Outcomes Associated with Manual Therapy for Workers with Non-Chronic Low Back Pain

Dongchun Wang
Kathryn Mueller
Randy Lea

WCRI
Workers Compensation Research Institute

ABOUT THE INSTITUTE

OUR MISSION:

To be a catalyst for significant improvements in workers' compensation systems, providing the public with objective, credible, high-quality research on important public policy issues.

THE INSTITUTE:

Founded in 1983, the Workers Compensation Research Institute (WCRI) is an independent, not-for-profit research organization which strives to help those interested in making improvements to the workers' compensation system by providing highly regarded, objective data and analysis.

The Institute does not take positions on the issues it researches; rather, it provides information obtained through studies and data collection efforts, which conform to recognized scientific methods. Objectivity is further ensured through rigorous, unbiased peer review procedures.

The Institute's work includes the following:

- Original research studies of major issues confronting workers' compensation systems (for example, worker outcomes)
- Studies of individual state systems where policymakers have shown an interest in change and where there is an unmet need for objective information
- Studies of states that have undergone major legislative changes to measure the impact of those reforms and draw possible lessons for other states
- Presentations on research findings to legislators, workers' compensation administrators, industry groups, and other stakeholders

With WCRI's research, policymakers and other system stakeholders—employers, insurers, and labor unions—can monitor state systems on a regular basis and identify incremental changes to improve system performance. This results in a more enduring, efficient, and equitable system that better serves the needs of workers and employers.

For more information and to view other WCRI studies, please visit our website: www.wcrinet.org

WCRI
Workers Compensation
Research Institute

OUTCOMES ASSOCIATED WITH MANUAL THERAPY FOR WORKERS WITH NON-CHRONIC LOW BACK PAIN

Dongchun Wang
Kathryn Mueller
Randy Lea

WC-21-23
September 2021

WORKERS COMPENSATION RESEARCH INSTITUTE
CAMBRIDGE, MASSACHUSETTS

ISBN 978-1-61471-517-7

Acknowledgments

This study would not be possible without the contributions of many people. Our gratitude goes to Gary Franklin, Melissa McInerney, and Dan Safford. Gary Franklin is a research professor at the University of Washington Department of Environmental and Occupational Health Sciences, and the medical director at the Washington State Department of Labor & Industries. Melissa McInerney is an associate professor of economics at Tufts University, with expertise in public economics, health economics, labor economics, and applied microeconomics. Gary Franklin and Melissa McInerney served as technical reviewers of the draft. Their comments, suggestions, and constructive critiques of the draft report not only helped us to improve the accuracy and clarity of the final report, but also are valuable for our future research in this area. Daniel Safford is a board certified orthopedic clinical specialist, the lead physical therapist at the Arcadia University Good Shepherd Penn Partners site, and an adjunct instructor at the university. He also reviewed and provided clinically insightful comments on the draft report. We are grateful for many other reviewers whose comments and suggestions helped us to improve the clarity and readability of the report.

Our sincere thanks go to our supporters who were so generous with their knowledge and time. Several of our colleagues at WCRI also provided valuable assistance. We thank Carol Telles, Rebecca Yang, William Monnin-Browder, Olesya Fomenko, Te-Chun Liu, Eric Harrison, and Bryan Giblin for their knowledge of state policies and issues, data and underlying processes, and programming support. We thank Andrew Kenneally, the communications director at WCRI, for disseminating the research findings. Sebastian Negrusa, our new vice president of research, also contributed to the report at its final stage. Special thanks to John Ruser, president of the Institute, for his valuable input and guidance throughout the process. Sarah Solorzano provided excellent administrative assistance during the production of the report. She also managed the external review and publication process.

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

Dongchun Wang
Kathryn Mueller
Randy Lea
Cambridge, Massachusetts
September 2021

TABLE OF CONTENTS

List of Tables

LIST OF FIGURES

EXECUTIVE SUMMARY

Physical therapy (PT) is recommended by most guidelines for musculoskeletal injuries as a non-invasive, non-pharmacological treatment option before considering opioids and other invasive procedures.[1] With an increasing number of workers with injuries receiving PT treatment, an important question is what treatment pattern makes a difference in terms of utilization and costs of medical resources and outcomes. Manual therapy (MT), a type of PT treatment, is a hands-on therapy to mobilize or manipulate joints and soft tissues with the intent to increase joint range of motion, reduce pain, and eliminate soft tissue swelling and inflammation. These services are often provided by physical therapists with special training in MT techniques, osteopathic physicians, or chiropractors.[2] In this study, we focus on low back pain (LBP) claims that did not have surgery but received MT and other medical services provided by non-chiropractic providers.[3] We compare utilization of medical services (magnetic resonance imaging [MRI], opioids, and spinal injections), medical and indemnity costs, and temporary disability (TD) duration between LBP claims with early versus late MT and between LBP claims that had MT as part of PT treatment versus those that did not receive MT but received other PT treatment.[4] We also describe the patterns and variations of MT treatments across 28 study states.[5]

MAJOR FINDINGS

Overall, we found that when MT was prescribed for workers with LBP, early MT within 2 weeks of PT care was helpful in achieving lower costs and shorter TD duration. LBP claims with early MT also had a lower rate of MRI and injections and were less likely to receive opioid prescriptions, compared with those with late MT. When comparing LBP claims with MT as part of PT treatment with those that received no MT but received other PT services, the MT group on average had higher costs and slightly longer TD duration than the group of claims with no MT. While the results from our analysis provide useful information on the costs and outcomes of MT compared with no MT, the findings are not conclusive. More data are needed to capture clinical and quality-of-life outcomes over a longer time span to examine whether MT provides treatment that is cost-effective in treating workers with LBP. We summarize the key findings in three areas below.

---

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

[2] The difference between manual physical therapy and chiropractic care lies in the balance between hands-on manual therapy treatment and individualized exercise programs. Physical therapists may be more likely to provide active therapy, such as exercise, and use manual therapies to diagnose and reduce pain so that the patients can be active and care for themselves through exercise and maintaining good posture.

[3] For clarity and meaningful results, we excluded LBP claims that had surgery and claims that had chiropractors involved in care. The LBP claims included in this study represent the most commonly encountered clinical scenario seen in everyday practice. A small percentage of LBP claims had lumbar surgery. Although there is large variation in the prevalence of chiropractic care across states, this variation does not seem to affect the comparative results in this study. Note that, in this study, a vast majority of non-chiropractic MT providers are physical therapists. Chiropractic care will be addressed in a subsequent study. Treatment patterns for surgical LBP cases may be addressed in our future research.

[4] Other non-MT PT services include evaluation/assessment/education, passive physical modalities, and active therapeutic exercises and activities. Because we focus on nonsurgical LBP claims in this study, low back surgery is not part of the outcomes we examine. Future research may examine PT as conservative care with surgery as an outcome as well as patterns of pre- and post-surgical PT treatment.

[5] The 28 states are Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and Wisconsin.

INTERSTATE VARIATION IN PREVALENCE AND PATTERNS OF MT TREATMENT

In general, we found that early initiation of MT within 2 weeks of PT care with a treatment duration of less than or equal to 6 weeks was the most common pattern of MT treatment. However, we also saw large interstate variation in the utilization of MT services, which to some extent, might have been explained by differences in state policies influencing provider practices and billing.

- MT services were commonly used for treating workers with LBP. For LBP cases, with or without neurologic diagnoses,[6] the prevalence of MT ranged from 13 percent in Arkansas to 46 percent in New Mexico. The prevalence of MT varied by the type of case.[7] Neuro back cases with more than seven days of lost time were most likely to have PT (87 percent of neuro LBP cases) and the majority of these cases had MT services (64 percent of the claims with PT).
- When workers with LBP had MT services, most of them received it early, within the first 1–2 weeks of PT care. The percentage of all LBP claims receiving MT within 1 week ranged from 65 percent in Florida to 88 percent in Iowa. By the end of the second week of PT treatment, 79 to 95 percent of cases received MT, depending on the state. For those who received MT, most had MT treatment for less than or equal to 6 weeks. However, for those workers who had MT treatment beyond 6 weeks, the duration of MT treatment varied substantially across states.
- There was large interstate variation in the number of MT visits per claim, from 3.4 in Texas to 14.1 in New York, with the 28-state median at 6.5 visits per claim. The numbers for these two states are substantially different from those of the other 26 study states, contributing to larger interstate variation. However, the interstate variation in the same measure was still considerably large among the 26 states without New York and Texas.[8] Several possible reasons may help explain the interstate variation. They include state policies limiting the number of PT visits or services, fee schedule reimbursement and billing/coding rules, treatment guidelines, and utilization review rules. Although there is no clear evidence for optimal utilization of MT, the large interstate variation in the utilization of MT suggests inconsistency in practice regarding MT. For states with substantially higher or lower utilization of MT services, policymakers and stakeholders may want to further examine the results for their own states and explore any issues regarding MT and other medical services used for treating workers with low back pain.

EARLY MT IS ASSOCIATED WITH LOWER UTILIZATION OF MEDICAL SERVICES, LOWER MEDICAL AND INDEMNITY PAYMENTS, AND SHORTER TD DURATION

- After adjusting for various factors affecting treatment choice and outcomes,[9] the average medical cost per claim was $4,192 for LBP claims with early MT, 27 percent lower than that for similar LBP claims with late

[6] LBP claims with neurologic diagnoses refer to those that had ICD-10 codes indicating nerve involvement, such as radiculopathy or low back pain with sciatica.

[7] We looked at the prevalence of MT services separately for LBP-only claims and LBP claims with nerve involvement, as well as for whether claims had more than seven days of lost time.

[8] See Chapter 3 for more details.

[9] We controlled for a substantially large number of factors, including type of low back condition, seven-day lost time status, presence and number of comorbidities, and pre-PT injections as a proxy for severity. We also controlled for the characteristics of workers (age, gender, marital status, wage, job industry, and tenure with preinjury employer) and their claims (e.g., attorney involvement and time to initial care) and environmental factors (e.g., rural area, median household income, health insurance coverage, unemployment rate, etc.). In addition, we created and controlled for several variables that help capture differences in delivery of health care (e.g., same-billing-entity PT providers, supply of MT providers, and patient care-seeking behavior). See Chapter 2 for more details.

MT. For workers receiving MT within 2 weeks of PT care compared with similar cases[10] with late MT, fewer cases had MRI (30.3 versus 43.4 percent), received opioid prescriptions (18.6 versus 23.3 percent), and had pain management injections (12.6 versus 16.5 percent).

- The per-claim indemnity payments and TD duration were also lower when workers with LBP received MT early. The average indemnity payment per claim was 28 percent lower when MT was initiated early and the average TD duration per claim was 22 percent shorter for workers with early MT compared with those with late MT.
- We measure the timing of MT from first PT to first MT visit to capture the timeliness of MT treatment once PT treatment starts, which reflects how MT is integrated into PT treatment regimens. Note that in the previous WCRI study on early PT (Wang, Muller, and Lea, 2020), the timing of PT was measured from the date of injury to first PT visit. In that study, we found that overall PT within 2 weeks postinjury was associated with lower utilization and costs of medical services and shorter TD duration. The findings from these two studies suggest that for workers who are assessed as needing these services, prompt referral to PT and incorporating MT services during initial PT treatment is likely helpful to achieve better outcomes.

HIGHER COSTS AND SLIGHTLY LONGER TD DURATION FOR LBP CLAIMS WITH MT WHEN COMPARED WITH SIMILAR CASES WITHOUT MT SERVICES

- The average worker with MT treatment tended to receive more medical services, with a higher medical cost, when compared with the average worker who did not have MT but received other PT services. The average medical cost was $3,099 per claim for workers who received PT without MT. For similar cases with MT, the medical cost per claim was 35 percent higher. Workers with MT were more likely to receive MRI (29.4 percent for those with MT versus 25.2 percent for those without MT), and slightly more likely to have opioid prescriptions (18.1 percent versus 16.7 percent) and pain management injections (11.3 percent versus 10.2 percent). These results are based on the adjusted data for LBP claims receiving PT services, which allows us to compare similar cases between the MT and no-MT groups.
- The adjusted results show smaller differences in indemnity payments and TD duration between MT and no-MT groups when compared with the unadjusted results, but the differences are statistically significant. After the adjustment, the per-claim indemnity payment was $3,140 for claims with MT, 15 percent higher than that for those without MT. The difference before the adjustment was 45 percent. After the adjustment, the average worker with MT had 4.1 weeks of TD, 8 percent higher than 3.8 weeks for those with no MT. The unadjusted results show a 40 percent difference. Note that the results are based on all LBP claims, medical-only or indemnity. The indemnity payments and TD duration were computed on a per-claim basis.[11]
- It is important to note that we did the same analysis while excluding LBP claims with 1 or 2 PT visits, a possible indicator for disparity in severity. The results showed that MT continued to be associated with higher costs and slightly longer TD duration. However, the magnitudes of the differences in the outcomes between MT and no MT were reduced from 35 to 16 percent on medical costs per claim, from 15 to 8

[10] By similar cases, we mean that the cases between the two groups have similar values on average in the variables we controlled for in our statistical analysis. See Chapter 2 for more descriptions.

[11] The results reported here are based on nonsurgical LBP claims with non-chiropractic care regardless of whether the claim had lost time. We also ran the same analysis for a subset of LBP claims with more than seven days of lost time and for LBP only claims with more than seven days of lost time. The comparative results are similar; they can be found in Technical Appendix C.

percent on indemnity payments per claim, and from 8 to 4 percent on the average TD duration. When we compared the outcomes between early MT and no MT, the results did not change—early MT is also associated with higher costs and slightly higher TD duration when compared with the no-MT group.[12]

- Based on our analysis, we found several factors that had large and significant effects on the choice of MT treatment. Besides severity and comorbidity indicators, we found that access to qualified MT providers[13] and the integration of MT practice in health care organizations that had integrated PT units had a large and significant effect on treatment choice. Access to MT providers was highly predictive of the likelihood of having MT and receiving it early. Workers receiving MT treatment from the same billing entity[14] were less likely to have MT; and for those who had it, MT was less likely to be early. Workers' demo-socio-economic factors were also significant, but the magnitudes of the effect were not as large.
- We found that neuro back cases were more likely to have MT. There has been mixed guidance on application of MT related to low back pain with nerve involvement. While guidelines differ on the recommendations in use of MT for neuro back conditions, there is evidence supporting the use of symptom modulating interventions, including MT, when the patient presents with more severe symptoms of irritability and volatility (Alrwaily, 2016).

It is important to note that most observational studies are limited regarding true causation analysis. We applied statistical techniques to adjust the data and ensure valid comparison of costs and TD duration between different treatment groups (early versus late MT and MT versus no MT). Although we controlled for various factors that may be correlated with unobserved severity and patient complexity,[15] we cannot directly measure and control for these factors that most likely influence treatment choice and outcomes. Because of this limitation, we interpret the results on the relationship between treatment patterns and outcomes as association, not causation.

Another caveat is regarding the measurement of long-term outcomes on quality of care. In the comparison of early versus late MT and MT versus no MT, we only evaluated medical and indemnity costs and TD duration at 18 months postinjury. Is MT treatment necessary to help LBP workers return to work sooner, and does it produce long-term improvements in quality of life? Our findings do not answer these questions because we did not have data to measure clinical and quality-of-life outcomes (e.g., the recurrence rate of LBP and patient self-reported outcomes on pain and functional recovery) and we did not observe the outcomes over a long period of time. At 18 months, the costs may be higher and duration of disability may be longer when MT is provided as compared with when it is not, but if the overall costs and lost time were reduced over a longer period of time, MT treatment at an earlier stage may still be cost-effective.[16]

Lastly, the findings from this study highlight the need to obtain additional data elements for worker self-

---

[12] Results are included in Technical Appendix C.

[13] Approximated by a variable we constructed using geographic variation across hospital referral regions.

[14] The term *same billing entity* indicates that the treating physician (or PT-referring physician) shares the same tax ID with the PT provider when billing for the services rendered. The same billing entity may imply one of the two things: (1) the treating physician and the PT provider 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 PT provider 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. See Chapter 2 for a more detailed description.

[15] By unobserved severity, we mean factors that cannot be represented fully in the coded conditions and comorbidities, such as the specific underlying conditions, pain intensity, and symptom irritability. Patient complexity refers to factors that go beyond medical severity but influence medical decision making and patient care-seeking behavior, such as preinjury health status and utilization patterns of medical services. See Chapters 1 and 2 for more details.

[16] We also compared the costs and TD duration between the early MT group and the group with no MT. The differences were smaller compared with the MT and no-MT comparison, but still statistically significant.

reported measures, pre-conditions, functional status, and quality outcomes. The data should cover a much longer time period to measure long-term outcomes.[17]

DATA AND APPROACH

Claims included in this study are those with injuries occurring from October 1, 2015, to September 30, 2017, with detailed medical data and benefit payment data in the WCRI Detailed Benchmark/Evaluation database capturing the first 18 months of experience. We included both LBP-only claims and LBP claims with nerve involvement (often referred to as *neuro back*) that received medical treatment with or without receiving indemnity benefits. We excluded low back claims that had International Classification of Diseases (ICD-10) codes indicating underlying red flag conditions (e.g., tumors, infectious diseases, fractures and dislocations) and/or neurological neck conditions.[18] We also excluded a small number of LBP claims that had a comorbid condition with severe complications, such as diabetes with hypoglycemia or ketoacidosis, substance abuse with psychotic disorders, and bipolar disorders.[19] A few claims with specific procedure codes (MRI, for example) that may indicate a previous low back pain occurrence or a previous low back surgery were also excluded from the study sample. As a result, the claims included in this study are mostly claims with acute or subacute low back pain. We also excluded from this study LBP claims that had low back surgery and LBP claims with chiropractic care so the results will be useful for medical providers, policymakers, and the majority of workers with low back pain.[20] There are 28 states included in the study.

