industry		-0.036	-0.019	-0.018	-0.040
Trade		0.124	0.139 *	0.139 *	0.138 *
Low-risk industry		0.002	0.018	0.017	0.014
Other industries		0.143 *	0.165 *	0.171 **	0.133
Missing data on industry		-0.154	-0.156	-0.151	-0.227

continued

Table TA.C1 Coefficient Estimates of Logistic Regression—Likelihood of Receiving MRI during First Year of Treatment (continued)

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Firm size (reference: medium size firm with payroll between 10 and 30 million)					
Payroll under 1 million		-0.181 *	-0.184 *	-0.177 *	-0.201 **
Payroll between 1 and 10 million		-0.059	-0.068	-0.071	-0.081
Payroll greater than 30 million		0.002	0.001	0.009	0.006
Missing data on payroll		-0.014	-0.016	-0.003	0.000
Attorney involvement and time to first medical visit					
Claim with (defense) attorney involvement (=1, 0 otherwise)		1.062 ***	1.048 ***	1.048 ***	1.052 ***
Days from injury to 1st medical visit		-0.001	-0.001	0.000	0.000
Severity and comorbidities					
Worker had injections postinjury before receiving PT treatment (=1, 0 otherwise)			0.669 ***	0.662 ***	0.668 ***
Worker had low back surgery postinjury before PT treatment (=1, 0 otherwise)			-0.771 *	-0.765 *	-0.769 *
Having at least one comorbidity			0.551 ***	0.553 ***	0.544 ***
Health care setting where worker received care					
Same-billing-entity providers for office visits and PT services				0.129 ***	0.117 ***
Direct PT (receiving PT services without an office visit)				-0.228 ***	-0.222 **
County-level population data					
Rural vs. urban area (1=rural area, 0 otherwise)					0.010
Prevalence of physical activity (0 - 100)					-0.016 **
Unemployment rate					0.043 ***
Number of licensed physical therapists, per 100,000 population (2009 data)					0.0001

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.
The asterisks next to the estimates indicate the level of statistical significance, where *** is statistically significant at the 1 percent level, ** at the 5 percent level, and *** at the 10 percent level.

Key: DLT: days of lost time; LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy.

Table TA.C2 Coefficient Estimates of Logistic Regression—Likelihood of Receiving Opioid Prescriptions during First Year of Treatment

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	-0.945 ***	-0.655 ***	-0.685 ***	-0.609 ***	-1.309 *
PT timing (reference: PT initiated within 3 days of injury)					
4–7 days	0.002	-0.057	-0.062	-0.075	-0.059
8–14 days	0.383 ***	0.309 ***	0.297 ***	0.260 ***	0.274 ***
15–30 days	0.626 ***	0.534 ***	0.520 ***	0.463 ***	0.471 ***
After 30 days	0.838 ***	0.754 ***	0.701 ***	0.638 ***	0.634 ***
Controlling for state-specific factors (reference: MI)					
AR		0.669 **	0.639 **	0.646 **	0.807 **
CA		-0.340 ***	-0.337 ***	-0.291 **	-0.293 **
CT		-0.496 ***	-0.504 ***	-0.483 ***	-0.544 ***
DE		-0.312	-0.292	-0.295	-0.247
FL		-0.212	-0.197	-0.178	-0.122
GA		0.103	0.103	0.116	0.150
IA		0.357	0.343	0.347	0.413
IL		-0.483 ***	-0.488 ***	-0.473 ***	-0.539 ***
IN		-0.175	-0.186	-0.164	-0.065
KS		0.081	0.026	0.044	0.110
KY		-0.310	-0.355	-0.337	-0.372
LA		0.807 ***	0.780 ***	0.793 ***	0.757 ***
MA		-0.045	-0.068	-0.057	0.014
MD		-0.036	-0.036	-0.022	0.050
MN		0.235	0.198	0.230	0.326
MO		-0.430 **	-0.429 **	-0.421 **	-0.399 **
NC		0.448 ***	0.425 **	0.433 **	0.462 ***
NJ		-0.855 ***	-0.872 ***	-0.870 ***	-0.856 ***
NV		0.079	0.063	0.096	0.116
NY		-0.420 **	-0.476 ***	-0.456 **	-0.456 **
PA		-0.225	-0.238	-0.245	-0.243
SC		0.269	0.263	0.257	0.310
TN		0.195	0.161	0.177	0.223
TX		0.266 *	0.274 **	0.310 **	0.416 ***
VA		0.288	0.272	0.272	0.373 *
WI		0.237	0.201	0.221	0.245
Worker's age (reference: 35–44 years of age)					
Younger than 25 years old		-0.497 ***	-0.476 ***	-0.478 ***	-0.487 ***
25–34 years of age		-0.183 ***	-0.176 ***	-0.178 ***	-0.166 ***
45–54 years of age		0.057	0.048	0.047	0.040
55 years or older		0.106	0.095	0.092	0.091
Missing data on age		0.045	0.072	0.084	0.090
Worker's gender (reference: female)					
Male		-0.152 ***	-0.154 ***	-0.153 ***	-0.164 ***
Missing data on gender		0.115	0.134	0.141	0.000
Worker's marital status (reference: single)					
Married		0.025	0.030	0.028	0.031
Other		-0.129 **	-0.123 **	-0.131 **	-0.128 **
Missing data on marital status		-0.061	-0.063	-0.065	-0.077
Worker's average weekly wage		0.014	0.011	0.011	0.011
Worker's tenure with preinjury employer (reference: from 2 to 5 years)					
Shorter than 2 years		0.056	0.052	0.054	0.060
From 5 up to 10 years		-0.052	-0.060	-0.058	-0.061
From 10 up to 20 years		-0.103	-0.123	-0.124	-0.116
Longer than 20 years		-0.161	-0.164	-0.165	-0.149
Missing data on tenure		0.203 ***	0.210 ***	0.207 ***	0.210 ***
Industry (reference: clerical and professional)					
Manufacturing		-0.041	-0.009	-0.009	-0.037
Construction		0.053	0.075	0.075	0.072
High-risk industry		-0.220 **	-0.190 **	-0.189 **	-0.207 **
Trade		-0.079	-0.048	-0.049	-0.065
Low-risk industry		-0.164 *	-0.139	-0.137	-0.158
Other industries		-0.122	-0.088	-0.095	-0.152
Missing data on industry		0.225	0.225	0.230	0.280

continued

Table TA.C2 Coefficient Estimates of Logistic Regression—Likelihood of Receiving Opioid Prescriptions during First Year of Treatment (continued)

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Firm size (reference: medium size firm with payroll between 10 and 30 million)					
Payroll under 1 million		0.034	0.035	0.032	0.022
Payroll between 1 and 10 million		0.154 *	0.148	0.152	0.133
Payroll greater than 30 million		-0.015	-0.011	-0.016	-0.007
Missing data on payroll		0.028	0.028	0.015	0.031
Attorney involvement and time to first medical visit					
Claim with (defense) attorney involvement (=1, 0 otherwise)		0.469 ***	0.450 ***	0.452 ***	0.463 ***
Days from injury to 1st medical visit		-0.006 ***	-0.006 ***	-0.006 ***	-0.007 ***
Severity and comorbidities					
Worker had injections postinjury before receiving PT treatment (=1, 0 otherwise)			1.049 ***	1.048 ***	1.038 ***
Worker had low back surgery postinjury before PT treatment (=1, 0 otherwise)			1.199 **	1.190 **	1.126 **
Having at least one comorbidity			0.718 ***	0.721 ***	0.704 ***
Health care setting where worker received care					
Same-billing-entity providers for office visits and PT services				-0.126 ***	-0.102 **
Direct PT (receiving PT services without an office visit)				0.095	0.092
County-level population data					
Rural vs. urban area (1=rural area, 0 otherwise)					0.306 **
Prevalence of physical activity (0 - 100)					0.002
Unemployment rate					0.086 ***
Number of licensed physical therapists, per 100,000 population (2009 data)					0.0016

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.
The asterisks next to the estimates indicate the level of statistical significance, where *** is statistically significant at the 1 percent level, ** at the 5 percent level, and *** at the 10 percent level.