To support the comparative analyses, we used a propensity score approach. It is a two-stage statistical analysis that helps eliminate or mitigate any bias in the comparative results due to potential selection issues.[21] In Chapter 4 and 5, we report both adjusted and unadjusted results. The adjusted results support our major findings that compare the utilization of medical services, costs, and TD duration between claims with early and late MT. The same approach was also applied to the comparison between LBP claims with and without MT. More details about data and approach can be found in Chapter 2 and Technical Appendices A–C. We also discuss several limitations of the study in Chapter 2.

---

[17] With data for workers' compensation health care, two-year follow-ups may be more likely to identify recurrent cases.

[18] A red flag is a medical condition which, by medical consensus or evidence, requires immediate testing or intervention due to the likelihood of possible permanent, significant impairment or the need for expedited surgery. See Chapter 2 and Technical Appendix A for a more detailed description of the exclusions.

[19] These more serious comorbid conditions were identified using an ICD-10 code list we established for comorbidities (Wang, Mueller, and Lea, 2020). Chapter 2 and Technical Appendix B provide more detailed descriptions.

[20] There was a small percentage of surgical cases that were excluded from the study. The extent of exclusions for chiropractic care varied by states. We tested the potential impact of this variable exclusion on the interstate variation in the prevalence and patterns of care and did not see evidence that the exclusions would affect the comparative results.

[21] The two-stage method first models treatment choice (early versus late MT and MT versus no MT). At the second stage, it uses the results of the first stage to balance the mix of cases in the treatment and comparison groups. By doing so, we make sure that the findings are based on a comparison of outcomes for two groups that are similar in terms of characteristics of workers and their claims as well as provider and environmental factors that might have influenced treatment choice and outcomes. See Chapter 2 for further discussion.

1

INTRODUCTION

Physical therapy (PT) is recommended by most guidelines for musculoskeletal injuries as a non-invasive, non-pharmacological treatment option before considering opioids and other invasive procedures.[1] With an increasing number of workers with injuries receiving PT treatment, an important question is what treatment pattern makes a difference in terms of utilization and costs of medical resources and outcomes. There are many different ways to describe PT treatment patterns in terms of provider type, service type, timing, frequency, duration, and intensity. After analyzing the data that capture PT treatments delivered to workers with low back pain, we identified several common PT treatment patterns, including patterns of manual therapy (MT)—the subject of this study.[2] Manual therapy, a type of PT treatment, is a hands-on therapy to mobilize or manipulate joints and soft tissues with the intent to increase joint range of motion, reduce pain, and eliminate soft tissue swelling and inflammation. These services are often provided by physical therapists with special training in MT techniques, by osteopathic physicians, or by chiropractors.[3]

OBJECTIVE AND SCOPE OF THE STUDY

This study is focused on nonsurgical low back pain (LBP) claims and examines patterns of care for MT and other PT services that were provided by non-chiropractic providers, mostly physical therapists.[4] It describes patterns of MT services and compares costs and temporary disability (TD) duration across different treatment patterns. Specifically, we address the following policy relevant questions:

---

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

[2] The three research topics on PT treatment patterns are separately focused on (1) manual therapy, (2) chiropractic care, and (3) risk factors for higher-than-expected use of PT services. See Technical Appendix A for a description of the common PT patterns we identified.

[3] The difference between manual physical therapy and chiropractic care lies in the balance between hands-on manual therapy treatment and individualized exercise programs. Physical therapists may be more likely to provide active therapy, such as exercise, and use manual therapies to diagnose and reduce pain so that the patient can be active and care for themselves through exercise and maintaining good posture.

[4] We focus on nonsurgical claims with non-chiropractic care for two reasons. First, because this is a study of specific medical care issues, it requires a specific setting in which the results can be interpreted in a meaningful way to practitioners and policymakers. Since most non-chiropractors in our study sample are physical therapists, the results are useful for this group of providers. Unfortunately, we cannot differentiate other non-chiropractors from physical therapists (e.g., osteopathic physicians), which could help further disentangle the factors influencing care and outcomes. Second, nonsurgical LBP cases with care by non-chiropractors represent the most commonly encountered clinical scenario seen in everyday practice. A study of these common cases would be most useful for overall improvement of care. Note that the LBP claims are the LBP-only claims and low back claims with nerve involvement that do not have recorded diagnoses of red flag conditions (i.e., cancer, infectious diseases, fractures, dislocations, and severe psychological complications). By medical consensus or evidence, these more serious conditions require immediate testing or intervention due to the likelihood of possible permanent, significant impairment or the need for expedited surgery.

- How prevalent is MT among workers with low back pain receiving non-chiropractic care?
- What are the patterns of MT treatment in terms of timing, frequency, duration, and intensity?
- Does MT make a difference in the costs of treatment and the use of opioids and injections?
- How do costs and TD duration compare for LBP claims with and without MT?

In the main report, we answer these questions based on the results of our analysis for all medical and indemnity claims with LBP that had no surgery but had MT and other medical services. Comparative results are similar for LBP claims and LBP-only claims with more than seven days of lost time; these can be found in Technical Appendix C.

For this study, a vast majority of MT services were identified using the CPT4 code 97140.[5] Because the current coding system does not provide detailed information on the type of MT services, our analysis has to be focused on all MT services in aggregate without subgroup analyses of specific MT services. We also include osteopathic manipulative therapy (OMT) in the study to focus on non-chiropractic MT.[6] Because of the self-limiting nature of low back pain, it is possible that some workers with less serious low back pain do not receive PT treatment or have only one to two visits for evaluation and education.

Recognizing that almost all observational studies are limited regarding true causation analysis, we applied statistical techniques to adjust the data to ensure valid comparisons of costs and TD duration between different treatment groups. Although we controlled for various factors that might influence treatment choice and outcomes, we do not have data to directly measure severity and complexity, which affects our ability to draw definitive conclusions. As a result, we interpret the findings on the relationship between treatment patterns and outcomes as association, not causation. We also recognize that the outcome measures we use for the study may not be enough to address the cost-effectiveness of MT. More data are needed to capture quality outcomes that should be evaluated over a longer period of time. We discuss these limitations in more detail in Chapter 2.

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 exceed $100 billion per year, two-thirds of which are indirect costs including lost wages and reduced productivity (Katz, 2006). The prevalence and costs of low back pain has led to debate regarding how to best manage LBP-related conditions (Hanney et al., 2016). As a non-invasive, non-pharmacological treatment option, physical therapy and related treatment [7] are recommended widely by treatment guidelines, and more recently by opioid prescribing guidelines, as first-line

[5] CPT® (Current Procedural Terminology) is a registered trademark of the American Medical Association.

[6] We focus on non-chiropractic MT partially because the data enable us to distinguish chiropractors from non-chiropractors, but not to further differentiate physical therapists from physicians and other PT providers. We use the terms *non-chiropractic PT providers* and *chiropractors* when it comes to type of providers, knowing that a vast majority of the non-chiropractic providers are physical therapists.

[7] Physical therapy and related treatment consists of physical modalities (often referred to as passive physical therapies, such as hot and cold pads, soft tissue massage, traction, and acupuncture), manual therapy (e.g., joint or soft tissue mobilization and manipulation, connective tissue message, and manual tractions, etc.), and active therapies (e.g., therapeutic exercises and related education and training, active counseling, and work hardening). Evaluation/measurement, functional assessment are also part of physical medicine to evaluate and monitor the progress of treatment.

conservative care.[8]

Manual therapy, a part of PT treatment, is a hands-on therapy on the joints and soft tissues with the intent to increase joint range of motion, reduce or eliminate soft tissue swelling and inflammation, induce relaxation, and modulate pain.[9] It consists of joint and soft tissue mobilization and manipulation, connective tissue massage, manual traction, trigger point therapy, etc. Spinal manipulative services are typically provided by certified physical therapists with special training in mastering MT techniques.

Most guidelines for occupational low back pain allow specific types of MT treatment for treating acute and subacute LBP and encourage the use of MT therapy in conjunction with specific exercises to support and maintain the improvements.[10] Outside workers' compensation, manual therapy received a positive review in a systematic review by Chou et al. (2017), which found moderate evidence for the effectiveness of manual therapy equal to other commonly used treatments. The clinical practice guidelines for low back pain from the Orthopaedic Section of the American Physical Therapy Association guidelines, which linked care to the International Classification of Functioning, Disability, and Health (ICF), also advocated for manual therapy, especially for cases demonstrating mobilization limitations (Delitto et al., 2012). The initial MT treatment is recommended for mild to moderate/severe pain for up to six visits. Treatment may be continued if functional progress is recorded. The total number of visits and treatment duration allowed by most guidelines is generally 10–12 visits over 6–8 weeks. A number of studies examined the efficacy and effectiveness of MT for acute and subacute low back and neck pain,[11] focusing on manipulation and mobilization.[12] These studies suggest that for acute and subacute LBP, manipulation and mobilization is at least as effective as other commonly ordered therapies and relatively safe (Rubinstein et al., 2012, Hidalgo et al., 2014, and Paige et al., 2017).[13]

Few studies have examined the cost-effectiveness of manipulation and mobilization for low back pain, none of which include workers' compensation patients or residents of the United States. For example, a systematic review by Michaleff et al. (2012) included six studies, three for low back pain (conducted in the United Kingdom and Finland, with one for both low back and neck pain) and three for neck pain (in the

---

[8] See the ACOEM, ODG, and Washington State opioid guidelines.

[9] Manual therapy techniques may be performed on individuals with a limited range of motion, muscle spasm, pain, soft tissue swelling, inflammation, or restriction.

[10] The national guidelines commonly used are ACOEM and ODG; state guidelines include, for example, low back treatment guidelines in Colorado and New York.

[11] For chronic low back pain, numerous randomized controlled trials have examined the benefit and harm of spinal manipulative treatment (SMT), but in general, SMT is not currently recommended as a first-line treatment for chronic low back pain (from Rubinstein et al., 2019). However, the two most recent systematic reviews provide some evidence supporting the use of SMT for the treatment of chronic low back pain. Coulter et al. (2018) conducted a meta-analysis and found moderate evidence supporting a decrease in pain and increase in function for thrust manipulation compared with mobilization and found both treatments to be safe. Rubinstein et al. (2019) conducted a systematic review and meta-analysis of randomized controlled trials and concluded that SMT has similar effects to recommended therapies for chronic low back pain, although it seems to be better for short-term improvement in function.

[12] This is narrower than the definition of manual therapy we use in this study. Our definition is based on a real-world coding definition that indicates therapies in addition to classic joint mobilization and manipulation.

[13] For example, a Cochrane review by Rubinstein et al. (2012) found moderate evidence for a small, but not clinically significant, pain decrease and functional improvement at one month when manipulation was compared with other exercise types of PT programs for acute low back pain. Manipulation was deemed to be safe from serious side effects but no more effective than other commonly used treatments (Rubinstein et al., 2012). A recent systematic review by Hidalgo et al. (2014) compared manipulation with mobilization and soft tissue techniques or both combined. Of the three new high-quality studies included in this review, which all included sham manipulation, three showed significant decreases in pain with manipulation and one of the three found decreased disability. A more recent systematic review and meta-analysis by Paige et al. (2017) concluded that there was a modest clinically meaningful benefit in pain reduction and functional improvement from spinal manipulation. However, most of the studies were low quality and a meta-analysis may not have been appropriate given the variety of studies involved.

Netherlands and Finland). Regardless of pain regions, the review concluded that spinal manipulative treatment (SMT) appears to be a cost-effective treatment when used alone or in combination with other treatment approaches.[14] A German study by Walker et al. (2017) used propensity matching to compare large cohorts of acute low back pain patients who received manipulations with those who did not. This study closely resembles our work. The authors found that medical costs and sick leave were slightly lower for patients with manipulations than for those without SMT, but the difference was not statistically significant.

It is worth noting that there has been a lack of consistency in the evidence for manual therapy among the studies, due to differences in study sample, design, comparison groups, and the outcomes measured (Coulter et al., 2018; Groeneweg, 2017).[15] Such inconsistencies make it difficult to draw conclusions that are definitive and evidence based. In addition, many of the studies we reviewed were not focused specifically on the lumbar region or acute as opposed to subacute or chronic low back pain; none of the studies that examined costs and sick leave were from the United States and none included workers' compensation patients. As of July 2021, we are not aware of any studies in the United States or for a workers' compensation population.

Another issue worth noting is the challenge to address the potential bias in the measured relationship between treatment and outcomes due to selection of patients into the treatment and the lack of appropriate controls for unobserved severity and patient complexity, which is especially the case for observational studies. Several studies (Chevan and Riddle, 2011; Babitsch et al., 2012; Blanchette et al., 2016) used Andersen's behavioral framework as a guide in searching for covariates and confounding factors.[16] More recently, a number of studies (for example, Park, 2016; Tonelli et al., 2018) examined key elements in the observational data that may be used to indicate the level of patient complexity, including patient's pre-conditions and utilization patterns of medical services in the past. According to Tonelli et al. (2018), patient complexity can be defined as an interaction between the personal, social, and clinical aspects of the patient's experience that complicates patient care and goes beyond medical severity and comorbidities.

We chose to study manual therapy for several reasons. First, MT services are commonly performed by non-chiropractic providers for treating workers with LBP. In the typical state we studied, 46 percent of all nonsurgical LBP claims received PT services and 65 percent of those with PT services had manual therapy, by non-chiropractic providers. The percentages were higher for LBP claims with nerve involvement and for claims with more than seven days of lost time. The average number of MT services typically ranged between 7 and 18 for LBP-only claims with more than seven days of lost time.[17] Second, few studies examined costs and effectiveness of manual therapy, and these studies focused on populations outside the United States and outside workers' compensation (see a summary of the literature above). Third, there is a lack of consistency in the specific MT services. Most guidelines (including ACOEM and ODG) allow manipulation and mobilization and separately list other types of MT services (e.g., trigger point message and dry needling). There is a lack of consistency in nomenclature for different services included in manual therapy and no standardized coding is available to facilitate the tracking of specific MT services. Our study focuses on workers' compensation in the

[14] Note that the cases included in these studies were mostly cases with subacute or chronic pain, and the treatment patterns were usually once per week for four to six weeks (Michaleff et al., 2012).

[15] Coulter et al.'s meta-analysis of MT pointed out the inconsistencies between studies on how MT was administered (dose and duration) and by whom, comparison groups, and outcomes measured. Groeneweg et al. focused on the wide variation in nomenclature used to describe MT and how that hinders study comparisons.

[16] Initially developed by Andersen (1995) and later explicated by Andersen and Davidson (2001), Andersen's behavioral model incorporates both individual and contextual determinants of health service use and divides all factors into three categories: predisposing factors, need factors, and enabling factors.

[17] The numbers are based on the same data used for this study.

United States and examines practice patterns of manual therapy, using a real-world, broad coding base. The study also highlights the need to develop a standardized nomenclature and coding system that enables policymakers and stakeholders to track specific MT services delivered to workers with occupational injuries.

Our study is unique in that it fills many of the gaps in the current knowledge about the use and cost-effectiveness of manual therapy in workers' compensation systems. We focus on utilization of manual therapy and compare utilization, costs, and TD duration of the claims with manual therapy with those that did not have manual therapy. In terms of the scope, we include manual therapy and osteopathic manipulative therapy provided by non-chiropractic providers, excluding manual therapy and chiropractic manipulative therapy by chiropractors. Chiropractic practice patterns will be examined in a subsequent study.

Our study is limited for two reasons. First, it is based on observational data (claims data and detailed transactions of medical services) that capture the experience of workers with LBP over an 18-month period from the date of injury. Although we were able to control for many factors,[18] which to some extent, may represent severity and patient complexity, we were not able to directly observe and measure these factors that likely influence treatment choice and outcomes. This is a limitation to observational studies and our study is no exception. Because of this, we discuss our findings as evidence of association, not causation, between the MT treatment patterns and outcomes. Second, we use medical and indemnity payments as well as TD duration as outcomes variables, and we measured these outcomes at 18 months postinjury. We do not have data on clinical and quality-of-life outcomes that are typically used in medical effectiveness studies, such as recurrence rate of low back pain. Nor do we have data on subjective outcomes, such as self-reported functional status. The patient's impression of how they are functioning in their life is of utmost importance to the individual worker and is usually considered in determining whether a treatment is considered to be medically effective. Because our study is purely based on medical/indemnity costs and disability, at 18 months after injury, the results from our study may not reflect the ultimate effect of treatment on the long-term functional outcomes for workers with LBP. Due to our lack of ability to comment on the patient's impression of their functional outcome, it is likely that our results may differ from some of the medical studies on the same treatment. Chapter 2 and Technical Appendices A–C provide more discussion of technical issues.

ORGANIZATION OF THIS REPORT

The report is organized into six chapters. Chapter 2 describes the data used for the study and our approach to comparing outcomes between different treatment patterns. Chapter 3 describes the prevalence and patterns of MT treatment across the 28 study states. Chapters 4 and 5 provide results from our statistical analyses that address two related but different questions. Chapter 4 provides evidence that early MT is associated with lower costs and TD duration. Chapter 5 compares two different PT treatment patterns among non-chiropractic providers: one with MT and the other one without MT. In Chapter 6, we discuss implications of the findings as well as our outlook for future research.

The statistical appendix has several tables that are aimed at providing more detailed data for readers who are interested in diving deeper into the data for their own analysis.

[18] We assessed our ability to address confounding factors by comparing the set of variables we controlled for with those that have been addressed in the relevant literature in the context of Andersen's framework and patient complexity. Based on our assessment, we believe that the set of variables we used in our analysis is among the most complete set of controls in the empirical studies using administrative data. However, we do not have the data needed to capture workers' pre-condition and prior utilization of medical services, which is part of the patient complexity indicator examined in several studies outside workers' compensation. Chapter 2 and Technical Appendices A–C provide more discussion.