Key: DLT: days of lost time; LBP: low back pain; PT: physical therapy.

Table TA.C3 Coefficient Estimates of Logistic Regression—Likelihood of Receiving Pain Management Injections during First Year of Treatment

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	-2.497 ***	-3.110 ***	-3.145 ***	-3.245 ***	-3.470 ***
PT timing (reference: PT initiated within 3 days of injury)					
4–7 days	-0.185 *	-0.181 *	-0.185 *	-0.164	-0.176
8–14 days	0.006	-0.047	-0.078	-0.025	-0.028
15–30 days	0.240 ***	0.141	0.075	0.149	0.140
After 30 days	0.709 ***	0.432 ***	0.236 **	0.313 ***	0.314 ***
Controlling for state-specific factors (reference: MI)					
AR		0.877 **	0.833 **	0.816 **	0.843 **
CA		0.071	0.071	0.007	-0.034
CT		0.550 **	0.573 **	0.549 **	0.559 **
DE		-0.361	-0.322	-0.319	-0.215
FL		0.513 **	0.544 **	0.522 **	0.524 **
GA		0.979 ***	0.999 ***	0.985 ***	0.948 ***
IA		0.222	0.048	0.035	0.034
IL		0.127	0.102	0.099	0.056
IN		0.699 **	0.646 **	0.636 **	0.670 **
KS		0.984 ***	0.842 **	0.840 **	0.836 **
KY		0.799 ***	0.798 ***	0.789 ***	0.728 **
LA		0.783 ***	0.702 **	0.696 **	0.646 **
MA		-0.337	-0.400	-0.379	-0.310
MD		-0.060	-0.118	-0.129	-0.106
MN		0.408	0.342	0.307	0.333
MO		0.392	0.399	0.395	0.398
NC		0.771 ***	0.683 ***	0.676 ***	0.657 ***
NJ		-0.114	-0.193	-0.202	-0.197
NV		0.975 ***	0.910 ***	0.871 ***	0.826 ***
NY		0.326	0.273	0.248	0.218
PA		0.033	-0.017	-0.001	0.012
SC		0.431 *	0.392	0.413	0.422
TN		0.358	0.269	0.251	0.213
TX		-0.467 **	-0.469 **	-0.521 **	-0.530 **
VA		0.694 ***	0.723 ***	0.721 ***	0.743 ***
WI		-0.017	-0.201	-0.245	-0.241
Worker's age (reference: 35–44 years of age)					
Younger than 25 years old		-0.615 ***	-0.603 ***	-0.601 ***	-0.594 ***
25–34 years of age		-0.365 ***	-0.333 ***	-0.330 ***	-0.336 ***
45–54 years of age		0.016	0.012	0.016	0.007
55 years or older		-0.042	-0.061	-0.054	-0.075
Missing data on age		-0.844	-0.766	-0.737	-0.756
Worker's gender (reference: female)					
Male		0.029	0.023	0.018	0.022
Missing data on gender		0.235	0.327	0.315	0.000
Worker's marital status (reference: single)					
Married		0.009	0.023	0.028	0.026
Other		0.003	0.036	0.049	0.039
Missing data on marital status		0.105	0.126	0.129	0.136
Worker's average weekly wage		0.028	0.018	0.019	0.018
Worker's tenure with preinjury employer (reference: from 2 to 5 years)					
Shorter than 2 years		-0.178 **	-0.209 **	-0.214 **	-0.217 ***
From 5 up to 10 years		-0.051	-0.086	-0.090	-0.096
From 10 up to 20 years		0.021	-0.061	-0.063	-0.065
Longer than 20 years		-0.072	-0.121	-0.125	-0.119
Missing data on tenure		0.058	0.009	0.014	0.005
Industry (reference: clerical and professional)					
Manufacturing		0.098	0.172	0.177	0.138
Construction		0.281 *	0.338 **	0.336 **	0.251
High-risk industry		-0.066	-0.005	-0.007	-0.021
Trade		0.070	0.132	0.129	0.113
Low-risk industry		-0.003	0.043	0.042	0.013
Other industries		0.046	0.143	0.148	0.122
Missing data on industry		-0.570	-0.730 *	-0.722 *	-1.121 *

continued

Table TA.C3 Coefficient Estimates of Logistic Regression—Likelihood of Receiving Pain Management Injections during First Year of Treatment (continued)

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Firm size (reference: medium size firm with payroll between 10 and 30 million)					
Payroll under 1 million		0.045	0.080	0.085	0.065
Payroll between 1 and 10 million		0.170	0.163	0.158	0.150
Payroll greater than 30 million		0.180	0.206	0.217 *	0.229 *
Missing data on payroll		0.228 **	0.255 **	0.273 **	0.287 **
Attorney involvement and time to first medical visit					
Claim with (defense) attorney involvement (=1, 0 otherwise)		0.828 ***	0.830 ***	0.829 ***	0.844 ***
Days from injury to 1st medical visit		0.003 **	0.004 ***	0.005 ***	0.005 ***
Severity and comorbidities					
Worker had injections postinjury before receiving PT treatment (=1, 0 otherwise)			17.431	17.429	17.491
Worker had low back surgery postinjury before PT treatment (=1, 0 otherwise)			-0.265	-0.282	-0.314
Having at least one comorbidity			0.915 ***	0.916 ***	0.870 ***
Health care setting where worker received care					
Same-billing-entity providers for office visits and PT services				0.172 ***	0.176 ***
Direct PT (receiving PT services without an office visit)				-0.352 **	-0.339 **
County-level population data					
Rural vs. urban area (1=rural area, 0 otherwise)					0.215
Prevalence of physical activity (0 - 100)					0.001
Unemployment rate					0.041
Number of licensed physical therapists, per 100,000 population (2009 data)					-0.0005

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.
The asterisks next to the estimates indicate the level of statistical significance, where *** is statistically significant at the 1 percent level, ** at the 5 percent level, and *** at the 10 percent level.

Key: DLT: days of lost time; LBP: low back pain; PT: physical therapy.

Table TA.C4 Coefficient Estimates of Logistic Regression—Likelihood of Receiving Low Back Surgery during First Year of Treatment

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	-4.547 ***	-6.668 ***	-6.393 ***	-6.812 ***	-5.516 **
PT timing (reference: PT initiated within 3 days of injury)					
4–7 days	-0.220	-0.299	-0.323	-0.266	-0.219
8–14 days	0.147	-0.012	0.111	0.061	0.102
15–30 days	0.280	0.066	0.066	0.169	0.206
After 30 days	1.343 ***	0.584 ***	0.596 ***	0.699 ***	0.736 ***
Controlling for state-specific factors (reference: MI)					
AR		0.443	0.430	0.424	0.368
CA		0.576	0.582	0.488	0.677
CT		1.036 *	1.128 **	0.989 *	0.880
DE		1.614 *	1.711 **	1.613 *	1.678 *
FL		0.114	0.265	0.092	0.158
GA		0.850	0.928	0.824	0.955
IA		0.101	0.101	0.095	0.137
IL		0.686	0.677	0.655	0.670
IN		1.133 *	1.190 *	1.114 *	1.095
KS		1.453 **	1.400 *	1.439 **	1.472 **
KY		0.409	0.359	0.391	0.328
LA		1.456 **	1.439 **	1.429 **	1.438 **
MA		-1.099	-0.593	-1.103	-1.215
MD		0.578	0.388	0.546	0.624
MN		0.294	0.307	0.227	0.319
MO		0.737	0.779	0.723	0.650
NC		0.830	0.889	0.824	0.879
NJ		0.506	0.665	0.503	0.454
NV		1.470 **	1.446 **	1.414 **	1.569 **
NY		0.757	0.877	0.705	0.522
PA		-0.423	0.372	-0.409	-0.441
SC		1.332 **	1.376 **	1.357 **	1.433 **
TN		0.327	0.350	0.305	0.260
TX		-0.293	0.280	-0.371	-0.266
VA		1.108 *	1.130 *	1.104 *	1.199 *
WI		-1.123	-0.645	-1.196	-1.179
Worker's age (reference: 35–44 years of age)					
Younger than 25 years old		-0.490	-0.441	-0.489	-0.452
25–34 years of age		-0.518 **	-0.410 **	-0.514 **	-0.504 **
45–54 years of age		0.095	0.151	0.101	0.096
55 years or older		0.300 *	0.316 **	0.312 *	0.334 *
Missing data on age		-7.567	-7.547	-7.559	-7.563
Worker's gender (reference: female)					
Male		-0.162	-0.066	-0.168	-0.075
Missing data on gender		0.099	0.302	0.085	0.000
Worker's marital status (reference: single)					
Married		0.044	0.054	0.047	0.049
Other		0.022	0.004	0.036	0.040
Missing data on marital status		-0.193	-0.230	-0.194	-0.198
Worker's average weekly wage		0.225 ***	0.185 ***	0.225 ***	0.218 ***
Worker's tenure with preinjury employer (reference: from 2 to 5 years)					
Shorter than 2 years		-0.427 **	-0.461 ***	-0.434 **	-0.444 **
From 5 up to 10 years		-0.442 *	-0.477 **	-0.450 *	-0.448 *
From 10 up to 20 years		-0.229	-0.220	-0.227	-0.231
Longer than 20 years		-0.187	-0.226	-0.196	-0.210
Missing data on tenure		-0.002	0.010	-0.004	-0.008
Industry (reference: clerical and professional)					
Manufacturing		0.653 **	0.601 **	0.655 **	0.590 *
Construction		0.674 *	0.462	0.677 *	0.645 *
High-risk industry		0.194	0.147	0.190	0.188
Trade		0.121	0.036	0.122	0.072
Low-risk industry		0.446	0.247	0.450	0.407
Other industries		0.070	-0.029	0.078	0.010
Missing data on industry		-0.936	-0.644	-0.934	-0.350

continued

Table TA.C4 Coefficient Estimates of Logistic Regression—Likelihood of Receiving Low Back Surgery during First Year of Treatment (continued)

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Firm size (reference: medium size firm with payroll between 10 and 30 million)					
Payroll under 1 million		0.032	0.183	0.036	-0.077
Payroll between 1 and 10 million		0.229	0.207	0.221	0.219
Payroll greater than 30 million		0.386	0.209	0.388	0.388
Missing data on payroll		0.057	-0.029	0.077	0.084
Attorney involvement and time to first medical visit					
Claim with (defense) attorney involvement (=1, 0 otherwise)		0.483 ***	0.445 ***	0.475 ***	0.471 ***
Days from injury to 1st medical visit		0.011 ***	0.010 ***	0.011 ***	0.010 ***
Severity and comorbidities					
Worker had injections postinjury before receiving PT treatment (=1, 0 otherwise)			-0.050	0.106	0.113
Worker had low back surgery postinjury before PT treatment (=1, 0 otherwise)			62.674	62.875	63.656
Having at least one comorbidity			1.298 ***	1.261 ***	1.262 ***
Health care setting where worker received care					
Same-billing-entity providers for office visits and PT services				0.262 *	0.280 *
Direct PT (receiving PT services without an office visit)				-0.022	0.035
County-level population data					
Rural vs. urban area (1=rural area, 0 otherwise)					0.063
Prevalence of physical activity (0 - 100)					-0.020
Unemployment rate					-0.014
Number of licensed physical therapists, per 100,000 population (2009 data)					0.0046

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.
The asterisks next to the estimates indicate the level of statistical significance, where *** is statistically significant at the 1 percent level, ** at the 5 percent level, and *** at the 10 percent level.

Key: DLT: days of lost time; LBP: low back pain; PT: physical therapy.

Table TA.C5 Coefficient Estimates of OLS—Payments per Claim for All Medical Services during First Year of Treatment

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	7.977	7.741	7.729	7.689	8.005
PT timing (reference: PT initiated within 3 days of injury)					
4–7 days	-0.044 **	-0.031	-0.033	-0.026	-0.029
8–14 days	-0.020	-0.023	-0.032 *	-0.013	-0.012
15–30 days	0.018	0.018	0.009	0.036 **	0.036 *
After 30 days	0.255 ***	0.208 ***	0.174 ***	0.202 ***	0.196 ***
Controlling for state-specific factors (reference: MI)					
AR		-0.220 **	-0.215 **	-0.222 **	-0.238 ***
CA		-0.023	-0.014	-0.037	-0.024
CT		0.054	0.060	0.054	0.043
DE		0.313 ***	0.335 ***	0.346 ***	0.373 ***
FL		0.021	0.038	0.030	0.025
GA		0.223 ***	0.230 ***	0.226 ***	0.223 ***
IA		0.239 ***	0.231 ***	0.227 ***	0.237 ***
IL		0.263 ***	0.269 ***	0.271 ***	0.255 ***
IN		0.565 ***	0.556 ***	0.552 ***	0.549 ***
KS		0.109	0.084	0.082	0.079
KY		0.255 ***	0.242 ***	0.240 ***	0.218 ***
LA		0.450 ***	0.436 ***	0.436 ***	0.413 ***
MA		-0.505 ***	-0.509 ***	-0.499 ***	-0.499 ***
MD		-0.117 **	-0.108 **	-0.108 **	-0.100 **
MN		0.111 **	0.098 *	0.088	0.117 **
MO		0.256 ***	0.268 ***	0.268 ***	0.253 ***
NC		0.158 ***	0.155 ***	0.152 ***	0.147 ***
NJ		0.141 ***	0.141 ***	0.139 ***	0.120 ***
NV		0.176 ***	0.171 ***	0.155 **	0.153 **
NY		-0.442 ***	-0.438 ***	-0.443 ***	-0.506 ***
PA		0.242 ***	0.248 ***	0.256 ***	0.245 ***
SC		0.003	0.004	0.011	0.010
TN		-0.158 ***	-0.173 ***	-0.177 ***	-0.201 ***
TX		-0.045	-0.033	-0.052	-0.051
VA		0.579 ***	0.581 ***	0.582 ***	0.603 ***
WI		0.556 ***	0.537 ***	0.523 ***	0.530 ***
Worker's age (reference: 35–44 years of age)					
Younger than 25 years old		-0.187 ***	-0.173 ***	-0.172 ***	-0.171 ***
25–34 years of age		-0.095 ***	-0.090 ***	-0.089 ***	-0.089 ***
45–54 years of age		0.026	0.022	0.023	0.016
55 years or older		0.054 ***	0.047 ***	0.050 ***	0.043 **
Missing data on age		-0.010	-0.009	0.003	0.004
Worker's gender (reference: female)					
Male		-0.072 ***	-0.072 ***	-0.074 ***	-0.055 ***
Missing data on gender		0.235 ***	0.237 ***	0.233 ***	0.000
Worker's marital status (reference: single)					
Married		0.009	0.010	0.012	0.013
Other		-0.022	-0.020	-0.015	-0.013
Missing data on marital status		0.002	0.001	0.002	0.002
Worker's average weekly wage		0.024 ***	0.021 ***	0.022 ***	0.022 ***
Worker's tenure with preinjury employer (reference: from 2 to 5 years)					
Shorter than 2 years		-0.034 *	-0.035 **	-0.037 **	-0.039 **
From 5 up to 10 years		-0.034	-0.036	-0.037 *	-0.037 *
From 10 up to 20 years		0.000	-0.006	-0.007	-0.007
Longer than 20 years		-0.005	-0.004	-0.004	-0.003
Missing data on tenure		0.031	0.035	0.038 *	0.027
Industry (reference: clerical and professional)					
Manufacturing		0.040	0.052 *	0.055 *	0.056 *
Construction		0.081 **	0.083 **	0.084 **	0.067 **
High-risk industry		-0.051 **	-0.038	-0.037	-0.035
Trade		0.001	0.011	0.011	0.013
Low-risk industry		0.005	0.014	0.014	0.014
Other industries		0.037	0.051 *	0.055 *	0.050 *
Missing data on industry		-0.088	-0.097	-0.094	-0.165 **

continued

Table TA.C5 Coefficient Estimates of OLS—Payments per Claim for All Medical Services during First Year of Treatment (continued)