The technical appendices cover several technical issues. Technical Appendix A describes the identification of LBP claims and common PT treatment patterns, which led us to focus on our three study topics, including the present MT study. Technical Appendix B describes in more detail what we did to identify comorbidities in the administrative data and thoughts about patient complexity. Technical Appendix C describes the statistical techniques we used for our analyses that support findings in Chapters 4 and 5. We also present the key results from our statistical analyses in this technical appendix, as well as several sensitivity analyses. These are followed by a glossary and list of references.

2

DATA AND APPROACH

This chapter explains the data and methods we used for this study. We describe the outcome variables we used for comparing different treatment patterns, factors that may affect treatment choice and outcomes, and our statistical analyses that compare costs and outcomes between different PT treatment paths. We also briefly describe the LBP claims included in our PT study series; these claims were identified based on an algorithm established in a previous WCRI study. A more detailed description of the identification of LBP claims and common PT treatment patterns for LBP can be found in Technical Appendix A. Technical Appendix B describes how we address severity and comorbidities, and Technical Appendix C covers our statistical analyses and other related technical issues.

THE DATA

The data used for our PT studies are from the WCRI Detailed Benchmark/Evaluation (DBE) database, which provides us with more than 2 million open and closed claims from 28 states,[1] with injuries from October 1, 2015, through September 30, 2017. The observation window for treatment patterns and outcomes is 18 months from the date of injury, with detailed medical and payment transactions up to March 31, 2019. All except two study states have representative data in the DBE database.[2] Our study 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 38–77 percent of all workers' compensation claims, depending on the state, for the individual states we studied. The 28 states combined represent more than 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 charged by and 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 roots, 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

[1] The 28 states are Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Jersey, New Mexico, 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.

addressed in medical treatment guidelines. This choice limited us to include claims with injuries occurring on or after October 1, 2015.[3] We limited the date of injury up to September 30, 2017, in order to observe treatments and benefit payments for 18 months, based on the DBE data as of March 31, 2019.

The LBP claims included in this study are (1) low back pain claims with radiating leg pain and/or neurological findings, and (2) low back pain only claims.[4] Throughout the reports, we use *LBP claims with nerve involvement* or *neuro back claims* and *LBP-only claims* as shorthand.

To make sure that these LBP claims did not have more serious conditions, we excluded those that had at least one mention in the ICD-10 codes of a red flag condition (e.g., tumors, infectious diseases, fractures and dislocations)[5] and/or neurological neck conditions.[6] Note that red flag is a term often used for a medical condition which, by medical consensus or evidence, requires immediate testing or intervention due to the likelihood of possible permanent, significant impairment or the need for expedited surgery. We also excluded a small number of LBP claims that had a comorbid condition with severe complications, such as diabetes with hypoglycemia or ketoacidosis, substance abuse with psychotic disorders, and bipolar disorders.[7] A few claims with specific procedure codes (MRI, for example) that may indicate a previous low back pain occurrence or a previous low back surgery were also excluded from the study sample. As a result, the claims included in this study are mostly claims with acute or subacute low back pain.

The LBP claims included are those LBP claims receiving medical care, regardless of whether they were medical-only or indemnity claims. We report results for all medical claims to provide a more complete picture of treatment patterns of physical therapy services. Results for LBP claims and LBP-only claims with more than seven days of lost time support the same findings, which are included in Technical Appendix C. We also examined a subset of LBP claims with 3 or more PT visits in our sensitivity analysis, which is discussed in Chapters 4 and 5 as well as Technical Appendix C.

To ensure the clarity of the report and meaningful interpretations of the results, we excluded from this study surgical LBP claims and claims with chiropractic care because the involvement of these types of care likely indicates different treatment paths.[8] Future research will address chiropractic care.

Table 2.1 provides claim counts that summarize the claims in the DBE database, LBP identification and exclusions, and the LBP claims we included in the study.

---

[3] 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 15-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.

[4] 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.

[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 tumor, infectious disease, and fracture and dislocation.

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

[7] These more serious comorbid conditions were identified using an ICD-10 code list we established for comorbidities. See Wang, Mueller, and Lea (2020).

[8] There may be a concern about potential bias due to these exclusions. If one believes that MT may help avoid surgery, the exclusion of surgical LBP cases might have an effect of making the MT group relatively more severe than the no-MT group. For LBP claims studied, there is a small percentage of cases with low back surgery, which is unlikely to distort the comparative results. There is a large variation across states in the prevalence of chiropractic care. We checked how the percentage of LBP claims with chiropractic care is correlated with the use of MT services and did not find evidence that the exclusion of the chiropractic cases would affect the comparative results in the prevalence and patterns of MT treatments.

Table 2.1 Number of Claims

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Total / 28-State Median
Number of all medical claims in DBE round 21 database	15,013	363,151	38,466	6,807	152,285	62,635	30,453	102,454	64,773	28,785	41,289	22,007	55,377	37,935	85,751	62,483	48,062	68,741	85,858	17,869	27,588	89,373	103,152	33,027	56,929	209,217	56,304	65,881	2,031,665
Number of claims with at least one LBP diagnosis	2,348	75,303	7,638	1,278	27,386	11,855	4,756	17,594	8,328	4,156	6,597	4,067	10,427	7,068	12,490	12,097	7,156	11,839	16,043	3,352	5,209	18,137	16,876	5,588	9,139	36,735	9,236	11,324	364,022
Number of claims with predominant LBP[a]	1,705	54,270	5,313	828	19,114	8,557	2,678	12,034	5,828	2,532	4,603	2,831	7,271	4,991	8,797	8,416	4,656	7,914	11,245	2,216	3,523	11,550	11,394	3,521	6,495	28,728	6,465	7,626	255,101
Number of LBP claims after exclusions of claims with more serious conditions	1,592	51,035	4,918	708	17,657	7,908	2,418	10,959	5,423	2,299	4,250	2,446	6,608	4,641	8,227	7,731	4,369	7,294	10,222	2,068	3,306	9,150	10,446	3,201	5,986	27,073	6,021	7,020	234,976
% of all LBP claims after exclusions of more serious conditions	93%	94%	93%	86%	92%	92%	90%	91%	93%	91%	92%	86%	91%	93%	94%	92%	94%	92%	91%	93%	94%	79%	92%	91%	92%	94%	93%	92%	92%
Exclusions of surgical and chiropractic cases																													
Number of surgical LBP claims	16	606	113	13	177	123	51	242	112	39	51	82	102	66	47	93	92	104	250	11	35	207	169	62	98	263	64	71	3,359
% of LBP claims with surgery	1%	1%	2%	2%	1%	2%	2%	2%	2%	2%	1%	3%	2%	1%	1%	1%	2%	1%	2%	1%	1%	2%	2%	2%	2%	1%	1%	1%	1%
Number of LBP claims with chiropractor involvement	18	12,630	438	105	265	84	257	1,143	85	145	298	170	928	530	173	2,614	73	106	150	191	132	1,889	1,127	32	108	2,847	106	1,961	28,605
% of all LBP claims with chiropractic care	1%	25%	9%	15%	2%	1%	11%	10%	2%	6%	7%	7%	14%	11%	2%	34%	2%	1%	1%	9%	4%	21%	11%	1%	2%	11%	2%	28%	12%
LBP claims used for this study[b]																													
LBP claims Included[c]	1,558	38,036	4,383	593	17,221	7,703	2,114	9,609	5,228	2,117	3,906	2,206	5,598	4,051	8,007	5,052	4,204	7,086	9,830	1,869	3,149	7,117	9,187	3,107	5,784	24,115	5,854	5,012	203,696
LBP claims included as % of all predominant LBP claims	91%	70%	82%	72%	90%	90%	79%	80%	90%	84%	85%	78%	77%	81%	91%	60%	90%	90%	87%	84%	89%	62%	81%	88%	89%	84%	91%	66%	80%
% of LBP claims with nerve involvement	20%	16%	23%	31%	24%	23%	23%	23%	21%	22%	23%	23%	26%	18%	18%	27%	18%	25%	28%	15%	12%	39%	23%	23%	24%	12%	22%	27%	21%

Notes: Claims included are those with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. The claims in the DBE database represent approximately 38–77 percent of all workers' compensation claims, depending on the state. See Chapter 2 for more details about the data used for this study.

[a] Predominant LBP claims are those that had at least one low back diagnosis and more than 70 percent of the medical payments were for services used in treating LBP conditions.

[b] The LBP claims used for this study are those LBP claims that did not have low back surgery during the first 18 months of treatment, but received medical services from non-chiropractic providers.

[b] The LBP claims included are those LBP claims after the exclusions of cases with more serious conditions that did not have surgery and did not receive care from a chiropractor. The LBP claims were identified using the ICD-10 algorithm we established in a previous WCRI study on physical therapy services. These claims had medical services predominantly used to treat low back conditions excluding those that had ICD-10 codes indicating more serious red flag conditions, neurological neck pain, or more severe comorbidities. The difference in the number of LBP claims used for this study from the number of claims with LBP conditions reflects several exclusions we applied to ensure sample data contain more clinically homogenous LBP cases. See Chapter 2 for a more detailed description.

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

MANUAL THERAPY AND TREATMENT PATTERNS

This study is mainly focused on manual therapy. Manual therapy is one of the oldest treatments. The simplest definition for MT can be found by looking at the Latin root origin of the word manual, which is *manus* and means the hand. Manual therapy is a subgroup of therapy treatments that are delivered hands-on as opposed to other types of therapy that are more "hands-off," such as supervised exercise. In concept, manual therapy targets soft tissues (i.e., muscles, tendons, ligaments, and fascia), joints, or both.[9] For soft tissues, manual therapy may help relieve spasm or help break up scar tissue or adhesions within those soft tissues; services include manual massage and other instrument-assisted methods (e.g., Graston or ASTYM techniques), trigger point release, and active release techniques (e.g., myofascial release or release of painful muscle and fascia trigger point). For joints, the most often mentioned manual therapy is mobilization. There are a number of maneuvers used by different types of providers that perform mobilizations that are delivered with varying force, speed, and amplitude, all of which help increase the motion of a joint, which in turn should help restore normal joint mechanics and thus decrease pain. Combined techniques are used to address issues with both soft tissues and joints, for example, muscle energy techniques which are reported to increase joint motion and lengthen shortened muscles.

In practice, however, these widely different types of MT services have been billed almost exclusively using CPT code 97140 since 1998. In that year, CPT code 97140 was first published, representing a collapsing of five other CPT codes that were used prior to 1998 to represent soft tissue mobilization, joint mobilization, manipulation by a physician (initial area and each additional area), and manual traction.[10] In 2020, two new CPT codes (20560 and 20561) were published to represent dry needling; they are not in our study sample.

Because of this broad coding scheme, we are not able to identify specific types of MT services. CPT code 97140 can be used by physical therapists and chiropractors when billing for MT services, but the types of services rendered and billed are likely to be different. For this reason, we exclude claims with chiropractic care so we can focus on MT services that are provided by non-chiropractic providers. A separate study will be focused on patterns of chiropractic care (see Technical Appendix A and Figure TA.A1). While most of the non-chiropractic PT/MT providers are physical therapists, we use the terms *non-chiropractic providers* or *non-chiropractors* for accuracy. In this study, we focus on all MT services, regardless of specific type, by non-chiropractic providers in terms of timing of MT treatment, frequency of visits, duration, and intensity.

In practice, what falls under the umbrella of manual therapy are services that vary greatly in the level of complexity and skill involved. This is likely to be compounded by the use of an umbrella code for billing (97140, which is generally inclusive of hands-on care). As a result, 97140 may be reflective of the type of care that is expected to be associated with improved outcomes, but it can also be reflective of other less-skilled services that may not be as helpful (e.g., paraprofessional performing passive muscle stretching). Thus, something as simple as passive stretch of a patient's thigh muscle can be billed using the same code as more complex maneuvers such as manipulation of the spine that require additional training and experience to safely perform. Since any provider can bill for manual therapy, the variation from state to state may be reflecting different practice patterns and the availability of qualified therapists in the region. Practice and billing patterns may also be different between large corporate providers versus smaller privately-owned clinics. We may also see providers that bill for therapeutic exercise aggressively and bill 97140 sparingly, which could result in differences in

[9] See *Specific Manual Physical Therapy Techniques* (Daul, 2006). Available at https://www.spine-health.com/treatment/physical-therapy/specific-manual-physical-therapy-techniques.

[10] See American Physical Therapy (APTA) Public Policy, Practice, and Professional Affairs Unit (2014).

outcomes related to MT.

MEASURING UTILIZATION AND OUTCOMES

There are several key aspects of physical therapy treatments, including timing of initiation, type of provider and services, and frequency, duration, and intensity of PT services. We expanded our previous study on PT timing (Wang, Mueller, and Lea, 2020) to consider these additional dimensions to identify common treatment patterns of physical therapy and related services. Note that we use the term *physical therapy and related services* or *PT services* as shorthand throughout the report, recognizing that in practice, many practitioners may think of PT as physical therapy services provided by physical therapists.[11] *Physical therapy and related services* or *PT services* are those that are provided by physical therapists and other non-chiropractic providers, including occupational therapists, medical doctors, and osteopathic doctors.

The utilization variables were constructed based on detailed medical transactions for medical services, including PT services, rendered during the first 18 months of treatment. The same set of utilization variables was also created for the period of initial care. The specific types of medical services and procedures were identified using CPT codes. See the tables in Technical Appendix A for more details. Table 2.2 provides a list of variables we used for the study, and we briefly describe these variables below.

[11] It should be noted that for many physical therapists, the terms *PT* or *PT services* refer to physical therapy services performed by licensed physical therapists. However, the CPT codes for PT services are not exclusive to physical therapists. Other clinicians can deliver similar treatments using the same CPT codes. The term *PT services* we defined and used in this report refers to not only physical therapy services prescribed and performed by licensed physical therapists but also similar services by other non-physical therapist providers.

Table 2.2 Measuring Utilization, Costs, and Outcomes

Variables and Type	Description
Utilization, costs, and TD duration (observed during 18 months after injury)	
% of claims receiving MRI	Percentage or likelihood of receiving lumbar MRI, based on the claim-level variable that has value 1 if the claim received MRI and 0 if not. See the early PT report (Wang, Mueller, and Lea, 2020) for more details.
% of claims receiving opioid Rx	Percentage or likelihood of receiving opioid Rx, based on the claim-level variable that has value 1 if the claim had opioid Rx and 0 if not. See the early PT report for more details.
% of claims receiving pain management injections	Percentage or likelihood of receiving spinal pain management injections, based on the claim-level variable that has value 1 if the claim received injections and 0 if not. The CPT codes for spinal injections can be found in Table 2.2 of the early PT report.
Medical cost per claim	Mean and median value of medical benefit payments per claim for medical services, based on payors' payment and credit transaction data at 18 months postinjury.
Indemnity payments per claim	Mean and median value of indemnity benefit payments per claim, based on payors' payment and credit transaction data at 18 months postinjury.
TD duration in weeks	Mean and median number of weeks of temporary disability benefit payments, based on payors' payment and credit transaction data at 18 months postinjury.
Utilization patterns of MT services	
Prevalence	
% of claims with PT	Percentage of LBP claims (with or without nerve involvement) that received PT services during 18 months of treatment postinjury.
% of claims with MT	Percentage of LBP claims (with or without nerve involvement) that received MT services during 18 months of treatment postinjury.
Timing	
% of claims with early MT	Percentage of LBP claims receiving MT within 2 weeks of PT care, based on detailed medical transaction data.
Days from injury to 1st MT visit	Number of days from the date of injury to the date of first MT visit, based on detailed medical transaction data.
Days from injury to 1st medical visit	Number of days from the date of injury to the date of first medical visit, based on detailed medical transaction data.
Days from 1st medical visit to 1st PT visit	Number of days from the date of first medical visit to the date of first PT visit, based on detailed medical transaction data.
Days from 1st PT visit to 1st MT visit	Number of days from the date of first PT visit to the date of first MT visit, based on detailed medical transaction data.
Frequency, duration, and intensity	
Number of PT visits	Number of unique dates of visits for PT services, based on detailed medical transaction data.
Number of MT visits	Number of unique dates of visits for MT services, based on detailed medical transaction data.
MT duration (in days or weeks)	Number of days or weeks from the first date of MT visits to the last date of MT visits, based on detailed medical transaction data.
% of claims with MT that had MT duration ≤ 6 weeks	Percentage of LBP claims that had MT duration less than or equal to 6 weeks, based on the claim-level MT duration variable.
Number of MT visits per week	Mean or median values of a claim-level variable that is computed by dividing the number of MT visits by the MT duration in weeks.
Number of MT services per visit	Mean or median values of a claim-level variable that is computed by dividing the number of MT services by the number of MT visits.

Key: CPT: Current Procedural Terminology; MRI: magnetic resonance imaging; MT: manual therapy; PT: physical therapy; Rx: prescription(s); TD: temporary disability.

- Opioid prescriptions are identified based on drug transactions in the DBE database using the therapeutic classification scheme developed by Medi-Span®.[12] These are controlled substances scheduled at the federal level based on their analgesic potency and risk for abuse and dependence.[13]
- Medical costs and indemnity benefit payments. The claim-level medical and indemnity payments for individual claims were constructed based on carriers' payment and credit transactions data over the period of 18 months starting from the date of injury. These claim-level variables were used to compute cost measures at an aggregate level across claims in a defined study group. For example, when examining interstate variations, we computed the average medical cost per claim across claims within a state. For the comparisons between early and late MT or between the MT and no-MT group, the average medical cost per claim was computed across claims within each treatment group based on the 28-state pooled data.
- Duration of temporary disability. The average TD duration was derived based on the same data as for medical and indemnity payments.[14] It should be noted that the duration of TD benefits does not exactly reflect the duration of time that workers were away from work. Several possible scenarios include (1) workers received TD benefits until reaching maximum medical improvement and started 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.[15] However, for this study that compares outcomes between early and late MT and between MT and no MT, the duration of temporary disability should be sufficient to detect differences between the two groups. It is worth noting that across states with different system features, there is large variation in the duration of TD benefits. For example, TD duration is much longer in wage-loss states than in non-wage-loss states, because unlike in a non-wage loss state, workers in a wage-loss state do not shift to receive 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.
- In addition to costs and TD duration, we also compare different treatment patterns and assess how these patterns are associated with the utilization of medical services. Specifically, the outcome variables we use for the study include the percentage of claims with key medical services (magnetic resonance imaging [MRI], opioid prescriptions, and pain management injections),[16] the utilization and costs of overall physical medicine services, the average medical and indemnity benefit payments per claim, and the average number of weeks (or days) of TD benefits. These measures were constructed based on the payment transaction data for the low back claims included in this study.