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Firm size (reference: medium size firm with payroll between 10 and 30 million)					
Payroll under 1 million		0.002	-0.001	0.003	-0.027
Payroll between 1 and 10 million		-0.015	-0.020	-0.022	-0.020
Payroll greater than 30 million		0.053 **	0.053 **	0.057 **	0.055 **
Missing data on payroll		0.075 ***	0.073 ***	0.080 ***	0.082 ***
Attorney involvement and time to first medical visit					
Claim with (defense) attorney involvement (=1, 0 otherwise)		0.520 ***	0.507 ***	0.507 ***	0.514 ***
Days from injury to 1st medical visit		-0.001 *	-0.001 *	0.000	0.000
Severity and comorbidities					
Worker had injections postinjury before receiving PT treatment (=1, 0 otherwise)			0.431 ***	0.425 ***	0.416 ***
Worker had low back surgery postinjury before PT treatment (=1, 0 otherwise)			1.288 ***	1.291 ***	1.229 ***
Having at least one comorbidity			0.444 ***	0.444 ***	0.444 ***
Health care setting where worker received care					
Same-billing-entity providers for office visits and PT services				0.064 ***	0.055 ***
Direct PT (receiving PT services without an office visit)				-0.149 ***	-0.152 ***
County-level population data					
Rural vs. urban area (1=rural area, 0 otherwise)					-0.013
Prevalence of physical activity (0 - 100)					-0.005 **
Unemployment rate					0.008
Number of licensed physical therapists, per 100,000 population (2009 data)					0.0002

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.
The asterisks next to the estimates indicate the level of statistical significance, where *** is statistically significant at the 1 percent level, ** at the 5 percent level, and *** at the 10 percent level.

Key: DLT: days of lost time; LBP: low back pain; OLS: ordinary least squares; PT: physical therapy.

Table TA.C6 Coefficient Estimates of OLS—TD Weeks per Claim First Year Postinjury

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	1.431	1.307 ***	1.302 ***	1.285 ***	2.018 ***
PT timing (reference: PT initiated within 3 days of injury)					
4–7 days	-0.043	-0.030	-0.031	-0.028	-0.023
8–14 days	0.132 ***	0.126 ***	0.120 ***	0.128 ***	0.130 ***
15–30 days	0.357 ***	0.322 ***	0.317 ***	0.328 ***	0.327 ***
After 30 days	0.711 ***	0.575 ***	0.556 ***	0.569 ***	0.565 ***
Controlling for state-specific factors (reference: MI)					
AR		-0.111	-0.109	-0.110	-0.156
CA		0.203 ***	0.209 ***	0.199 ***	0.237 ***
CT		-0.035	-0.032	-0.037	-0.040
DE		0.222 *	0.236 *	0.236 *	0.245 *
FL		-0.013	-0.002	-0.006	-0.010
GA		0.302 ***	0.306 ***	0.303 ***	0.312 ***
IA		-0.178 **	-0.182 **	-0.184 **	-0.170 *
IL		0.037	0.040	0.036	0.025
IN		-0.006	-0.011	-0.015	-0.041
KS		-0.182 *	-0.193 *	-0.195 *	-0.205 *
KY		0.347 ***	0.340 ***	0.337 ***	0.280 ***
LA		0.464 ***	0.457 ***	0.452 ***	0.390 ***
MA		0.122 **	0.119 **	0.116 **	0.125 **
MD		-0.058	-0.051	-0.056	-0.047
MN		-0.124 *	-0.132 *	-0.139 **	-0.075
MO		-0.312 ***	-0.305 ***	-0.307 ***	-0.326 ***
NC		0.341 ***	0.342 ***	0.341 ***	0.340 ***
NJ		-0.100 *	-0.100 *	-0.101 *	-0.125 **
NV		-0.035	-0.037	-0.044	-0.045
NY		-0.006	0.000	-0.007	-0.018
PA		0.031	0.034	0.036	0.019
SC		0.244 ***	0.242 ***	0.243 ***	0.252 ***
TN		-0.114 *	-0.121 *	-0.125 *	-0.184 ***
TX		-0.095 *	-0.089 *	-0.097 *	-0.105 **
VA		0.073	0.076	0.075	0.103
WI		-0.175 **	-0.185 ***	-0.191 ***	-0.172 **
Worker's age (reference: 35–44 years of age)					
Younger than 25 years old		-0.130 ***	-0.123 ***	-0.123 ***	-0.124 ***
25–34 years of age		-0.056 ***	-0.054 **	-0.053 **	-0.054 **
45–54 years of age		0.010	0.007	0.007	0.007
55 years or older		0.026	0.021	0.022	0.022
Missing data on age		-0.084	-0.087	-0.089	-0.084
Worker's gender (reference: female)					
Male		-0.008	-0.008	-0.009	0.030
Missing data on gender		-0.013	-0.006	-0.006	0.000
Worker's marital status (reference: single)					
Married		-0.034 *	-0.034 *	-0.034 *	-0.034 *
Other		0.013	0.014	0.016	0.013
Missing data on marital status		-0.089 ***	-0.091 ***	-0.091 ***	-0.091 ***
Worker's average weekly wage		0.001	-0.001	0.000	0.000
Worker's tenure with preinjury employer (reference: from 2 to 5 years)					
Shorter than 2 years		0.034	0.033	0.032	0.030
From 5 up to 10 years		-0.039	-0.041	-0.041	-0.044
From 10 up to 20 years		-0.026	-0.030	-0.030	-0.031
Longer than 20 years		0.027	0.028	0.028	0.027
Missing data on tenure		0.068 **	0.070 **	0.071 **	0.069 **
Industry (reference: clerical and professional)					
Manufacturing		-0.086 **	-0.080 **	-0.080 **	-0.089 **
Construction		0.081 *	0.083 *	0.082 *	0.079 *
High-risk industry		-0.048	-0.041	-0.042	-0.045
Trade		-0.037	-0.032	-0.032	-0.033
Low-risk industry		0.004	0.009	0.009	0.008
Other industries		0.070 *	0.078 **	0.079 **	0.072 *
Missing data on industry		-0.149	-0.153	-0.155	-0.166 *

continued

Table TA.C6 Coefficient Estimates of OLS—TD Weeks per Claim First Year Postinjury (continued)

Explanatory Variables	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Firm size (reference: medium size firm with payroll between 10 and 30 million)					
Payroll under 1 million		0.090 **	0.089 **	0.090 **	0.087 **
Payroll between 1 and 10 million		0.032	0.030	0.029	0.028
Payroll greater than 30 million		0.048	0.049	0.050	0.054 *
Missing data on payroll		0.028	0.026	0.028	0.034
Attorney involvement and time to first medical visit					
Claim with (defense) attorney involvement (=1, 0 otherwise)		0.738 ***	0.726 ***	0.725 ***	0.725 ***
Days from injury to 1st medical visit		0.001 *	0.001 *	0.001 *	0.001 *
Severity and comorbidities					
Worker had injections postinjury before receiving PT treatment (=1, 0 otherwise)			0.188 *	0.189 *	0.191 *
Worker had low back surgery postinjury before PT treatment (=1, 0 otherwise)			0.591 ***	0.592 ***	0.596 ***
Having at least one comorbidity			0.280 ***	0.280 ***	0.278 ***
Health care setting where worker received care					
Same-billing-entity providers for office visits and PT services				0.027	0.029 *
Direct PT (receiving PT services without an office visit)				0.016	0.017
County-level population data					
Rural vs. urban area (1=rural area, 0 otherwise)					0.018
Prevalence of physical activity (0 - 100)					-0.011 ***
Unemployment rate					0.010
Number of licensed physical therapists, per 100,000 population (2009 data)					0.0003

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.
The asterisks next to the estimates indicate the level of statistical significance, where *** is statistically significant at the 1 percent level, ** at the 5 percent level, and *** at the 10 percent level.

Key: DLT: days of lost time; LBP: low back pain; OLS: ordinary least squares; PT: physical therapy; TD: temporary disability.

We encountered several issues during our analysis that needed to be addressed to make sure that our results are not sensitive to them. The main issues include the following:

- Measurement and use of attorney involvement to capture issues that may delay care (e.g., pending compensability)
- Concerns about the possibility of a longer TD duration simultaneously affecting the PT timing
- Ability to capture comorbidities relying on multiple ICD-10 fields being populated
- Large states potentially dominating the results
- Unobserved characteristics of workers and possible impact

We discuss these issues and describe sensitivity results in the rest of this appendix.

ATTORNEY INVOLVEMENT AS A PROXY FOR PENDING COMPENSABILITY AND OTHER ISSUES

Pending compensability issues often have the effect of delaying care or, in some cases, medical services being rendered but not paid under workers' compensation.[3] In either case, workers with pending compensability issues were likely to have claims in our data that had late PT. The same compensability issues may also create friction or litigation that is associated with a greater use of medical resources and late return to work. It is a valid concern that this confounding factor, if not addressed, will compromise the results on the effect of early versus late PT initiation.

In our statistical analysis, we controlled for defense attorney involvement and time from injury to first medical visit to account for issues that may delay care. These two variables, although not perfect, help indicate whether compensability issues might have occurred in the claims we have. However, both variables may reflect a wider range of issues than pending compensability.[4]

The defense attorney involvement variable in our data reflects claims with reported payments to a defense attorney. These include payments for in-house and outside counsel that are allocated to claims. On the one hand, it is possible, given the informal dispute resolution processes used in some states, that some compensability issues are resolved without attorney involvement. This would cause us to under-identify claims with pending compensability. On the other hand, for states with a dispute resolution system, it is more likely that defense attorney involvement captures most of the compensability issues because of the actions taken and resources involved. In this case, the defense attorney indicator may over-identify claims with pending compensability.

One way to address under-identification of cases with pending compensability is to create a combined indicator of defense and worker attorney involvement. We tested this as a sensitivity analysis because we have

[3] This may happen in most workers' compensation jurisdictions except those with pay-without-prejudice. Massachusetts, for example, requires 180 days of pay-without-prejudice, where workers receive medical and indemnity benefits without the insurer accepting liability. Benefits may or may not terminate after 180 days depending on whether the insurer accepts liability based on compensability rules.

[4] Defense attorneys may be involved in disputes between the carrier and worker over compensability issues and issues related to maximum medical improvement, impairment/disability ratings, and the determination of permanent partial disability. Defense attorneys could also be involved in disputes over payments and medical necessity issues between the carrier and providers. Time from injury to first medical service may reflect issues that could delay medical care, including pending compensability, delayed injury notice to employers and insurers, access to care, and in some cases, a delay in seeking care on the part of the worker.

to rely on a subset of data sources for the analysis.[5] Table TA.C7 shows the results of this analysis, which are similar to the results presented in the main report.

Table TA.C7 Results of Sensitivity Analysis Using the Combined Indicator of Defense or Worker Attorney Involvement

	PT Timing Group				
	Within 3 Days	**4–7 Days**	**8–14 Days**	**15–30 Days**	**After 30 Days**
Average number of TD weeks per claim					
Unadjusted	7.4	6.6	7.9	9.7	13.9
Adjusted (model 5 in Table 4.7)	8.2	7.7	8.7	10.2	13.0
Adjusted (model 5), subset of LBP-only claims with either defense or worker attorney involvement	8.7	8.1	9.0	10.1	12.4
Average number of TD weeks per claim, indexed to that of the PT within-3-days group					
Unadjusted	1.00	0.90	1.07	1.32	1.89
Adjusted (model 5 in Table 4.7)	1.00	0.93	1.06	1.24	1.58
Adjusted (model 5), subset of LBP-only claims with either defense or worker attorney involvement	1.00	0.93	1.04	1.16	1.43

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. The results for worker attorney involvement were based on a subset of claims as a result of our data quality process. Model specifications for our statistical analysis can be found in Table 4.1.

Key: LBP: low back pain; PT: physical therapy; TD: temporary disability.

To address the over-identification issue, we conducted a sensitivity analysis using the data for a subset of claims that did not have recorded disputes or legal issues, that is, claims that had neither defense nor worker attorney involvement.[6] The idea behind this sensitivity analysis is to see whether the results would be different when there is no variation in the prevalence of pending compensability issues across the PT timing groups. Our assumption is that it is unlikely that carriers and self-insured employers would not maintain records on disputed issues given the actions taken and expenses involved. Table TA.C8 provides the results of this sensitivity analysis for the results reported on TD duration. Results for the other outcome variables we studied are similar.

[5] This is because worker attorney involvement is adequately captured in some but not all of our data sources. If we wanted to include worker attorney involvement, we would have to exclude some data sources where these data are not available.

[6] This subset of claims accounted for three quarters of LBP-only claims included for the PT timing analysis.

Table TA.C8 Results of Sensitivity Analysis Based on Claims That Had Neither Defense nor Worker Attorney Involvement

	PT Timing Group				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
Average number of TD weeks per claim					
Unadjusted	7.4	6.6	7.9	9.7	13.9
Adjusted (model 5 in Table 4.7)	8.2	7.7	8.7	10.2	13.0
Adjusted (model 5), subset of LBP-only claims with neither defense nor worker attorney involvement	5.7	5.5	6.2	7.1	9.6
Average number of TD weeks per claim, indexed to that of the PT within 3 days group					
Unadjusted	1.00	0.90	1.07	1.32	1.89
Adjusted (model 5 in Table 4.7)	1.00	0.93	1.06	1.24	1.58
Adjusted (model 5), subset of LBP-only claims with neither defense nor worker attorney involvement	1.00	0.96	1.08	1.24	1.68

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. The results for worker attorney involvement were based on a subset of claims as a result of our data quality process. Model specifications for our statistical analysis can be found in Table 4.1.

Key: LBP: low back pain; PT: physical therapy; TD: temporary disability.

As Table TA.C8 shows, the estimated effect of early PT becomes somewhat smaller, but the difference in the number of TD weeks is still significantly longer for the claims in the groups with PT after the first week of injury, and especially longer for claims with PT initiated more than 14 days after injury.