---

[12] 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).

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

[14] A small number of claims that had missing or unreasonable TD duration were 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.

[15] See Savych, Neumark, and Lea (2018) for further discussion.

[16] The rate of surgery is also an important outcome of initial care. However, we do not capture this outcome due to the exclusion of surgical LBP claims. We made this decision because surgical claims follow different treatment patterns, which requires different analysis of pre- and post-surgical physical medicine treatment. Even for nonsurgical claims, various types of providers and services involved add to the complexity of analysis and interpretations of results.

STATISTICAL ANALYSES

In this study, we applied statistical techniques to the analyses that help address two research questions: (1) whether early MT was associated with lower utilization and costs of medical services, lower indemnity payments, and shorter TD duration; and (2) how costs and TD duration compare between LBP claims with MT and those without MT. For these comparative analyses, it is critical to control for various factors that might affect treatment choice and outcomes because cases in different treatment groups can be quite different, not only in demo-socio-economic characteristics of the workers, but also state policies and other environmental factors. For example, workers with LBP who had early MT were more likely to have LBP-only conditions (without nerve involvement), have fewer comorbidities, initially see a physical therapist who may perform MT, and have economic means and social support to receive early treatment,[17] when compared with those who had late MT. State policies and health care market conditions may also be different between the two groups. Many of these factors can also affect costs and TD duration. Without properly adjusting for these factors, the comparative results may be biased to the extent that the difference in the outcomes would be partially attributable to some of these factors. In this section, we discuss, at a high level, the general idea of these statistical analyses and variables we used for the analyses. The results of these two comparative analyses are presented in Chapters 4 and 5. More detailed technical notes and results can be found in Technical Appendix C.

TWO-STAGE ANALYSIS USING THE INVERSE PROPENSITY TREATMENT WEIGHTING APPROACH

We performed a two-stage statistical analysis by applying a propensity score approach. Instead of matching individual cases between treatment and control, we applied the inverse probability treatment weighting (IPTW) method to adjust the data. This approach has been used by several studies, including Walker et al. (2017) and Weeks et al. (2015). The basic idea is to estimate an individual's likelihood of receiving certain treatment based on factors affecting treatment choice and use the inverse of the predicted likelihood as weights to balance the data for individuals between two different groups so that, at the aggregate level, the cases in the two groups would have similar values for the factors addressed. Two assumptions should be met for this analysis to be successful: (1) the propensity distributions should overlap significantly between the two treatment groups, allowing little or no exclusions of cases due to an "outlier" value in propensity, and (2) factors used for the analysis cover all that are expected to influence treatment choice and outcomes. We checked the interim results to make sure that the first assumption holds (see Technical Appendix C). The second assumption may imply a limitation of this study because even though we were able to control for various factors that we believed were important, we could not rule out the possible existence of such a factor that cannot be represented by the variables we used for our analysis.

In search of covariates and factors that might influence treatment choice and outcomes, we used Andersen's Behavioral Model as a guide. This conceptual framework, initially developed by Andersen (1995) and later explicated by Andersen and Davidson (2001), has been used in a number of studies investigating the use of health services (Chevan and Riddle, 2011; Babitsch et al., 2012; Blanchette et al., 2016). In short, Andersen's framework incorporates both individual and contextual determinants of health services use and divides all factors into one of three categories: predisposing factors, need factors, and enabling factors. The

[17] By economic means and social support, we refer to those socio-economic factors that affect the patient's ability to receive care. For example, a patient who owns a car or has access to a transportation system and who has secure income may be more willing to go to a PT facility to receive treatment. If a family member or a friend is willing to help provide transportation or cover other family responsibilities, the patient would be more likely to attend treatment.

predisposing factors include an individual's sociodemographic characteristics (e.g., worker's age, gender, education, occupation, and family status) and contextual factors predisposing individuals to the use of health services (e.g., demographic and social composition of communities, and cultural norm). The need factors include perceived need for health care (by the patient) and evaluated need (by health care providers) as well as environmental need (health-related conditions in the environment). These may include severity, comorbidities, and disability status. The enabling factors are those factors enabling health care services, which may include state policies, provider supply and organization, and local practice norms. Table 2.3 summarizes the factors we included in our analysis under this framework.

Table 2.3 Capturing Factors Affecting Treatment Choice and Outcomes

Factors	How the Factors Are Being Addressed
Predisposing factors	
Individual's demo-socio-economic factors	
Age	Worker's age (DBE variable).
Gender	Worker's gender (DBE variable).
Marital status	Marital status (DBE variable).
Tenure with preinjury employer	Job tenure in years (DBE variable).
Average weekly wage	Preinjury average weekly wage (DBE variable).
Job industry	Industry group of worker's preinjury job (DBE variable).
Contextual factors (external data)	
Urban/rural area	Urban/rural designated to the area where the worker lives, based on the Area Health Resource File (using ZIP code Rural-Urban Commuting Areas [RUCAs] geographic taxonomy, available at https://ruralhealth.und.edu/ruca).
Education (college or above)	Percentage of population with college or higher degree for a given county where the worker with low back pain resided. The data are based on the 2012–2016 American Community Survey (ACS) Summary File, U.S. Census Bureau, merged to the study sample by zip code.
Neighborhood economic status	Percentage of population who are below the federal poverty level. The federal poverty level data are from the 2012–2016 American Community Survey (ACS) Summary File, U.S. Census Bureau, at the county level for a given county where the worker with low back pain resided.
Median household income	Median household income for a given county where the worker with low back pain resided. The data are based on the 2012–2016 American Community Survey (ACS) Summary File, U.S. Census Bureau, merged to the study sample by zip code.
Unemployment rate	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/.
Need factors	
Evaluated need factors (severity and comorbidities)	
Neuro back claims	Neuro back claims were identified based on ICD-10 codes and how they were mentioned in the detailed medical transactions. See Technical Appendix A for more detail.
Comorbidities	Seven types of comorbidities were identified by checking pre-designated codes in the multiple ICD-10 fields, including alcohol or drug abuse, chronic pain or symptoms within 3 months postinjury, diabetes, obesity, psychosocial issues, smoking, and other lifestyle issues (e.g., lack of physical activities). We controlled for at least one comorbidity and multiple comorbidities. See Technical Appendix A for more discussion.
Had injection(s) before PT care	Used as a proxy for severity. In the early PT study, we used pre-PT invasive procedures (injections and surgery) as a proxy for severity. This study focuses on nonsurgical cases, so we use pre-PT injections as a control.
Perceived need factors	
Patient self-reported health status	No data
Patient health status and utilization of medical services prior to injury	
Pre-conditions	No data in workers' compensation
Medical resource utilization prior to LBP treatment	No data in workers' compensation

continued

Table 2.3 Capturing Factors Affecting Treatment Choice and Outcomes (continued)

Factors	How the Factors Are Being Addressed
Public health indicators	
Health insurance coverage	Percentage of population who are not covered by health insurance at the county level for a given county where the worker with low back pain resided. The health insurance coverage data are from the Bureau of Census' Small Area Health Insurance Estimates (SAHIE) file, merged to our study sample by zip code.
Physical activity	Percentage of population who had any physical activity published by IHME based on self-reported data in the Behavioral Risk Factor Surveillance System (BRFSS), a state-based random-digit telephone survey that covers the majority of U.S. counties.
Enabling factors	
Attorney involvement (Indicates possible issues, including injury reporting, pending compensability determination, and direction of care. These issues may influence treatment paths for individual workers and their outcomes.)	Attorney involvement is used as a proxy to capture these possible issues. The DBE defense attorney variable is more consistent across data sources than the claimant attorney, which we used in the analysis. See the early PT report (Wang, Mueller, and Lea, 2020) for a discussion regarding defense and claimant attorney involvement and related sensitivity tests.
Injury reporting	We do not have consistent data on the timing of injury reporting across the whole sample.
Access to care	The number of days from injury to first medical visit (access to medical providers and issues arising from the administrative process, such as delays in case management, pending compensability issues).
PT referrals	The number of days from the first medical visit to first PT visit (PT referrals).
Provider practice factors (derived based on the DBE data)	
Same billing entity for PT	Variable created based on detailed medical data. The variable was assigned value 1 if the tax ID for the PT provider was the same as for that for the office visits prior to PT treatment, 0 otherwise.
Direct access to PT	Variable created based on detailed medical data. The variable was assigned value 1 if there were no office visits prior to PT treatment, 0 otherwise.
Multiple PT providers	Variable created based on detailed billing data for PT services. The variable was assigned value 1 if a claim has 2 or more unique tax IDs for PT providers.
Provider supply and fitness culture (external data)	
Access to care	Measured by the waiting time to initial medical visit, to PT, and to MT.
Provider supply	Number of physical therapists per 100,000 population. Data for licensed physical therapists were from the National Center for the Analysis of Healthcare Data (NCAHD), representing the 2009 licensed physical therapists having a current license and residing within the state of licensure. The denominator is based on the U.S. Census data (2010–2016).
Likelihood of having MT	Used as a proxy for access to physical therapists for manual therapy. Derived based on the DBE data at the hospital referral region (HRR) level. The variable was created for each claim as the percentage of all other claims in the same HRR area that had MT services.
Health service environment	
Physical activities	Percentage of survey respondents who reported having physical activities in the past weeks. Data was aggregated at the county-level physical activity. The source is the 2011 survey data from the IHME data files. Although the IHME data are not concurrent with our data in years, it is less likely that the county-level characteristics would change dramatically over several years.
State-specific policy and environmental factors (state fixed effect)	
System features (e.g., TD benefit structure)	Controlled by state fixed effect (i.e., controlled by state dummy variables)
Medical management policies (e.g., provider choice/change, UR/preauthorization rules, fee schedule and reimbursement rules)	Controlled by state fixed effect (i.e., controlled by state dummy variables)
Health care market conditions, concentration of occupational medical centers/networks	Controlled by state fixed effect (i.e., controlled by state dummy variables)

Key: DBE: Detailed Benchmark/Evaluation database; IHME: International Health Metrics and Evaluation, an institute at the University of Washington; MRI: magnetic resonance imaging; MT: manual therapy; PT: physical therapy; TD: temporary disability; UR: utilization review.

Several factors presented in Table 2.3 deserve additional notes, which we provide as follows.

STATE POLICIES AND ENVIRONMENT

Different state policies have direct and indirect impacts on medical decision making and outcomes. Some states have policies and guidelines that encourage manual therapy and the same states may also have other policies on other medical treatment options and return to work. If the interstate differences in policies were not controlled for, the results may not be comparable between the treatment and comparison groups. For example, states have different benefit structures. TD duration is much longer in wage-loss states than in non-wage-loss states. If proportionally more claims in the MT group are from wage-loss states that have policies encouraging MT services, the comparative results on outcomes between claims with MT and claims without MT could be biased against the MT group in that the average TD duration per claim with MT would have been longer than the true result. In addition, there may be other state-specific factors (e.g., differences in the mix of health care organizations with different delivery patterns and outcomes, economic environment) that affect the comparative results. We adjusted for these state-specific factors with state fixed effects (using state dummy variables). Note that we did not try to isolate different policies because the purpose of this study is to examine the effect of MT treatment, not the policy impact on certain treatments. The state dummies were used to hold constant the effect of these policy factors and state-specific environmental factors on outcomes for the treatment and control groups.

FACTORS RELATED TO PROVIDER SUPPLY AND PRACTICES

- *Same-billing-entity PT and direct PT.* Many clinics/centers have organization-level treatment protocols that encourage the use of different types of PT services and facilitate quick access to the referred 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 call the *same-billing-entity health care providers.*[18] The same-billing-entity provider may imply one of two things: (1) the treating physician and the PT provider 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 PT provider 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 setting PT treatments are provided in, this direct relationship between the referring physicians and the PT providers is likely to be subject to the same organization-level protocols and lead to a higher rate of PT referrals and certain PT treatment paths. We controlled for the same-billing-entity PT to equalize the impact of different organization-level treatment protocols that may bias the estimated effect of early PT. Note that there is a small percentage of claims that had PT treatment without office visits. This may in part reflect policies in some states that allow patients to see physical therapists directly without a referral from a physician.

[18] 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 to have same-billing-entity PT treatment. 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 to have 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.

- *Multiple PT providers.* When PT treatment is managed by different providers or provider organizations, it may signal different levels of complexity on the part of the patients and their conditions. It may also be associated with complex treatment patterns that may suggest certain issues in the claim and medical management. For example, a patient might start with one physical therapist and the condition was not improving. Subsequently, the patient was referred to another provider, with or without involving an employer or attorney. Whether the additional services were used to rectify the issues in prior treatment or were medically unnecessary, the additional services contribute to higher costs, longer TD duration, and delayed return to work.
- *Individual likelihood of receiving MT services.* The number of manual therapists available in a local area is likely associated with the use and timing of manual therapy services. Unfortunately, there is no data available to indicate which providers received advanced training in manual therapy.[19] To capture access to manual therapists, we constructed, for individual workers, a variable that approximates the likelihood of having MT within the local area (e.g., a hospital referral region) based on the experience of all other workers in the same area.[20] We used this variable as a proxy for supply of manual physical therapists. This constructed variable may also reflect demand for manual therapy in a local area, which to some extent helps capture certain unobserved factors of workers' care-seeking behavior.

FACTORS RELATED TO SEVERITY AND PATIENT COMPLEXITY

For a comparative analysis of outcomes between two medical interventions, a key concern is about potential bias that may be introduced due to different medical severity and patient complexity. Workers with low back pain receive different treatments because they may have different medical conditions and comorbidities. Even if two workers have the same medical condition and comorbidities, the level of pain and symptom irritability may be different; and greater intensity and volatility of symptoms is likely to worsen the prognosis and affect clinical decision making and outcomes. These severity factors may be noted in medical records but are not directly measured using observational data. Even though we controlled for a large number of factors that may represent some of the unobserved severity and patient complexity, we cannot fully address the concern of potential bias without being able to directly measure, for example, pain intensity and symptom irritability. Also, as mentioned previously, several studies explored the measurement and control of patient complexity; they identified key elements in the observational data that may be used to indicate the level of patient complexity. Variables on patients' pre-conditions and utilization patterns of medical services in the past may help control for additional confounding factors affecting patient care-seeking behavior, provider decision making in ordering medical services and shaping treatment paths, and, consequently, costs and outcomes. Unfortunately, the administrative data in workers' compensation does not provide the information needed to measure these factors. The studies that examined these factors are outside workers' compensation. This is indicated in Table 2.3 and discussed as a limitation of our study.

[19] The lack of data on providers qualified for manual therapy is mainly due to the fact that there are many credentialing organizations offering professional training and certification. This decentralized approach leads to large variation in the certification process and, therefore, in the availability of certified physical therapists for manual therapy in a local area. It is conceivable that one can practice manual therapy at a very high level with a high degree of advanced training but not be identified as a certified manual therapist.

[20] The variable is constructed based on the same idea in Savych, Neumark, and Lea (2018). Instead of constructing an instrumental variable, we use this to approximate the supply of certified manual therapists.

OTHER ADJUSTMENTS TO ADDRESS DATA ISSUES

In addition to the two-stage IPTW approach to examining costs and TD duration between different treatment groups, we applied several statistical methods to address some specific issues with the data and estimations. Unlike our previous study on the timing of PT, we include all medical claims regardless of whether a worker had lost time or received indemnity benefits. The data we analyze include both medical-only and indemnity claims—many claims did not receive indemnity benefits and did not have temporary disability. As a result, a very large number of claims had zero values in indemnity payments and TD duration when we estimated the effect of a treatment on costs and TD duration. In this case, we applied a two-part regression approach; the first part was to estimate the likelihood of receiving indemnity payments or having TD duration based on all medical claims, and the second part was to estimate the effect of treatment on indemnity and TD duration based on claims with positive values in the outcome variable. The estimated indemnity payments and TD duration per claim were computed based on the estimates from the two-part regressions. We also ran the same statistical analysis on subsets of LBP claims (all LBP claims with more than seven days of lost time and LBP-only claims with more than seven days of lost time). All results support our findings included in the main report; we used the results for all LBP claims in the discussion of findings.

For medical costs, indemnity payments, and TD duration, the distributions show many of the claims at the lower end of the spectrum. We transformed these variables in the natural log form to meet the normality assumption of the linear regression. For the likelihood of receiving MRI, opioids, and pain management injections, we used logistic regressions. There was also a small percentage of claims that had unusually high values. For the claims with unusually high values, we capped the value at 3 times of the 99th percentile; this was applied uniformly on medical costs and indemnity payments. For TD duration, we capped a few cases at the extreme values at 82 weeks since the longest amount of time we observed is 18 months.

SENSITIVITY TESTS

The two-stage statistical technique makes the second stage linear regression less sensitive to a potential specification issue by shifting the focus to the first stage, which identifies determinants of specific treatment choice (e.g., early versus late MT and MT versus no MT). We tested several different specifications for the first-stage logistic regression to see whether the estimated propensity distributions for treatment and comparison groups, the weights, and the second-stage results were sensitive to different specifications. The results were not sensitive to several alternative specifications tested.

There may be concerns about how we deal with certain data and measurement issues (e.g., the presence of multiple ICD-10 codes; our ability to capture comorbid conditions; and the type of defense attorney involvement, which may help indicate pending compensability issues). These issues and our analyses are discussed in Technical Appendices B and C.

LIMITATIONS AND CAVEATS

This study describes prevalence and patterns of MT services and examines how utilization, costs, and duration of temporary disability are associated with use and early use of manual therapy. Several limitations should be noted to facilitate appropriate interpretation and use of the study findings.

First, the comparisons of medical utilization and costs, indemnity payments, and TD duration between different treatment groups (early versus late MT and MT versus no MT) are based on our statistical analyses

that controlled for various factors that might influence treatment choice and outcomes. In this study, we controlled for a large number of factors to maximize our ability to examine outcomes between different treatments in a comparable manner.[21] Although the factors we controlled for may represent to some extent injury severity and patient complexity, we were not able to directly observe and measure all these factors (e.g., pain intensity and symptom irritability). Because of this, we interpret our findings on the relationship between the use and early use of MT and outcomes as association, not causation.

Second, our comparative analysis of MT versus no MT suggests that LBP workers with MT had higher use of MRI, opioids, and injections; higher medical and indemnity payments per claim; and slightly longer TD duration. The findings we report on medical and indemnity costs and TD duration are by no means enough to address the question of whether manual therapy is cost-effective. Finding a definitive answer to such a question relies on clinical and quality-of-life outcomes, including, in the case of low back pain, the recurrence rate of low back pain and patient-reported outcomes on pain level, functional status, and satisfaction.[22] These quality outcomes should be evaluated over a longer period of time than those we could observe at 18 months postinjury.

Third, this study focuses on MT treatment overall that is provided by non-chiropractic MT providers. This scope reflects two underlying issues—one is related to how MT services are being coded and the other has to do with our ability to identify types of MT providers. There are several specific types of MT services, including manipulation and mobilization of soft tissues or joints, myofascial techniques, manual traction, dry needling, etc. There are clear distinctions for these specific types in clinical settings and in many treatment guidelines. However, when these services are provided and billed for, a vast majority of MT services are coded under CPT code 97140 (manual therapy techniques consist of, but are not limited to, connective tissue massage, joint mobilization and manipulation, manual traction, passive range of motion, soft tissue mobilization and manipulation, and therapeutic massage). The broad coding scheme does not help differentiate different types of MT services. For MT providers, there are three main types—physical therapists, chiropractors, and physicians or other qualified medical providers. The provider specialty information is available in our data, but the level of detail has not been consistent across the data sources. We are able to identify chiropractors in the vast majority of the cases. However, it is not straightforward to differentiate physical therapists from physicians and other medical providers, especially when a provider is affiliated with an occupational medicine or

[21] In this study, we did a number of things to address the concern of the potential impact of selection on the observed relationship between MT treatment and outcomes. First, we applied several exclusions (discussed above) when constructing the study sample to ensure a relatively homogenous study sample. Second, we controlled for a substantially large number of factors that we could measure. For severity, we controlled for type of low back condition (neuro back), seven-day lost time status, and presence and number of comorbidities. We also controlled for pre-PT injections as a proxy for severity. Note that we did not control for pre-PT MRI and opioids because the use of these services could reflect to a larger extent differences in provider practices than severity. We also controlled for the characteristics of workers (e.g., age, gender, marital status, wage, job industry, and tenure with preinjury employers), their claims (e.g., attorney involvement and time to initial medical care), and environmental factors (e.g., rural area, median household income, health insurance coverage, level of physical activities). In addition, we created and controlled for several variables that help capture differences in the delivery of health care (e.g., same-billing-entity PT providers), supply of qualified MT providers and patient demand for care and care-seeking behavior (i.e., the MT indicator we created at the hospital referral region level). Our statistical analysis show that after adjusting for these factors, the cases were similar in the measured characteristics between the treatment and control groups (see Technical Appendix C). Because the propensity score method is limited to the measured covariates and confounding factors, we could not fully address the issue of unmeasured severity and patient complexity (e.g., pain intensity and symptom irritability). To test the sensitivity of our results to this concern, we ran the same statistical analysis using a subset of LBP-only claims with more than seven days of lost time (the subset of cases that are more homogenous); the results (provided in Technical Appendix C) are similar to the findings we report.

[22] Several survey-based tools are particularly helpful for gathering information on patient self-reported functional performance and behavioral response to injury, including the Fear Avoidance Beliefs Questionnaire, the Pain Catastrophizing Scale, or the Keele STarT Back Screening Tool.

rehabilitation center. For this reason, we identify PT providers as chiropractors and non-chiropractic PT providers. We excluded claims with chiropractic care from this study because of likely different practice patterns between physical therapists and chiropractors (due to different focus of treatment that serves the same goal). Manual therapy by chiropractors will be addressed in another study.

Fourth, we controlled for severity and comorbidities to the extent we could with the available data, but this may not be enough to address patient complexity. 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 those with comorbidities varied across different treatment 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 needs to better understand the extent of understatement of comorbidities and, more importantly, investigate whether the understatement affected the observed difference between different PT treatment patterns. It is worth noting that patient complexity has been recognized as an important confounding factor for treatment choice and outcomes. Patient complexity has been measured and used in an increasing number of studies outside workers' compensation, recognizing that the severity factor in the context of medical treatment extends beyond medical severity. Most studies measure patient complexity based on the patient's pre-condition and medical care experience prior to the current episode of care. Unfortunately, we do not observe workers' experience and health status prior to their injuries.

3

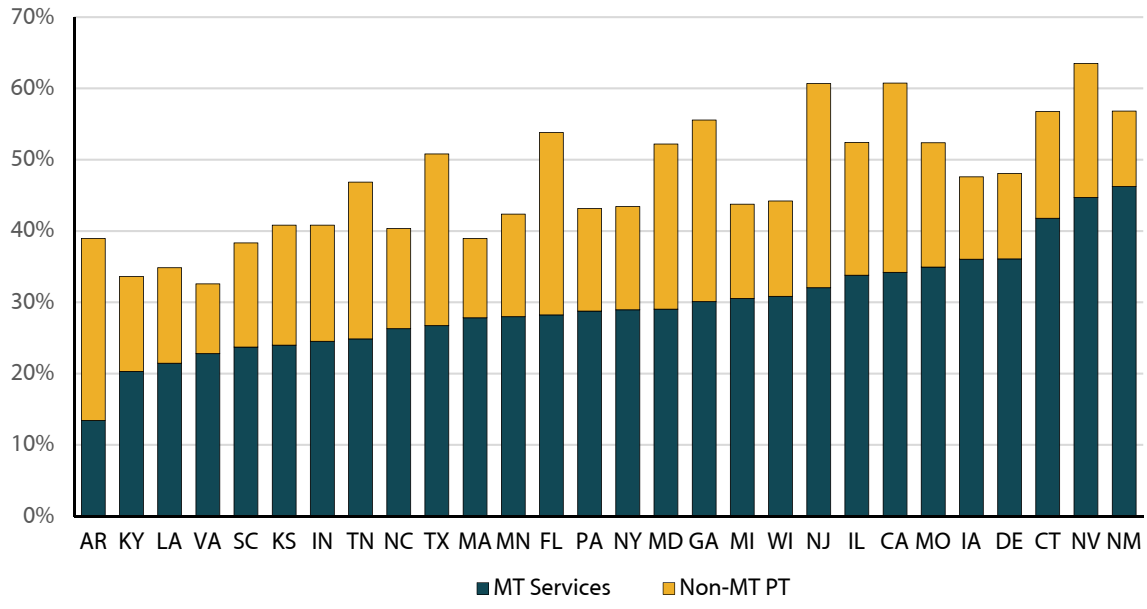
MANUAL THERAPY: PREVALENCE AND PATTERNS

This chapter describes the prevalence and patterns of MT services across the 28 study states. In general, we found that early initiation of MT within 2 weeks of PT care with a treatment duration under 6 weeks was the most common pattern of MT treatment. We also saw large interstate variations in the utilization of MT services, which in part might be explained by several state policies.

PREVALENCE

MT services were frequently used for treating workers with LBP. Figure 3.1 shows that for all LBP cases regardless of type, the percentage of LBP claims receiving MT ranged from 13 percent in Arkansas to 46 percent in New Mexico. The results are for all nonsurgical LBP claims regardless of whether the claims had more than seven days of lost time.

Figure 3.1 Proportion of LBP Claims with PT and MT across 28 States, All LBP Claims



Note: Included are nonsurgical LBP claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. These are medical-only and indemnity claims. We excluded LBP claims with chiropractic care.

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

Table 3.1 shows the percentage of LBP claims receiving PT and MT, by type of LBP and lost time in the median of the 28 study states. The results for individual states are presented in the statistical appendix (Table SA.1).

Table 3.1 Percentage of LBP Claims Receiving PT and MT Services by LBP Type and Lost Time, Median Values of 28 Study States

	LBP-Only Claims ≤ 7DLT	LBP-Only Claims > 7DLT	Neuro Back Claims ≤ 7DLT	Neuro Back Claims > 7DLT	All LBP Claims
% of claims that had PT	34%	75%	60%	87%	46%
% of claims that had MT (as part of PT)	19%	50%	40%	64%	29%

Notes: Included are nonsurgical LBP claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. These are medical-only and indemnity claims. We excluded LBP claims with chiropractic care.

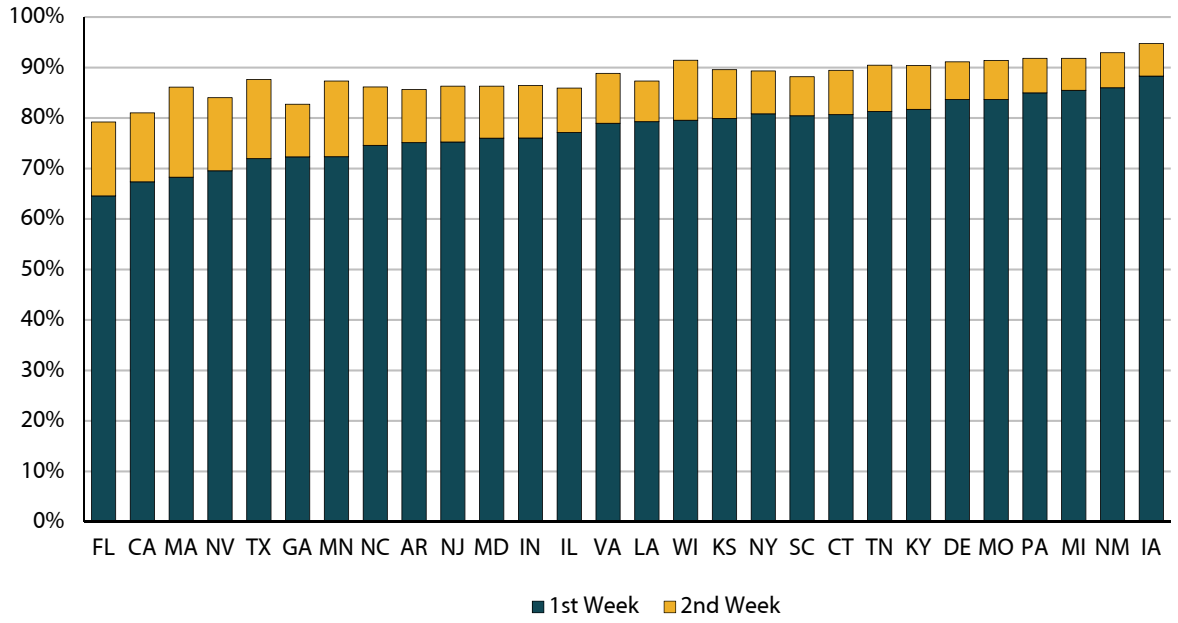
Key: 7DLT: 7 days of lost time; LBP: low back pain; MT: manual therapy; PT: physical therapy.

As Table 3.1 shows, neuro back cases with more than seven days of lost time were most likely to have PT, and the majority of these cases had MT services. In the typical state, 87 percent of the cases received PT services and 64 percent had MT services, which means that 3 in 4 of the workers with PT received MT services. The LBP-only claims that had seven or fewer days of lost time were the least likely to have PT and fewer had MT services. For all LBP claims, 46 percent had PT and 29 percent received MT services in the median state.

TIMING AND DURATION OF MT SERVICES

When LBP workers had MT services, most of them received MT treatment within the first 2 weeks of PT care. Figure 3.2 shows that the percentage of LBP claims with MT within 1 week of PT care ranged from 65 percent in Florida to 88 percent in Iowa. By the end of the second week of PT treatment, 79–95 percent of workers had MT, depending on the state.

Figure 3.2 Timing of MT Treatment, All LBP Claims with MT



Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care.

Key: LBP: low back pain; MT: manual therapy.

In this study, we measure timing of MT treatment as the number of days from the date of first PT visit to the date of first MT visit, which captures how early MT services were rendered as part of PT treatment. To describe how early MT is initiated from the onset of LBP, we also present data on the number of days from the date of injury to the first date of MT treatment and data describing timing of different events that lead to MT treatment, from the date of injury to first medical visit, to first PT visit, and to first MT visit (Table 3.2).

Table 3.2 shows that in the median state, it typically took 33 days from the date of injury to receive MT treatment. The average worker waited for 6 days to see a medical provider; it took 17 days to have the first PT visit after seeing the first medical provider and then 8 days to start receiving MT services. The data also suggest that there was large variation in the timing of MT initiation.

Table 3.2 Timing of MT Treatment Initiation, LBP Claims with MT

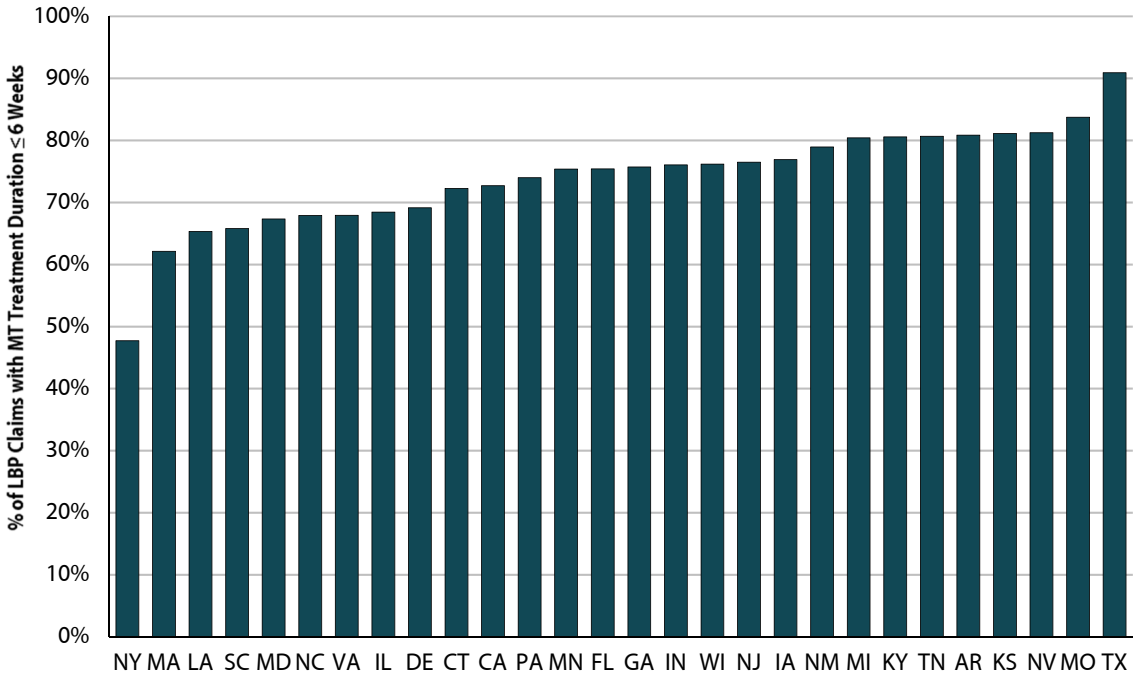
	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Number of LBP claims with MT	209	13,008	1,831	214	4,861	2,318	762	3,247	1,282	508	793	473	1,558	1,176	2,445	1,414	1,469	1,864	3,150	864	1,408	2,060	2,642	737	1,438	6,444	1,335	1,545	
% of claims with MT initiated within …																													
First week of PT care	75%	67%	81%	84%	65%	72%	88%	77%	76%	80%	82%	79%	68%	76%	85%	72%	84%	75%	75%	86%	70%	81%	85%	80%	81%	72%	79%	80%	79%
Second week of PT care	86%	81%	89%	91%	79%	83%	95%	86%	86%	90%	90%	87%	86%	86%	92%	87%	91%	86%	86%	93%	84%	89%	92%	88%	90%	88%	89%	91%	88%
Days from injury to first MT visit and events leading to first MT visit																													
From injury to 1st MT visit	40	37	28	33	41	38	25	31	33	34	30	61	38	32	22	36	24	45	28	22	21	44	25	47	36	22	41	27	33
From injury to 1st medical visit	4	8	5	9	6	6	7	7	6	7	5	7	8	6	4	8	5	6	6	5	3	10	5	6	7	5	6	7	6
From 1st medical visit to 1st PT visit	23	17	14	17	21	19	14	16	17	19	21	41	21	16	12	18	12	28	14	12	10	25	14	32	22	11	26	15	17
From 1st PT visit to 1st MT visit	12	12	8	7	14	13	4	9	9	8	6	12	9	10	6	10	6	10	8	5	7	8	6	9	8	7	9	5	8

Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care.