It is worth noting that although worker attorney involvement may be helpful to indicate pending compensability issues, we chose to use defense attorney involvement in the analysis for two reasons. First, while our data capturing worker attorney involvement has improved in recent years, the data adequate for analysis cover a smaller set of claims compared with the data on defense attorney involvement. Second, with this smaller set of data, our sensitivity analyses (discussed above) suggested that the results we presented in the main report are not sensitive to the omission of the worker attorney involvement indicator. This is partially because there is a strong correlation between the defense and worker attorney involvement variables, which is consistent with findings in Yang, Rothkin, and Dolinschi (2017).

SIMULTANEOUS IMPACT OF TD DURATION ON PT TIMING

It is a valid concern that although TD duration is an outcome variable in our study, it may also simultaneously influence PT timing because how long a worker has stayed out of work may be one of the considerations for some medical providers. For example, a worker who initially saw a provider with low back pain may not be referred for PT treatment immediately for various reasons. The worker may need other medical services or the worker may be instructed to come back if pain persists, because the provider is aware that most back pain decreases over time and does not routinely order PT initially.[7] When the worker comes back two weeks later, the doctor may want to try PT since the worker is still out of work after more than two weeks, which may or

[7] Many clinical guidelines recommend only advice and education for patients with non-specific low back pain during the initial weeks of management, and physical therapy is recommended when recovery is delayed (Childs et al., 2015).

may not indicate a delayed recovery. However, the most likely reason is that some providers do not routinely order PT at an initial visit for workers whose low back pain may be self-limiting. This is consistent with our finding that the percentage of workers with early PT was much higher for those whose low back pain was managed by physicians affiliated with the same health care organizations as the physical therapist, compared with those whose low back pain was managed by providers outside these organizations (Table 3.3). However, same-billing-entity health care organizations were not associated with lower utilization and costs of medical services and shorter TD duration than their counterparts (Tables TA.C1 through TA.C6).[8] The results suggest that same-billing-entity health care organizations are less likely to link early PT timing and outcomes, and some workers receiving early versus late PT treatment is reflective of differences in provider practice.

Since 14 days seems to be a natural breaking point for early versus late PT, we stratified the low back claims into a two-by-two grid by PT timing and TD duration using 14 days as a threshold. Table TA.C9 provides results in this framework.

Table TA.C9 Relationship between TD Duration and PT Timing

Measure	LBP-Only Claims with			
	PT ≤ 14 Days TD ≤ 14 Days	PT ≤ 14 Days TD > 14 Days	PT > 14 Days TD ≤ 14 Days	PT > 14 Days TD > 14 Days
	A	B	C	D
# of LBP-only claims	2,236	6,229	1,106	6,461
% of LBP-only claims	14%	39%	7%	40%
Utilization of medical services during the first year of treatment				
% of claims that had MRI	10.1%	33.8%	21.6%	42.4%
% of claims that received opioid prescriptions	20.2%	34.0%	36.0%	45.9%
% of claims that had pain management injections	1.7%	8.7%	4.4%	12.1%
% of claims that had low back surgery	0.1%	1.2%	0.3%	2.9%
Medical payments per claim by end of first year after injury				
Medical payments per claim, mean	$2,275	$4,658	$2,822	$5,345
Medical payments per claim, median	$1,713	$2,965	$2,087	$3,292
TD duration in weeks by end of first year after injury				
Number of TD weeks, mean	1.5	9.4	1.5	13.2
Number of TD weeks, median	1.6	5.3	1.6	8.4

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment.

Key: LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy; TD: temporary disability.

[8] The effect of same health care organization PT was statistically significant for MRI, opioid prescriptions, injections, and overall medical costs, but the magnitude was smaller compared with other factors affecting these outcomes. The same billing entities had little or no effect on surgery and TD duration.

For the two groups of LBP-only claims with TD duration less than or equal to 14 days (columns A and C in Table TA.C9), TD duration did not influence the timing of PT initiation.[9] For these two groups of claims, it is clear that workers in the before-14-days group had a lower utilization of MRI, opioid prescriptions, injections, and surgery, compared with those in the PT after-14-days group. This suggests that for less severe claims (i.e., workers who stayed out of work for up to two weeks), early PT is associated with lower utilization and costs of medical services. Note that the LBP-only claims in column C accounted for only 7 percent of LBP claims included in the PT timing analysis. These claims had PT initiated after their TD benefits ended within 14 days. We do not know the reason for later PT in this group of claims. However, it is possible that a few workers may return to work but still have symptoms to the extent that PT might be ordered to address the symptoms and at the same time to keep them at work.

One may be concerned that a worker with a longer TD duration may receive late PT and if so, the estimated effect of late PT on medical cost may be overstated to the extent that some of the direct TD effect on medical costs is misattributed to the effect of late PT. In the following analysis, we examine the ***direct*** and ***indirect*** impact of longer TD duration on medical costs and concluded that even if some workers with a longer TD duration did receive late PT, it is unlikely to distort the findings on the association between late PT and higher medical costs per claim.

Our comparison of columns A and B of Table TA.C9 illustrates that there is a direct association between longer TD duration and higher utilization and costs of medical services, and this association is not linked to PT timing. Column B of Table TA.C9 shows the claims that had PT initiated within 14 days after injury but TD duration longer than 14 days. For this group of claims, a longer TD duration is unlikely to influence PT timing within 14 days. However, this group of claims had much higher utilization and costs of medical services, when compared with claims in column A, those with PT and TD duration within 14 days. For example, the average medical payment per claim for claims with TD longer than 14 days was double the cost for claims that had TD duration shorter than or equal to 14 days ($4,658 versus $2,275), and these are claims with PT within 14 days.

For those with TD duration longer than 14 days (columns B and D of Table TA.C9), the PT after-14-days group (column D) had a higher utilization of medical services and higher medical payments per claim, compared with the group of claims that had PT within 14 days after (column B). For example, the average medical payment per claim for the PT after-14-days group was 14.7 percent higher than that for the PT within-14-days group ($5,345 versus $4,658). The difference in the median values was 11.0 percent. The average TD duration per claim was 13.2 weeks (median was 8.4 weeks) for the PT after-14-days group, compared with 9.4 weeks (median was 5.3 weeks) for the group with PT initiated within 14 days after injury.

For claims with both PT and TD longer than 14 days (column D of Table TA.C9), it is possible that a longer TD duration may influence some providers' decision making as to whether and when to order PT and, therefore, indirectly affect the utilization and costs of medical services. This indirect effect, if not controlled, may bias the estimated effect of early versus late PT on the outcomes studied. It is also likely that a longer TD duration directly contributes to higher utilization and costs of medical services regardless of PT timing, which is illustrated in our comparison of columns A and B above. In this case, the estimated impact of PT timing would not be distorted. Based on our analysis, we believe that this potential issue is less likely to affect our key findings in a material way for two reasons. First, as we discussed earlier, many workers with low back pain

[9] Some providers may consider prolonged disability or longer TD duration as a marker for delayed recovery. If a worker has not returned to work within a certain period of time, the provider may prescribe PT to help the worker recover. However, this is unlikely to be the case for the claims in columns A and C, where TD duration for individual claims was shorter than or equal to 14 days.

might be sorted in a late PT timing group if the provider does not routinely order PT treatment. The difference in practice patterns might have placed identical workers in different PT timing groups. Second, even if some providers ordered PT treatment in part because the worker stayed out of work longer, the ***direct*** impact of longer TD on utilization and costs (regardless of PT timing) is likely to be larger than the ***indirect*** impact of longer TD that may influence a provider's decision to order PT to the extent that longer TD may be considered a marker for delayed recovery (see the results of our comparisons above). Note that claims with both TD and PT after 14 days (column D) had an average TD duration of 13.2 weeks and a median duration of 8.4 weeks. Given that PT treatment is an up-front service that is typically seen in the initial month after injury for the low back claims we studied, the result suggests that it is less frequent to see workers with a longer TD duration starting PT after 30 days postinjury because of delayed recovery presumed based on their longer TD duration. It is important to note that even though we controlled for a rich set of factors and found a strong association, we cannot measure the causal effect of early versus late PT on the outcomes we studied.