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

When receiving MT, most workers had treatment for a short duration. Figure 3.3 shows that in most states, the percentage of LBP claims with MT duration of less than or equal to 6 weeks was in a narrow range between 62 and 84 percent. New York and Texas were two exceptions. In New York, only 48 percent of workers had MT treatment under 6 weeks, which means that more than half of the workers had MT treatment longer than 6 weeks. By contrast, 91 percent of the workers in Texas had MT duration under 6 weeks—only 9 percent had MT treatment beyond 6 weeks.

Figure 3.3 Proportion of LBP Claims with MT Treatment Durations Less Than or Equal to 6 Weeks



Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care.

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

The statistical appendix provides more detailed data on utilization patterns of MT and other medical services for workers with MT services (Tables SA.2a and SA.2b).

INTERSTATE VARIATION IN UTILIZATION PATTERNS OF MT AND OTHER MEDICAL SERVICES

Table 3.3 provides interstate comparisons on utilization of MT services for all LBP claims in the 28 study states, including average number of MT visits, services, and intensity (measured as the number of services per visit).

Table 3.3 Interstate Variations in Utilization Patterns of MT Services, LBP Claims with MT

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Number of claims	209	13,008	1,831	214	4,861	2,318	762	3,247	1,282	508	793	473	1,558	1,176	2,445	1,414	1,469	1,864	3,150	864	1,408	2,060	2,642	737	1,438	6,444	1,335	1,545	1,454
Duration of MT treatment																													
% of claims with MT duration 6 weeks or shorter	81%	73%	72%	69%	75%	76%	77%	68%	76%	81%	81%	65%	62%	67%	80%	75%	84%	68%	77%	79%	81%	48%	74%	66%	81%	91%	68%	76%	76%
MT duration in weeks, mean	5.0	7.5	7.9	8.4	6.3	6.4	6.0	7.2	5.6	4.8	5.3	8.9	8.2	7.1	5.1	6.3	4.7	7.7	5.9	6.0	5.1	12.9	6.5	8.7	5.1	3.1	7.4	5.6	6.3
MT duration in weeks, median	2.0	3.0	3.0	4.0	3.0	3.0	3.0	4.0	3.0	2.0	3.0	4.0	4.0	4.0	2.0	3.0	2.0	3.0	3.0	2.0	2.0	7.0	3.0	4.0	3.0	2.0	4.0	3.0	3.0
Utilization of MT services																													
# of MT visits, mean	5.6	5.8	6.6	10.7	5.8	5.3	6.9	9.1	7.0	5.1	5.9	9.1	8.5	8.0	6.3	5.1	5.5	6.8	7.5	5.2	5.1	14.1	9.0	7.5	5.4	3.4	7.7	5.8	6.5
# of MT services, mean	6.5	7.0	8.2	12.5	7.2	6.5	8.5	11.4	9.2	6.2	7.2	11.5	10.9	9.6	8.0	6.6	6.6	9.0	9.7	6.3	5.7	15.9	11.3	9.5	7.1	3.9	10.2	8.2	8.2
# of services per visit for MT, mean	1.1	1.2	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.2	1.1	1.2	1.2	1.2	1.2	1.3	1.1	1.1	1.1	1.2	1.2	1.2	1.1	1.3	1.3	1.2

Note: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. Table SA.A2 provides more results for individual states.

Key: LBP: low back pain; MT: manual therapy.

As shown in Table 3.3, the average number of MT visits was 6.5 in the median state. The same figure was substantially lower in Texas (3.4 MT visits per claim, 47 percent lower than the 28-state median) and higher in several states, including Delaware, Illinois, Louisiana, Massachusetts, and Pennsylvania (31–64 percent higher than the 28-state median). New York was the highest on this measure, with 14.1 MT visits per claim, more than double that of the median state. The results for New York and Texas were quite different from the other 26 states, contributing to the larger interstate variation.[1] However, the interstate variation was still large when excluding these two states.[2] We also saw large variation in the number of MT services per claim. The intensity, measured by the number of services per visit for MT, was similar across all study states (Table 3.3).[3]

As mentioned above, the percentage of workers with MT treatment under 6 weeks showed smaller interstate variation, especially when looking at the 26 states without New York and Texas.[4] However, when we looked at MT duration in weeks, the interstate variation was larger (see Table 3.3).[5] This is because while most of the claims clustered at MT duration under 6 weeks, those that received MT treatment beyond 6 weeks had different MT durations across the states.

There are several factors that might help explain the large variation across the states in the utilization of MT services. First, several states have restrictive rules on the number of PT visits or services per visit that can be reimbursed. For example, without preauthorization, California caps PT visits at 24 visits, Kansas allows up to 21 PT visits, and North Carolina has a limit of 30 PT visits.[6] Texas allows 6 initial PT visits and requires preauthorization for additional PT visits.[7] Several other states are restrictive either on the number of services per visit or duration of PT treatment. If we look at the states with or without restrictive rules for PT, we see that the states with restrictive rules tended to have a lower number of MT visits and services.[8]

Second, state fee schedules with differential reimbursement amounts for specific services and their possible influence on provider practices and coding might explain some of the interstate differences in the utilization of MT services. For example, in Texas, the maximum reimbursement amount for CPT 97530 (therapeutic activities, direct patient contact, each 15 minutes) was higher than that for CPT 97140 (manual therapy techniques, one or more regions, each 15 minutes). In New York, the fee schedule for PT services was low in general, but the fee schedule amount for 97140 was 47 percent higher than that for 97530 across the four fee schedule regions over the study period.[9] The reason that we focus on the relative fee schedule amount between

---

[1] The coefficient of variation, an indicator of the extent of variability, was 0.308 on this measure across the 28 states.

[2] The coefficient of variation, was 0.227 for the 26 states without New York and Texas.

[3] Similar results on the number of services per visit across states may reflect policies limiting the number of CPT codes allowed to be billed per visit. If a treatment can be defined by multiple CPT codes, the code that has a higher level of payment is most likely to be used for billing the treatment.

[4] The coefficient of variation, an indicator for the extent of variability computed as a ratio between the standard deviation and the average across states, on the percentage of claims with MT duration ≤ 6 weeks was 0.1123. The same figure was 0.081 across the 26 states without New York and Texas.

[5] The coefficient of variation, on the mean values of MT duration was 0.282, and the same figure on the median values across the states was 0.332.

[6] If medically necessary, more PT visits may be provided.

[7] The rule went into effect in 2006 in response to the concern that preauthorization of all PT as required in House Bill 7 could delay initial treatment.

[8] Based on the information from WCRI's medical cost containment inventory (Rothkin and Tanabe, 2018), we identified the following states as having a restrictive rule regarding PT treatment: California, Florida, Georgia, Kansas, Kentucky, Louisiana, Minnesota, North Carolina, Nevada, South Carolina, Tennessee, and Texas. The correlation coefficient between the MT visits and restrictive PT states was -0.436 ($p<0.001$).

[9] The fee schedule amount for 97140 was 47 percent higher than that for 97530, based on New York's fee schedule prior to the changes in April 2019. There are four fee schedule regions in New York; the fee schedule amount for the same procedure varies by region, but the ratio between 97140 and 97530 was almost the same. Note that there have been several fee schedule changes on and after May 1, 2019. The fee schedule changes neutralized the difference in the reimbursement amount for 97140 and 97530.

97140 and 97530 has to do with billing/coding rules. A number of state fee schedules are linked to the resource-based relative value scale (RBRVS) to determine how much medical providers should be paid.[10] Among those states with RBRVS-based fee schedules, some also adopted the Centers for Medicare & Medicaid Services (CMS) coding policy, also known as National Correct Coding Initiative (NCCI) edits.[11] The coding rule regarding CPT codes 97140 and 97530,[12] coupled with differential reimbursement amounts for these services, may help explain, to some extent, a higher number of MT visits in some states, including New York.[13]

Although there is no clear evidence for optimal utilization of MT, the large interstate variation in the utilization of MT suggests inconsistency in practice regarding MT. For states with substantially higher or lower utilization of MT services, policymakers and stakeholders may want to further examine the results for their own states and explore any issues regarding MT and other medical services used for treating workers with low back pain and whether there is an impact on outcomes.

Table 3.4 describes the characteristics of workers with LBP who received MT across the 28 study states. One possible reason for the wide interstate variation in the utilization patterns of MT could be that the cases are very different across the states. Table 3.5 describes utilization patterns of other relevant medical services to provide a bigger picture.

As Table 3.4 shows, the interstate differences are small for workers' age, gender, marital status, wage, and tenure. The interstate variation in industry group was considerable—several states had proportionally more workers in manufacturing (Arkansas, Indiana, Iowa, Kansas, and Wisconsin) and more workers in construction (Louisiana and Texas, for example). There was substantial variation in attorney involvement, and there was considerable interstate variation in the percentage of claims with nerve involvement and more than seven days of lost time.

There are several interesting patterns for other related medical services (Table 3.5). For example, the percentage of LBP claims with MT that received pain management injections was substantially higher in Louisiana, New York, and South Carolina than typical of the 28 states. The same figure was much lower in California and Texas, as well as in several other states (Kentucky, Michigan, and Nevada). Louisiana also had a higher percentage of cases receiving opioid prescriptions. Texas was lower on the utilization of injections but higher on the proportion of workers receiving opioids. Most of the opioid prescriptions were for tramadol HCL and acetaminophen with codeine. For Texas, LBP guidelines, the drug formulary, and utilization review rules may explain some of the utilization patterns. In contrast, workers in New York were less likely to receive opioids but more likely to have MRI and pain management injections, which may also be partially explained by the state opioid policies and LBP guidelines.

[10] The payment system is partially used by Medicare in the United States and nearly all health maintenance organizations (HMOs).

[11] The National Correct Coding Initiative (NCCI) by CMS was created to promote correct national coding methodologies and to control improper coding that leads to inappropriate payment for Medicare part B. The NCCI policy manual archive can be found at https://www.cms.gov/Medicare/Coding/NationalCorrectCodInitEd/NCCI-Manual-Archive.

[12] In the CMS coding policy, there is a specific rule regarding billing services using CPT code 97140 (manual therapy techniques, one or more regions, each 15 minutes) and 97530 (therapeutic activities, direct patient contact, each 15 minutes). It states that the provider cannot bill for both 97140 and 97530 if these two services are performed during the same 15-minute time interval.

[13] Unfortunately, we cannot find an authoritative source to identify the states that have adopted RBRVS and NCCI edits; only Texas has confirmed the adoption of the NCCI edits.

Table 3.4 Characteristics of Workers and Their Claims, LBP Claims with MT

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Number of claims	209	13,008	1,831	214	4,861	2,318	762	3,247	1,282	508	793	473	1,558	1,176	2,445	1,414	1,469	1,864	3,150	864	1,408	2,060	2,642	737	1,438	6,444	1,335	1,545	1,454
Claim characteristics																													
% of LBP claims with nerve involvement	40%	23%	30%	43%	33%	31%	32%	34%	33%	30%	38%	39%	39%	33%	28%	38%	23%	39%	34%	17%	14%	49%	31%	38%	37%	17%	35%	35%	34%
% of LBP claims with > 7DLT	43%	35%	44%	43%	39%	39%	28%	46%	30%	30%	35%	50%	60%	47%	30%	37%	28%	41%	41%	21%	21%	59%	36%	49%	35%	29%	39%	33%	38%
% of LBP claims involving attorney	6%	9%	10%	16%	17%	19%	9%	19%	6%	16%	6%	20%	10%	17%	4%	5%	24%	15%	19%	2%	8%	19%	8%	24%	8%	1%	13%	3%	10%
Worker characteristics																													
Worker's age, mean	41	41	43	42	44	42	42	42	42	40	42	43	43	42	42	42	42	44	43	40	41	43	42	43	43	41	43	42	42
% female	39%	42%	41%	51%	45%	42%	42%	39%	43%	41%	45%	45%	37%	39%	46%	50%	46%	47%	36%	46%	48%	45%	38%	45%	41%	37%	44%	46%	44%
% married	36%	23%	23%	26%	31%	27%	36%	38%	30%	26%	36%	36%	30%	29%	21%	31%	27%	32%	27%	35%	24%	26%	29%	32%	32%	28%	33%	20%	30%
Preinjury average weekly wage, mean	$680	$763	$846	$739	$700	$685	$659	$752	$646	$642	$629	$718	$857	$832	$654	$740	$588	$646	$688	$593	$943	$839	$751	$660	$673	$708	$682	$724	$694
Years with preinjury employer, mean	5.7	6.2	7.1	5.8	6.6	5.4	6.8	7.4	6.2	5.3	5.6	6.0	6.7	6.3	6.4	6.8	5.9	6.8	6.3	5.1	5.3	8.0	7.4	5.8	6.5	5.0	6.0	6.3	6.2
% of LBP claims by industry group																													
Manufacturing	27%	11%	13%	9%	7%	15%	27%	17%	28%	26%	22%	7%	12%	11%	22%	15%	16%	16%	12%	9%	7%	9%	19%	23%	20%	14%	11%	27%	15%
Construction	4%	7%	5%	3%	6%	5%	5%	4%	5%	4%	5%	11%	8%	8%	4%	5%	5%	6%	6%	7%	7%	5%	5%	5%	6%	11%	7%	5%	5%
Clerical and professional	2%	7%	6%	5%	8%	5%	8%	7%	5%	4%	6%	7%	10%	7%	6%	9%	7%	5%	7%	6%	3%	8%	6%	4%	4%	8%	8%	6%	6%
High-risk industry	27%	31%	26%	29%	31%	25%	28%	31%	26%	28%	23%	27%	30%	23%	29%	33%	31%	21%	28%	35%	37%	34%	26%	31%	30%	27%	30%	30%	29%
Trade	18%	23%	19%	28%	21%	27%	16%	21%	21%	21%	19%	19%	20%	20%	17%	18%	20%	17%	29%	19%	24%	21%	23%	20%	19%	19%	20%	17%	20%
Low-risk industry	17%	11%	14%	19%	18%	17%	13%	13%	12%	14%	15%	18%	15%	21%	18%	17%	15%	22%	15%	15%	14%	18%	14%	14%	15%	14%	17%	12%	15%
Other industry	4%	8%	15%	4%	8%	5%	3%	7%	3%	2%	9%	10%	4%	10%	4%	3%	6%	11%	3%	6%	7%	4%	6%	2%	5%	7%	6%	3%	6%

Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. Table SA.A2 provides more results for individual states.

Key: 7DLT: 7 days of lost time; LBP: low back pain; MT: manual therapy.

Table 3.5 Interstate Variations in Utilization of Other Medical Services, LBP Claims with MT

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Use of injections and opioid Rx																													
% receiving injections	18%	8%	15%	20%	16%	21%	14%	17%	20%	16%	10%	29%	14%	14%	10%	13%	15%	20%	16%	12%	10%	21%	15%	24%	15%	4%	18%	13%	15%
% receiving MRI	43%	25%	26%	36%	53%	44%	27%	36%	34%	33%	38%	43%	27%	33%	24%	30%	26%	42%	39%	22%	23%	48%	34%	49%	39%	17%	34%	26%	34%
% receiving opioid Rx	37%	18%	12%	13%	25%	29%	21%	19%	20%	23%	13%	40%	9%	19%	16%	14%	17%	30%	10%	17%	18%	12%	15%	30%	25%	23%	25%	16%	18%
Questionable utilization patterns (claims with 1st medical visit within 2 weeks postinjury)																													
% of claims with 1st medical visit after 2 weeks postinjury	7%	12%	8%	14%	9%	10%	12%	11%	11%	11%	7%	11%	14%	10%	7%	14%	9%	11%	11%	8%	5%	20%	8%	11%	11%	7%	11%	12%	11%
% receiving X-ray at 1st medical visit	43%	47%	13%	29%	55%	60%	27%	47%	29%	39%	33%	51%	17%	25%	43%	23%	32%	33%	44%	35%	66%	33%	34%	39%	48%	50%	38%	22%	37%
% receiving DME at 1st medical visit	1%	26%	1%	4%	16%	1%	0%	6%	4%	1%	2%	1%	0%	0%	4%	4%	1%	2%	13%	5%	33%	1%	1%	0%	4%	4%	0%	1%	2%
% receiving opioid Rx at 1st medical visit	9%	7%	2%	2%	6%	8%	7%	4%	5%	9%	1%	6%	2%	4%	3%	5%	6%	8%	2%	6%	5%	2%	3%	6%	8%	9%	9%	5%	5%
% receiving MRI within 4 weeks of injury	10%	3%	5%	16%	21%	9%	9%	10%	9%	13%	11%	7%	6%	9%	6%	10%	8%	9%	9%	7%	4%	19%	14%	10%	11%	4%	7%	8%	9%

Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. Table SA.A2 provides more results for individual states.

Key: DME: durable medical equipment; MRI: magnetic resonance imaging; MT: manual therapy; PT: physical therapy; Rx: prescriptions.

In all, we found that non-chiropractic MT services were frequently used to treat workers with LBP. Early initiation of MT (within 2 weeks of PT care) over a short period of time (around 6 weeks) was the most common pattern of MT treatment. However, there was considerable interstate variation in utilization of MT services. We do not know the exact underlying reasons for a state to have higher or lower utilization of services but have offered several possible explanations. We do not know what the optimal utilization pattern is, and there are no widely-agreed upon treatment guidelines regarding these patterns. However, if the utilization pattern in a state is very different from most of the other states, policymakers and stakeholders in the state should investigate further to identify possible underlying reasons for the substantial difference and assess how the higher or lower utilization is associated with outcomes.

4

DOES EARLY MT MAKE A DIFFERENCE IN UTILIZATION, COSTS, AND TD DURATION?

In our previous study on early PT, we found that early PT was associated with lower utilization and costs of medical services and shorter TD duration. We ask a similar question in this study: When manual therapy is determined to be beneficial for treating LBP, does early MT make a difference in terms of costs and duration of temporary disability? In this chapter, we provide evidence that there is an association between early MT and lower costs and shorter TD duration, based on nonsurgical LBP claims with MT services that were provided by non-chiropractic providers.