CAPTURING COMORBIDITIES USING ICD-10 CODES

Treatment of comorbidities is not typically covered under workers' compensation. Because of this, many practitioners believe that it may not be practical to capture comorbidities in the workers' compensation detailed medical data. In our detailed data review, we do see ICD-10 codes that indicate comorbid conditions present in some detailed medical transactions. One important question is, to what extent do we capture comorbidities using the ICD-10 codes kept in the medical details? Table TA.C10 shows the percentage of claims identified as having at least one comorbidity for (A) claims included in the study, and (B) claims in the study that had at least one office visit where multiple ICD-10 codes are recorded, which is a summary of Tables TA.B2 and TA.B3. The results suggest that it is valuable for understanding a claim for providers to note comorbid conditions of their patients even though these conditions are not primarily treated in workers' compensation. Doing this helps to provide more complete comorbidity data for meaningful research.

Table TA.C10 Percentage of Claims with Comorbidities—Sensitivity to Presence of Multiple ICD-10 Codes

A. Claims included in the study

	Claims with ≤ 7 Days of Lost Time	Claims with > 7 Days of Lost Time
LBP-only claims	2.2%	4.7%
LBP claims with neurological findings and/or radiating leg pain	5.5%	12.9%

B. Claims included in the study that had at least one office visit with multiple ICD-10 codes

	Claims with ≤ 7 Days of Lost Time	Claims with > 7 Days of Lost Time
LBP-only claims	3.8%	6.7%
LBP claims with neurological findings and/or radiating leg pain	6.7%	14.5%

Key: ICD: International Classification of Diseases; LBP: low back pain.

Since the presence of multiple ICD-10 codes did not show a significant increase in the percentage of claims with comorbidities identified, it is reasonable to believe that a big factor causing the under-identification of comorbidity claims is due to provider coding. The question becomes that if claims with comorbidities are under-coded, could the under-coding be random so that we can use the comorbidities that we identified based on data to control for differences in comorbidities across the PT timing groups? We cannot answer this question unless we have another dataset that shares similar characteristics of workers and their injuries. However, we observed considerable variation in the prevalence of claims with comorbidities, ranging from 2.9 percent for LBP-only claims with PT within 3 days postinjury to 7.5 percent for those in the PT after-30-days group (Table 3.5). The figures for claims with at least one office visit of multiple ICD-10 codes were between 4.1 and 9.9 percent. The considerable variation in the frequency of claims with comorbidities identified suggests that even if we cannot fully control for comorbidities, we can get a sense of how much the result would change by comparing the result with the same model specification based on claims included in the study to a subset of claims with multiple ICD-10 codes. For this, we ran a sensitivity test based on claims that had at least one office visit with multiple ICD-10 codes recorded and kept in the data. Table TA.C11 provides the result of this sensitivity test.

Table TA.C11 Comparing Estimated TD Duration per Claim between the Reported and the Tested Multiple ICD-10 Results

Measure	Timing of PT Initiation Postinjury				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
Average number of TD weeks per claim					
Unadjusted	7.4	6.6	7.9	9.7	13.9
Adjusted (model 5)	8.2	7.6	8.7	10.2	13.0
Adjusted (model 5), subset of LBP-only claims with at least one office visit with multiple ICD-10 codes	9.0	8.3	9.0	10.7	13.2
Average number of TD weeks per claim, indexed to that of the PT within-3-days group					
Unadjusted	1.00	0.90	1.07	1.32	1.89
Adjusted (model 5)	1.00	0.93	1.06	1.24	1.58
Adjusted (model 5), subset of LBP-only claims with at least one office visit with multiple ICD-10 codes	1.00	0.92	1.00	1.19	1.46

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. The multiple ICD-10 results were based on a subset of claims that had at least one office visit in which multiple ICD-10 codes were present in the data. Model specifications for our statistical analysis can be found in Table 4.1.

Key: ICD: International Classification of Diseases; PT: physical therapy; TD: temporary disability.

As Table TA.C11 shows, the estimated impact of early PT was adjusted down, but the impact is still large and significant, especially when comparing the early PT groups to the later PT groups that had PT initiated after 14 days of injury.

IMPACT OF STATE-SPECIFIC FACTORS

States vary in terms of workers' compensation policies and other factors that may influence PT timing and outcomes. As mentioned previously, we address this by including state fixed effects. In addition, because the number of claims in our data is substantially different across the states, without weighting the data, the states with a large number of claims could dominate the descriptive statistics. To evaluate the impact of large-sized states, we created a set of weights that equalize the importance of the individual states. Table TA.C12 provides a comparison of some descriptive measures with and without equal-state weights. The table shows that the same conclusions regarding the association between PT timing and outcomes are obtained when equal-state weights are used as opposed to using unweighted data. In this study, we report the unweighted results based on the actual data pooled for the 27 states.

Table TA.C12 Comparing Unweighted and Weighted Results of Utilization of Medical Services and TD Duration by PT Timing Group

Measure	Unweighted Results by PT Timing Group					Weighted Results by PT Timing Group				
	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days	Within 3 Days	4–7 Days	8–14 Days	15–30 Days	After 30 Days
# of LBP-only claims	2,871	2,621	3,605	4,764	3,776	2,871	2,621	3,605	4,764	3,776
% of LBP-only claims	16%	15%	20%	27%	21%	16%	15%	20%	27%	21%
Utilization of medical services by end of first year after injury										
% of claims that had MRI	29.1%	27.3%	29.7%	35.4%	47.7%	24.8%	26.6%	30.0%	35.7%	49.7%
% of claims that received opioid prescriptions	27.2%	28.2%	36.4%	42.0%	47.5%	27.4%	29.3%	39.8%	46.1%	52.6%
% of claims that had pain management injections	7.7%	6.4%	7.6%	9.4%	14.4%	7.1%	6.8%	8.2%	11.3%	16.6%
% of claims that had low back surgery	1.0%	0.8%	1.2%	1.4%	3.9%	0.9%	0.7%	1.4%	2.0%	4.9%
Medical cost per claim for all medical services by end of first year after injury										
Medical payment per claim, mean	$4,069	$3,967	$4,299	$4,414	$5,802	$4,202	$4,172	$4,655	$4,809	$6,620
Medical payment per claim, median	$2,585	$2,528	$2,599	$2,798	$3,603	$2,625	$2,626	$2,767	$3,038	$3,868
TD duration by end of first year after injury										
TD weeks, mean	7.4	6.6	7.9	9.7	13.9	6.4	6.2	7.8	9.9	14.0
TD weeks, median	3.4	3.3	4.2	5.6	9.3	3.0	3.3	4.3	5.7	9.7
Duration of medical treatment by end of first year after injury										
Days from first to last medical services, mean	102	95	109	131	182	88	88	104	126	176
Days from first to last medical services, median	50	47	59	85	155	43	44	57	81	145

Notes: Included are LBP-only claims with more than seven days of lost time that had 3 or more visits for PT services. These are claims across 27 states, with injuries occurring from October 1, 2015, to March 31, 2017, and medical services received during the first year of treatment. For the weighted results, the weights were created based on the claim counts to equalize the claim volume across the 27 states.

Key: LBP: low back pain; MRI: magnetic resonance imaging; PT: physical therapy; TD: temporary disability.

UNOBSERVED CHARACTERISTICS OF WORKERS AND THE IMPACT

In Chapter 2, we briefly discussed the potential issue of unobserved characteristics of workers and how that might affect the results of our statistical analysis. We also mentioned an IV analysis we explored and our decision to not include the IV in the final analysis that supported the major findings. We provide more information in this section.