Table 4.1 presents unadjusted and adjusted results from our statistical analysis. Included are average medical and indemnity payments per claim, and the average TD duration in number of weeks. The unadjusted results are the underlying variables aggregated across claims in the early versus late MT groups, without controlling for factors that may affect treatment choice and outcomes, and the adjusted results are after adjusting for those factors so that the cases between early and late MT are similar.

Table 4.1 Comparing Utilization, Costs, and TD Duration between Early and Late MT, All LBP Claims with Non-Chiropractic MT

Outcome Measures	Unadjusted Results[a]			Adjusted Results[b]			
	Claims with Early MT in 2 Weeks of PT	Claims with MT after 2 Weeks	% or % Point Difference	Claims with Early MT in 2 Weeks of PT	Claims with MT after 2 Weeks	% or % Point Difference	
Number of claims	52,462	8,574					
Medical payments per claim	$4,110	$6,269	-34%	$4,192	$5,741	-27%	***
Indemnity payments per claim	$3,695	$6,631	-44%	$3,387	$4,731	-28%	***
TD duration in weeks per claim	4.7	8.5	-44%	4.6	5.8	-22%	***
% of claims that received MRI	29.2%	49.4%	-20.2	30.3%	43.4%	-13.0	***
% of claims that received opioid Rx	17.9%	26.8%	-8.9	18.6%	23.3%	-4.7	***
% of claims that received pain management injections	11.9%	19.9%	-8.0	12.6%	16.5%	-3.9	***

Note: Included are nonsurgical LBP claims that received MT and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury.

[a] The unadjusted results are the average values of a given variable across all claims, separately computed for the early and late MT groups.

[b] The adjusted results are the average values for the early and late MT groups, holding all other variables constant. All other variables are the covariates and factors we controlled for in our statistical analysis. See Chapter 2 and Technical Appendix C for more detail.

*** statistically significant at the 1 percent level.

Key: LBP: low back pain; MT: manual therapy; PT: physical therapy; Rx: prescriptions; TD: temporary disability.

The unadjusted numbers are the measures aggregated across the LBP claims in the early MT and late MT groups, separately. For example, the average medical cost was $4,110 per claim when MT was initiated within the first 2 weeks of PT care, which was 34 percent lower than the average medical cost per claim for LBP claims with MT initiated after 2 weeks. However, this difference in costs per claim may reflect the differences in the characteristics of workers and their injuries, access to providers and provider practices, and state-specific or local factors that may influence treatment choice and outcomes. After we adjusted for these factors, the size of the difference in medical costs per claim between the early and late MT groups decreased to 27 percent, but the direction remained the same. The results are similar for indemnity payments and TD duration per claim, with a large reduction, after adjustment, in the size of the difference between the early and late MT groups (Table 4.1). Based on our statistical analysis, there is an association between early MT and lower costs and shorter TD duration.

We also examine how early MT may be associated with the use of other medical services. Table 4.1 shows that LBP claims receiving early MT were less likely to have MRI, opioid prescriptions, or spinal injections, when compared with similar cases with MT after 2 weeks of PT care. For example, 18.6 percent of LBP claims in the early MT group received opioid prescriptions during the first 18 months of treatment; the same figure was 23.3 percent when MT was late—a 4.7 percentage point difference between early and late MT based on the adjusted data that controlled for differences in various factors between the two groups.

Tables 4.2 and 4.3 provide descriptive statistics of the key factors that were controlled in our statistical analysis. Table 4.2 shows that the late MT group tended to have proportionally more claims that were identified as having neuro back conditions, that experienced at least seven days of lost time, that had multiple comorbidities, and that had pre-PT pain management injections, when compared with the early MT group. On average, the two groups had similar demo-socio-economic characteristics, except that the late MT group had slightly older workers and more female workers (Table 4.2). The regional/neighborhood characteristics were similar between the early and late MT groups.

Table 4.2 Claim and Injury Characteristics and Contextual Factors for all LBP Claims with Early versus Late MT

Variables	Claims with Early MT in 2 Weeks of PT	Claims with MT after 2 Weeks	
Number of claims	52,462	8,574	
% of claims	86%	14%	
Worker characteristics			
Age, mean	42	43	
% female	42%	45%	***
% married	28%	28%	
Average weekly wage, mean	$731	$715	
Tenure in years, mean	6.3	6.3	
% of claims by industry group			
Manufacturing	14%	13%	***
Construction	6%	7%	
Clerical and professional	7%	7%	
High-risk industry	29%	30%	*
Trade	21%	21%	
Low-risk industry	15%	14%	
Other industries	7%	7%	*
Severity and comorbidities			
% of LBP cases that are neurological back cases	28%	37%	***
% of LBP cases with > 7 days of lost time	36%	47%	***
% of LBP cases with pre-PT injections	3%	5%	***
% claims with at least one comorbidity	5%	7%	***
% claims with 2 or more comorbidities	8%	11%	***
% of claims with 3 or more PT visits	91%	96%	***
Attorney involvement			
% of claims with attorney involvement	10%	17%	***
Regional factors			
% workers who live in rural area	4%	3%	***
% of population with college or higher degrees	32%	31%	*
Median household income	$60,208	$59,139	
% population under the federal poverty level	7%	7%	
% population with no health insurance	10%	11%	*
% of population reported having any physical activity	77%	77%	
Local unemployment rate	4.9	5.1	
Supply of physical therapists per 100,000 population	58.7	54.2	***
% of workers in the area that received early MT	86%	84%	***

Notes: Included are nonsurgical LBP claims that received MT and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury.

*** statistically significant at the 1 percent level, ** statistically significant at the 5 percent level, * statistically significant at the 10 percent level.

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

Table 4.3 Provider Factors for all LBP Claims with Early versus Late MT

Variables	Claims with Early MT in 2 Weeks of PT	Claims with MT after 2 Weeks	
Number of claims	52,462	8,574	
% of claims	86%	14%	
Timing of MT initiation, relative to medical and PT initiations			
Days from injury to 1st MT visit, mean	26	76	***
Days from injury to 1st medical visit, mean	6	6	
Days from 1st medical visit to 1st PT visit, mean	17	16	***
Days from 1st PT visit to 1st MT visit, mean	2	54	***
MT patterns and payments			
MT duration in weeks	6.5	6.6	
Number of visits for MT	6.6	5.6	***
Days from 1st medical visit to 1st PT visit, mean	1.2	1.2	
MT duration in weeks	1.2	1.2	***
By MT episode[a]			
% had single MT episode	88%	84%	***
% had 2 MT episodes	10%	13%	***
% had 3 or more MT episodes	2%	3%	***
Number of visits for MT during the 1st MT episode	5.7	4.6	***
Number of visits for MT during the 2nd MT episode	5.9	5.3	***
Average # of visits per week, 1st episode	1.5	1.4	***
Average # of visits per week, 2nd episode	1.4	1.3	***
Provider factors			
% of claims with direct access to PT	5%	4%	***
% of claims with same billing entity for PT	32%	37%	***
% of claims involving multiple PT providers	10%	22%	***
Questionable practice patterns (claims with 1st medical visit within 2 weeks postinjury)[b]			
X-ray at first medical visit	10%	11%	
X-ray at first medical visit	41%	50%	***
DME at first medical visit	7%	26%	***
Opioid Rx at first medical visit	5%	6%	***
Had MRI within 4 weeks of injury	8%	11%	***

Notes: Included are nonsurgical LBP claims that received MT and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury.

[a] An episode of MT is defined as a set of visits or unique dates for MT treatment with less than 30 days between any two consecutive visits.

[b] The questionable practice patterns refer to those utilization patterns of medical services that are inconsistent with widely agreed-upon treatment guidelines for treating low back pain.

*** statistically significant at the 1 percent level.

Key: DME: durable medical equipment; LBP: low back pain; MRI: magnetic resonance imaging; MT: manual therapy; OV: office visits; PT: physical therapy; Rx: prescriptions.

Late MT initiation had little to do with access/time to medical care or timing of PT referral; similar results were seen for both early and late MT groups (Table 4.3). More cases in the late MT group received PT services through "self-referrals" (i.e., through same billing providers), and they were twice as likely to be treated by multiple PT providers. It is worth noting that the late MT group exhibits certain care patterns for other services that are not consistent with medical treatment guidelines: More claims had X rays and durable medical equipment (DME) during the first medical visit. Workers in the late MT group were also more likely to receive MRI within 4 weeks of injury, although the average number of MT visits was slightly lower for claims with late MT.

Overall, after adjusting for these various factors, we found that early MT was associated with lower costs and shorter TD duration. The use of other medical services (MRI, opioids, and spinal injections) was also lower for LBP claims with early MT within 2 weeks of PT care, compared with those with MT after 2 weeks. The results are consistent with what we found in our previous study on early PT (Wang, Mueller, and Lea, 2020). Note that we measured the timing of MT as the number of days from first PT visit to first MT visit, which mostly reflects how early MT services were rendered as part of PT treatment. In the 2020 study, we measured the timing of PT treatment from the date of injury to first PT visit and found that early PT within 1–2 weeks postinjury was associated with lower utilization and costs of medical services and shorter TD duration. The findings from these two studies combined imply that for workers who received MT treatment, early initiation of PT treatment within 1–2 weeks and incorporating MT services within 1– 2 weeks of PT care would be helpful to achieve better outcomes.

It is worth noting that most observational studies are limited in addressing unobserved factors. Although we controlled for various factors, we cannot directly observe and measure injury severity and patient complexity, which might affect treatment choice and outcomes. Note that we repeated the same analysis based on LBP claims with 3 or more PT visits; this was one way we could test how sensitive the results are to differences in severity. The results from this sensitivity analysis did not change the findings in the outcome comparison between early and late MT. In all, our findings provide strong evidence of association, not causation, between early MT and lower utilization and costs of medical services and shorter TD duration. We discuss this in more detail in Chapter 2 and Technical Appendix C.

5

COSTS AND TD DURATION: MT VERSUS NO MT

In this chapter, we present results from our analysis that compares costs and TD duration between two groups of LBP claims—one received MT services as part of PT treatment and the other one had PT but did not receive MT. Our analysis starts with nonsurgical LBP claims receiving PT services provided by non-chiropractic providers, followed by an analysis based on the LBP claims with 3 or more PT visits. We also briefly discuss results that compare outcomes between early MT and no MT. More detailed discussions can be found in Chapter 2 and Technical Appendix C.

MT has been widely used as part of PT treatment, and many guidelines allow certain types of MT services for treating low back pain. Manual therapy is viewed positively in a systematic review by Chou et al. (2017); and the clinical practice guidelines for low back pain from the Orthopaedic Section of the American Physical Therapy Association guidelines also found moderate evidence for effectiveness of manual therapy equal to other commonly used treatments. Most major guidelines used in workers' compensation allow manipulation and mobilization for treating acute and subacute LBP, as long as functional outcomes are monitored. Usually, up to 6 visits are allowed initially and the patient is assessed for functional gain. More detailed discussion of guidelines and the literature regarding effectiveness of manual therapy can be found in Chapter 1.

Table 5.1 presents the results of a comparison between LBP claims with and without MT. Most of the LBP claims are those with LBP-only conditions; neuro back claims are also included in the table. We repeated the same analysis on different subsets of claims (e.g., LBP-only claims with more than seven days of lost time, neuro back claims) and the results are similar to what we report here.[1] The unadjusted results are the estimated medical costs, indemnity payments, and TD duration without controlling for any factors, which are equivalent to the simple average across the LBP claims in either the MT or no-MT group. The adjusted results are for the same measures estimated by holding all other factors constant between the MT and no-MT groups, only allowing the MT treatment variable to capture the effect of MT treatment relative to no MT treatment.

[1] See Technical Appendix C for a description of these sensitivity analyses.

Table 5.1 Comparing Utilization, Costs, and TD Duration between MT and No MT, All LBP Claims with Non-Chiropractic PT

Outcome Measures	Unadjusted Results[a]			Adjusted Results[b]			
	Claims with MT	Claims with No MT	% or % Point Difference	Claims with MT	Claims with No MT	% or % Point Difference	
Number of claims	59,035	36,424					
Medical payments	$4,256	$2,987	42%	$4,193	$3,099	35%	***
Indemnity payments	$3,864	$2,659	45%	$3,140	$2,723	15%	***
TD duration in weeks per claim	4.9	3.5	40%	4.1	3.8	8%	***
% of claims that received MRI	30.8%	22.8%	8.0	29.4%	25.2%	4.2	***
% of claims that received opioid Rx	18.7%	15.6%	3.1	18.1%	16.7%	1.4	***
% of claims that received pain management injections	12.4%	8.5%	3.8	11.3%	10.2%	1.1	***

Notes: Included are nonsurgical LBP claims that received PT (including MT) and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury. Note that the claims with MT in this analysis are a subset of those in the early versus late MT analysis. We excluded 3 percent of the claims with MT to make sure that the MT and no-MT groups are comparable in terms of the presence of other PT services. See Technical Appendix A for more detail regarding common PT patterns.

[a] The unadjusted results are the average values of a given variable across all claims, separately computed for the MT and no-MT groups.

[b] The adjusted results are the average values for the MT and no-MT groups, holding all other variables constant. All other variables are the covariates and factors we controlled for in our statistical analysis. See Chapter 2 and Technical Appendix C for more detail.

*** statistically significant at the 1 percent level.

Key: LBP: low back pain; MT: manual therapy; PT: physical therapy; Rx: prescriptions; TD: temporary disability.

The adjusted results in Table 5.1 suggest that the average worker with LBP who received MT had higher medical costs and indemnity payments, and slightly longer TD duration, when compared with those who had PT but did not receive MT services. For example, the average TD duration per claim was 4.1 weeks, 8 percent longer than that for claims without MT (3.8 weeks). However, the average medical cost per claim was still considerably higher for claims with MT after adjustment—the medical cost per claim with MT was 35 percent higher than that for claims without MT ($4,193 versus $3,099).

The statistical adjustment we applied to the data allows the MT and no-MT groups to be more comparable.[2] This is evident when comparing the adjusted with unadjusted results. Table 5.1 shows that the size of the MT effect was smaller for the adjusted results compared with the unadjusted results. The unadjusted average medical cost per claim was $4,256 for claims with MT, 42 percent higher than that for claims with no MT. The percentage difference was reduced to 35 percent after the adjustment. The largest reduction in the difference was for TD duration—the unadjusted average TD duration per claim was 40 percent longer for the MT group than for the no-MT group, and the difference reduced to 8 percent based on the adjusted data for similar claims between the two treatment groups. The differences between the unadjusted and the adjusted data capture the differences that are attributable to differences in the characteristics of the cases in the two groups. Those characteristics include workers' age, gender, marital status, wage, and job tenure and industry; severity

[2] In our statistical analysis, we modeled the choice between MT versus no MT based on a set of covariates and factors that likely influence MT decision making. As a result, we created a set of weights for individual claims using the propensity scores to balance the mix of cases so that on average, the MT and no-MT groups would look similar on the variable controlled. Table TA.C8 compares the characteristics between MT and no MT before and after applying the weights.

and comorbidity; provider factors; and state-specific policy and environmental factors. Technical Appendix C provides the results from our statistical analysis that included these variables in modeling treatment choice between MT and no MT.

Table 5.2 presents a comparison of workers' characteristics, severity and comorbidities, and several contextual factors. It suggests that the workers with MT were slightly more likely to be female and married, with a higher wage and longer tenure with the preinjury employer. The contextual factors appear to be similar between the two groups except that the workers in the MT group tended to live in areas that had more college graduates and higher median household income. Workers who received MT treatment were more likely to have neuro back conditions, to experience at least seven days of lost time, and to receive pre-PT injections. There has been mixed guidance on the application of MT related to low back pain with nerve involvement. Treatment guidelines differ on the recommendations in use of MT for neuro back conditions. However, there is evidence suggesting that the use of symptom modulating interventions, including MT, is beneficial when the patient presents with more severe symptoms of irritability and volatility (Alrwaily, 2016).

Table 5.2 Claim and Injury Characteristics and Contextual Factors for All LBP Claims: MT versus No MT

Variables	Claims with MT	Claims with No MT	
Number of claims	59,035	36,424	
% of claims	62%	38%	
Worker characteristics			
Age, mean	42	41	***
% female	42%	38%	***
% married	28%	25%	***
Average weekly wage, mean	$729	$674	***
Tenure in years, mean	6.3	5.8	***
% of claims by industry group			
Manufacturing	14%	15%	***
Construction	6%	7%	***
Clerical and professional	7%	6%	***
High-risk industry	29%	29%	
Trade	21%	21%	**
Low-risk industry	15%	14%	
Other industries	7%	7%	
Missing industry information	0%	1%	***
Severity and comorbidities			
% of LBP cases that are neuro back cases	29%	22%	***
% of LBP cases with > 7 days of lost time	36%	29%	***
% of LBP cases with pre-PT injections	3%	2%	***
% claims with at least one comorbidity	5%	4%	***
% claims with 2 or more comorbidities	8%	7%	***
% of claims with 3 or more PT visits	91%	71%	***
% with attorney involvement	10%	8%	***
Regional factors			
% that live in rural area	4%	4%	
% of people with college or above	32%	30%	***
Median household income	$60,134	$57,350	***
% below federal poverty level	7%	7%	***
% that had no health insurance	10%	11%	***
% of people who reported physical activity	77%	76%	***

Note: Included are nonsurgical LBP claims that received PT (including MT) and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury.

*** statistically significant at the 1 percent level, ** statistically significant at the 5 percent level,

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

Our statistical analysis (Table TA.C1) suggests that the factors discussed above had a relatively large and significant effect on the choice of MT treatment. In the regression, where other factors are controlled for, workers with multiple comorbidities were less likely to receive MT, unlike what the data in Table 5.2 may suggest.