There are two studies we found most relevant that applied an IV approach to addressing possible endogenous treatment variables (Savych, Neumark, and Lea, 2018; Frogner et al., 2018). The approach Frogner et al. (2018) applied for their study was based on the distance between the patient and the provider. The authors used the distance between the patient and the provider to create an IV and estimated the effect of having PT first and PT on health care utilization (including opioid prescriptions and MRI) and costs. Based on the IV analysis, the study found that having PT and having PT first resulted in lower health care utilization and costs in general, which is consistent with the literature.[10] Unfortunately, we do not have access to relevant information that enable us to replicate the IV approach suggested by Frogner et al. (2018).

We explored the same instrumental variable approach that was applied successfully in Savych, Neumark, and Lea (2018). This approach is essentially to take advantage of small area variation to create an early versus late PT variable that mimics the random assignment of claims between early and late PT groups. In that study, the authors created an instrumental variable to predict the likelihood of a worker receiving opioid prescriptions, which was based on the opioid receipts of all other workers living in the same geographic area but independent of whether the worker received opioids. The predicted likelihood of receiving opioids indicates the likelihood of the worker receiving opioids but is not correlated with the unobserved characteristics of the worker affecting outcomes. This predicted variable was used in the second stage of the two-stage regression to estimate the impact of opioid prescriptions on return to work.

Following the Savych, Neumark, and Lea (2018) example, we created a variable indicating the likelihood of a worker receiving PT early (within 7 days of injury) versus late (after 7 days). We used the same geographic area identifications used in Savych, Neumark, and Lea (2018). Instead of creating a variable on receiving opioids, we created a variable so that the likelihood of receiving early PT for a worker was based on the PT experience of all workers living in the same area as the worker but excluding the worker's PT experience. The IV variable we created highly predicted whether the worker received early PT, meeting the first of the four assumptions for a successful application of an IV approach.[11] However, the results of the second stage regression showed that the IV-predicted early PT had a larger and statistically significant effect on the outcome variables we studied. For example, the marginal effect of early PT on TD duration was -0.35 (statistically significant at 1 percent) from an OLS regression as part of our IV analysis, but the estimated effect of the IV-predicted early PT was -0.54 (also significant at 1 percent) based on the two-stage least squares (2SLS) regression.[12] With the IV approach, the effect of early PT remained in the same direction but was larger in

[10] It is not clear to us to what extent the IV approach helped to address confounding factors. They authors mentioned the lack of information on education and income as a limitation.

[11] There are four assumptions that should be held in order to have a successful application of an IV approach. The first assumption is that the IV is highly predictive of the exposure variable (i.e., early PT in our case). This is the only assumption that can be verified; the other three assumptions rely on subject-matter expertise. In essence, one needs to be able to argue that the IV helps to make the cases "exchangeable" among the PT timing groups. The IV should predict the likelihood of a worker getting into a particular PT timing group, but unrelated to the outcome so that it only influences the outcome through the predicted early PT.

[12] In our IV analysis, we used a dummy variable to indicate early PT within 7 days to simplify the analysis. We did not include the results of our IV analysis in this report.

magnitude, which was not consistent with what we hypothesized as a confounding factor.

In theory, the effect of an IV-predicted exposure (i.e., early PT) could be smaller or larger than the effect of actual exposure, depending on what is captured in the IV. In our case, our concern about the unmeasured confounder was the unobserved individual propensity toward being active and outgoing that could have resulted in an upward bias in the estimated effect of early PT, as we discussed in Chapter 2. If the IV we created helped assign the claims randomly into different PT timing groups, we would have a similar mix of cases in terms of the unobserved personal trait. Holding constant the mix of cases with the unobserved confounders in addition to various variables we controlled for, the average adjusted TD duration, for example, would be longer for the early PT group and shorter for the late PT group, compared with the adjusted results without the IV, which means that the size of the estimated effect of early PT would be smaller if still significant. This was not what we saw. It implies one of the two things: (1) the IV we created did not help randomize the workers with LBP-only injuries across the PT timing groups, or (2) the IV captured something else that offset the effect of what we suspected to exist before exploring the IV approach.

Even if the IV we constructed does not serve the purpose of addressing the potentially upward bias of the estimated early PT effect, it does not mean that an IV approach is not useful. An IV approach is a powerful tool, especially for observational studies for which the researchers identify important underlying issues about unobserved confounders. There have been a number of studies in economics and less often in the medical literature that have applied this approach. However, it may not always be successful, depending on whether there is a valid and useful IV.[13] In our case, the counter-intuitive result may imply that the IV we constructed may not help address the specific problem we suspected to exist that could upward bias the results.

Baiocchi, Cheng, and Small (2014) provide a useful guide to the type of issues for which an IV approach is most likely needed and helpful, what the assumptions are for an instrument to be valid, and how to find a way to verify each assumption on a case-by-case basis. We verified the first assumption—the IV strongly predicts the likelihood of early PT. While the rest of the assumptions for the IV to be valid are not verifiable, we suspect that the IV variable we created for this study might capture other underlying factors. If the geographic variable in early PT is associated with geographic variation in the proportion of "healthy workers" or health care environments that advocate early PT with better outcomes, this particular IV would not be helpful to break the suspected link between the exposure (i.e., early PT) and unobserved characteristics of workers (i.e., a violation of the second of the four assumptions). We do not know if this is the case, but we are not convinced that the IV we constructed met the rest of the assumptions for a valid IV. However, the IV analysis did not provide evidence suggesting that the estimated early PT effect in our analysis without the IV was biased toward exaggerating the positive effect of early PT. We did not include the IV in our final analysis for this study. Instead, we used the IHME's data that summarized the level of physical activity of the residents across U.S. counties and PT supply to help control for possible unobserved factors, which is described in Chapter 4.

In all, even though we did as much as we could to address confounding factors that may affect both PT timing and outcomes, there are still unobserved characteristics of workers and claims. This may include behavioral issues and responses of workers to treatments they receive. Without being able to control for these characteristics, we cannot assert that we measure the causal effect of early versus late PT.

[13] Vertosick et al. (2017) published a systematic review of IV studies in cancer research, suggesting cautious application of the IV approach for the specific set of problems.

GLOSSARY

case-mix adjustment: This is a statistical technique that helps hold the mix of claims and injury characteristics constant across different subsets in a comparative analysis so that the adjusted results reflect the difference in the utilization of medical services, not the difference in the mix of cases.

low back claims with radiating leg pain and/or neurological findings: The claims we identified based on the ICD-10 codes that had low back conditions being treated as a predominant condition and had at least one diagnosis indicating pain radiating down to the leg or neurological findings. These are the claims that did not have red flag conditions such as tumors, infectious diseases, fractures, and dislocations. Throughout the report, we refer to these claims as *low back claims with nerve involvement*.

low back pain only claims (LBP-only claims): The claims we identified using the ICD-10 codes that had low back pain being treated as a predominant condition, but did not have any mention of radiating leg pain or neurological findings. Claims with red flag conditions, such as tumors, infectious diseases, fractures, and dislocations, were excluded from this study.

medical treatment guidelines: A medical treatment guideline can also be referred to as a clinical guideline or practice guideline, which is a document intended to be used for guiding medical decision making by providing criteria regarding diagnosis and medical treatment. In this study, we focus on medical treatment guidelines that have been adopted by a state with the intention of providing a uniform set of clinical standards for medical providers and utilization review professionals, with or without an enforcement mechanism.

physical therapy (PT) treatment: The PT treatment we examine in this study includes all physical therapy services for claims with 3 or more PT visits during the first year of treatment after injury that were provided by physical therapists and other providers other than chiropractors. The inclusion of claims with 3 or more PT visits was to focus on the therapeutic aspect of PT treatment.

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