Table 5.3 compares provider factors, suggesting that the waiting time to initial medical care and time to PT referral were similar between the MT and no-MT groups—workers in both groups waited for 6 days to have their first medical visit and PT referrals took 16–17 days on average. Attorney involvement was slightly higher for workers with MT than for those without MT (10 percent versus 8 percent).

Table 5.3 Provider Factors for All LBP Claims with Non-Chiropractic PT: MT versus No MT

Variables	Claims with MT	Claims with No MT	
Timing of MT initiation, relative to medical and PT initiations			
Days from injury to 1st medical visit, mean	6	6	
Days from 1st medical visit to 1st PT visit, mean	17	16	
Attorney involvement			
% with attorney involvement	10%	8%	***
Provider factors			
% of claims with direct access to PT	5%	4%	***
% of claims with same billing entity for PT	33%	43%	***
% of claims involving multiple PT providers	12%	9%	***
Questionable patterns (claims with 1st medical visit within 2 weeks of injury)[a]			
% of claims with 1st medical visit after 2 weeks postinjury	11%	9%	***
X-ray at first medical visit	42%	46%	***
DME at first medical visit	10%	11%	***
Opioid Rx at first medical visit	6%	5%	***
MRI within 4 weeks of injury	8%	6%	***
Provider supply			
Number of PT providers per 100,000 population	58.2	54.2	
Likelihood of having MT within an HRR region	64%	58%	***

Notes: Included are nonsurgical LBP claims that received PT (including MT) and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury.

[a] The questionable practice patterns refer to those utilization patterns of medical services that are inconsistent with widely agreed-upon treatment guidelines for treating low back pain.

*** statistically significant at the 1 percent level.

Key: DME: durable medical equipment; LBP: low back pain; MRI: magnetic resonance imaging; MT: manual therapy; PT: physical therapy; HRR: hospital referral region; Rx: prescriptions.

Larger differences were seen in same-billing-entity PT and involvement of multiple PT providers. The percentage of claims with same billing entity for PT was much higher for the no-MT group than the MT group, which may suggest that there were fewer physical therapists performing manual therapy who were affiliated with vertically-integrated health care organizations. When workers were referred out of the organization, they were more likely to receive MT.

Based on the adjusted results, we conclude that the average worker with LBP who received MT services incurred higher medical and indemnity costs per claim and slightly longer TD duration than workers who did not have MT services but received other non-MT PT services. Our findings on costs and TD duration help shed light on the cost-effectiveness of MT, but these findings are not enough to answer the question of whether MT

treatment is cost-effective for two reasons. First, we only focused on medical and indemnity costs and TD duration. These are important measures for workers' compensation health care delivery, and to some extent, TD duration may help predict the recurrence rate of LBP (Wasiak et al., 2004).[3] However, it does not represent the clinical and quality-of-life outcomes referenced in a cost-effective analysis (e.g., recurrence rate of low back pain[4] and patient-reported outcomes such as pain level, functional status, and satisfaction).[5] Second, we evaluated costs and TD duration only at 18 months postinjury. A much longer observation window should be used to observe those quality outcomes.

It is worth noting that the adjusted results in Table 5.1 show the relationship between MT treatment and outcomes after addressing concerns about selection of cases into MT treatment groups. The statistical technique employed produces unbiased results if one measures and controls for all covariates and confounding factors that may affect treatment choice and outcomes. Because of this, it is critical for us to check if we were able do so in our analysis. Our assessment was based on a comparison of the variables we used for the analysis with what have been discussed in the literature (see Chapter 2). Based on our assessment, we believe that the variables we controlled for cover a majority of the factors, with the exception that we do not have data to directly measure severity beyond ICD-10 codes recorded in the data and certain patient complexity. Some of this unobserved severity and complexity may include different levels of LBP intensity and symptom irritability, which are likely to worsen the prognosis and influence providers' decision making. There have been studies outside workers' compensation that measured workers' pre-conditions, their care-seeking behavior, and utilization patterns of medical services based on patient experience prior to the LBP episode studied to address patient complexity. Unfortunately, we do not have these data for occupational injuries. Chapter 2 and Technical Appendix C provide a more in-depth discussion of the related issues.

---

[3] Based on new claims with LBP in New Hampshire with a three-year follow up, Wasiak et al. (2004) examined multiple risk factors associated with recurrence of low back pain. The researchers found that longer durations of the initial episode of care or work disability were the most powerful predictors of recurrence of low back pain, implying that shorter episodes of care and early return to work contribute to better outcomes. The study tested alternative definitions of recurrence based on a new episode of medical care and a new episode of work disability, and found that these risk factors better predicted disability-based than treatment-based recurrence (Wasiak et al., 2004).

[4] Wasiak, Kim, and Pranksy (2006) examined whether recurrences contribute to total medical and indemnity costs, and total duration of work disability, using the same data. They concluded that recurrences contribute disproportionally to the total burden of work-related non-specific LBP through additional care seeking and work disability. The rate of recurrent work disability was 17.2 percent, and the rate of recurrent care seeking was 33.9 percent. Individuals with recurrence had significantly higher total length of work disability and higher medical and indemnity costs. For those with recurrent work disability, 69 percent of total lost time from work, 71 percent of associated indemnity costs, and 84 percent of total medical costs occurred during the recurrent period. For those with recurrence of care, the respective values were 48 percent, 47 percent, and 42 percent.)

[5] Quality adjusted life years (QALYs) are used to perform cost utility analysis in health care. A QALY describes the number and quality of life expected for an individual with a specific diagnosis who receives a specific treatment. The QALY reflects the quality of life advantage of the tested treatment over the commonly used medical treatment for the same condition. Low back pain is not likely to have a significant effect on overall life span; therefore, the QALY adjustment will be related to the actual functioning of the patient and should reflect the patients' analysis of how the condition impacts their overall life. Thus, an effective treatment that improves the long-term functional outcome for an individual over years of life lived may often qualify as cost-effective even when it increases the total medical costs for the patient. The British health system has created a cost utility system by establishing limits on the amount of money that may be spent in order to achieve an improvement in a QALY. If a cost utility study demonstrates an amount less than that limit, it is considered cost-effective and should generally be covered by the health care system.

Medical studies assessing the effectiveness of medical treatments may include an objective outcome, such as stability on imaging of the spine after fusion surgery or ability to lift a specific weight. They all now also include a patient-reported functional status outcome. The patient's impression of how they are functioning in their life is of utmost importance to the individual worker and is usually considered in determining whether a treatment is considered to be medically effective. Our study is purely based on medical costs and disability, which likely does reflect the full extent of the patient's physical function. However, because we cannot comment on the patient's impression of their functional outcome, it is likely that our results may differ from some of the medical studies on the same treatment.

With our data, one way that may be helpful to further control for unobserved severity and complexity is to exclude LBP claims that had only 1 or 2 PT or MT visits from the analysis. This is a method we used for the 2020 study on early PT and we believe that this exclusion of claims with 1–2 PT visits could help make the cases more comparable between the MT and no-MT groups. Consistent with our expectation, Table 5.2 shows that 29 percent of the LBP claims in the no-MT group had only 1–2 PT visits, and the same figure is 9 percent for the MT group. If those LBP claims with 1–2 PT visits had only evaluation/assessment and/or instructions for home exercises, they are likely to be less severe, contributing to lower costs and shorter TD duration for the no-MT group, compared with the MT group. To test how sensitive the results are to this concern, we repeated the same analysis using a subset of LBP claims with 3 or more PT visits. Table 5.4 provides the results from this additional analysis.

Table 5.4 Comparing Utilization, Costs, and TD Duration between MT and No MT, All LBP Claims with 3+ PT Visits by Non-Chiropractors

Outcome Measures	Adjusted Results[a]			
	Claims with MT	Claims with No MT	% or % Point Difference	
Medical payments	$4,524	$3,902	16%	***
Indemnity payments	$3,628	$3,353	8%	***
TD duration in weeks per claim	4.8	4.6	4%	***
% of claims that received MRI	33.0%	30.6%	2.4	***
% of claims that received opioid Rx	19.1%	18.3%	0.8	***
% of claims that received pain management injections	12.9%	12.2%	0.7	***

Notes: Included are nonsurgical LBP claims that received PT (including MT) and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury. Note that the claims with MT in this analysis are a subset of those in the early versus late MT analysis. We excluded 3 percent of the claims with MT to make sure that the MT and no-MT groups are comparable in terms of the presence of other PT services. See Technical Appendix A for more details regarding common PT patterns.

[a] The adjusted results are the average values for the MT and no-MT groups, holding all other variables constant. The LBP claims included were those that had 3 or more PT visits. See the sensitivity analysis section of Technical Appendix C for more detail.

*** statistically significant at the 1 percent level.

Key: LBP: low back pain; MRI: magnetic resonance imaging; MT: manual therapy; PT: physical therapy; Rx: prescriptions; TD: temporary duration.

Comparing the results from our statistical analysis between Table 5.1 and Table 5.4, we see that after we excluded LBP claims with 1–2 PT visits (those we believed were less severe), the difference in the outcomes between the MT and no-MT groups became considerably smaller, although the direction remains the same. The results may suggest that if one can find a way to further subset the LBP claims to make them more clinically homogenous, eliminating possible differences in unobserved severity and complexity, the comparative results may become even smaller. One additional analysis we did was to repeat the same statistical analysis to compare outcomes between LBP claims with early MT and those with no MT, based on LBP claims with 3 or more PT visits. The results from this additional sensitivity analysis did not change our findings. We discuss this and present the results in Technical Appendix C. Any further investigations require more data that could be used to differentiate the LBP claims in terms of unobserved characteristics that affect treatment choice and outcomes. It is important to note that the findings reported do not mean that MT was causing higher costs or

longer TD duration. Our statistical analysis enables us to compare costs and TD duration between the two treatment groups as if the cases are similar on measured characteristics. Although we controlled for a large number of factors that may well represent factors affecting treatment choice and outcomes, we were not able to directly observe and measure severity and patient complexity, and therefore, the results we present provide evidence of an association but not a causal relationship.

6

IMPLICATIONS

Physical therapy is recommended as a non-invasive, non-pharmacological treatment option by most guidelines for musculoskeletal injuries before considering opioids and other invasive procedures.[1] With an increasing number of workers with injuries getting PT treatment, an important question is what PT pattern makes a difference in terms of utilization and costs of medical resources and outcomes. There are many different ways to describe PT treatment patterns with all the combinations and permutations of the key dimensions, including provider type, service type, timing, frequency, duration, and intensity. After exploring the data that capture PT treatments delivered to workers with low back injuries, we identified several common PT treatment patterns. From these patterns emerged research topics that are important for policymakers and stakeholders who are interested in finding ways to improve workers' compensation health care. We identified three research topics in this area to focus on (1) manual therapy, (2) chiropractic care, and (3) risk factors for higher-than-expected use of PT services. Of the three topics identified, manual therapy is the first we address in our PT studies; to the best of our knowledge, this study is the first to focus on the workers' compensation population in the United States.[2]

We found large interstate variation in the utilization of MT services, which had an impact on the utilization of other medical services. States with substantially higher utilization of MT services should investigate possible underlying reasons for the higher utilization and how it may impact the delivery of other medical services and outcomes. For example, Chapter 3 describes substantial variation in the number of MT visits, with New York and Texas at the two ends of the spectrum. When we look at the other 26 states, without New York and Texas, the variation was reduced but still considerably large. Several states have policies that limit the number of PT visits or services; and these states tended to have a lower number of MT visits. Reimbursement policies and utilization review/preauthorization rules may also influence provider practice patterns and coding for MT services. Many guidelines allow specific types of MT services, and the total number of MT visits and treatment duration allowed by most guidelines is generally 10–12 visits over 6–8 weeks. For states with substantially higher or lower utilization of MT services, policymakers and stakeholders may want to further examine the results for their own states and explore any issues regarding MT and other medical services used for treating workers with low back pain.

After adjusting for various factors that might affect treatment choice and outcomes, we concluded that there was strong evidence of an association between early MT and lower costs and shorter TD duration. This

[1] See the ACOEM, ODG, and Washington State opioid guidelines.

[2] Few studies have addressed utilization, costs, and outcomes of MT services. There have been a number of medical studies focusing on the efficacy of treatment and only two published studies on the cost-effectiveness of MT, both of which were focused on non-workers' compensation populations in several European countries (see Chapter 1 for a literature summary).

finding implies that when MT treatment is determined to be beneficial for workers with low back injuries, early initiation of MT within 2 weeks of PT care will be helpful to promote recovery and early return to work, at a lower cost. It is worth noting that in a previous study on early PT,[3] we found that early PT within 2 weeks postinjury was associated with lower utilization of medical services and shorter TD duration. The findings from these two studies combined suggest that for workers with low back pain who are likely to benefit from having these services, prompt PT referrals and access to quality manual therapy should be encouraged to achieve better outcomes. Incorporating such findings into medical treatment guidelines and the shared decision-making tools used for patient engagement are likely to help ensure prompt PT referrals and access to quality manual therapy for those workers with low back pain who are good candidates for MT.

Although MT is a common and important component of PT treatment, not every worker with LBP received MT services. The logical question is whether MT is cost-effective in comparison with other non-MT PT treatments. Michaleff et al. (2012) and Walker et al. (2017) addressed this issue based on the experience of a general population in several European countries and found similar cost-effectiveness of MT compared with other treatment patterns.[4] We are not aware of any study that focused on workers' compensation in the United States. In this study, we compare costs and TD duration of LBP claims with and without MT treatment. The results from our statistical analysis suggest that the LBP claims with MT had higher medical and indemnity costs and slightly longer TD duration (Chapter 5). Factors that have considerable influence on MT choice and outcomes include age, gender, marital status, wage, and tenure, as well as whether a neuro back condition was present. It is worth noting that use of manipulation for neuro back pain remains questionable. In some guidelines (e.g., the ACOEM and New York guidelines), manipulation is not recommended for low back pain with herniated disc or nerve involvement, but it is allowed in other guidelines.

The results we report in Chapter 5 are based on a comparison of similar cases with and without MT; costs and TD duration were evaluated at 18 months postinjury. Two limitations are important to note. First, we found that after adjusting the data, the costs and TD duration were still higher for workers with MT compared with those without MT, but the difference in these outcome measures became smaller. We controlled for a rich set of covariates and underlying factors that might affect MT treatment choice and outcomes, which resulted in large reductions in the size of the effect of MT treatment. However, we cannot rule out the potential bias caused by omitting certain unobserved factors, which, if controlled, might further reduce the difference between claims with and without MT. Second, our findings are limited to the outcomes we can measure and the time frame over which we can observe the outcomes. These findings are not enough to address the question of whether MT is cost-effective. To answer this question, one needs to examine quality outcomes, such as the recurrence rate of LBP and patient-reported outcomes, over a much longer period of time. If MT treatment has the effect of reducing the recurrence rate of LBP, for example, it will help decrease overall costs and improve long-term outcomes for workers with LBP. Despite the shortcomings, this study helps shed light on this issue and, hopefully, serves as a good starting point for future research.

There are two other technical issues that have practical implications. First, we heavily relied on one single CPT code (97140) to identify MT services. This is because the current coding scheme does not provide the level of specificity to enable researchers to study utilization patterns across different types of MT services. CPT code 97140 is broadly defined to cover a wide spectrum of MT services, from a simple hands-on movement of the knee (for example) to skilled manipulation of joints that requires specialized training and certification.

[3] Wang, Mueller, Lea (2020).

[4] See Chapter 1 for a literature summary.

Although many treatment guidelines do discuss specific types of MT services, there is no coding scheme to help bridge the gap between guidelines and practice. The purpose of the CPT4 coding scheme is to establish a uniform language that accurately describes medical, surgical, and diagnostic services, as an effective means for reliable communication among physicians, qualified health care professionals, patients, and third parties. The limitation to the identification of MT services highlights the need for establishing specific and accurate language and a coding scheme for MT services. Second, we controlled for a large number of factors in our statistical analyses, but our ability to address differences in severity, comorbidities, and patient complexity is limited to what is available in workers' compensation administrative data. In this study, we were able to capture and control, to some extent, for severity and comorbidities, which impacted the results. However, we were unable to capture differences in patient complexity, which can be measured in a general health setting based on the patient's conditions and medical treatment experience prior to the current episode of illness. Finding a way to measure these important characteristics will help research fully address potential confounding factors and provide definitive answers to research questions.

CLOSING REMARKS

Manual therapy, as a part of PT treatment, has been common in practice, but there has been a paucity of empirical research on patterns of MT treatment, costs, and outcomes. This study seeks to fill that knowledge gap. We describe common MT treatment patterns in relation to utilization of other medical services in a multistate context. We also provide evidence regarding how the use and early use of MT may impact costs and TD duration. The findings will be helpful for policymakers and stakeholders seeking opportunities to improve their health care delivery systems. Similar to other studies that explore under-researched areas, our study on MT will raise more questions than it can answer within its scope. For example: What are the differences in MT treatment provided by physical therapists versus chiropractors? [5] Is MT a viable alternative to opioid prescriptions? How is MT being used for LBP workers with surgery? Some of these questions will be addressed in our future studies in this area.

Our study provides the first look at treatment patterns of MT for workers with LBP in the United States. We were able to control for a large number of factors that may influence treatment choice and outcomes. This enables us to provide strong evidence to support our findings. However, our study is bounded by the same limitation of other studies using administrative data. Despite controlling for many important factors, the results from this study provide evidence of an association, not causation. Our study is also limited in terms of capturing quality outcome variables (e.g., recurrence rate of LBP, patient-reported satisfaction, and outcomes on pain level and functional status) and measuring these outcomes over a longer period of time beyond 18 months. Because of these limitations, the findings from our study cannot be used to answer the question of whether MT is cost-effective. Nonetheless, we believe this study provides a good starting point for future research in this area. This study also helps highlight certain practical issues that policymakers and stakeholders can act upon to improve health care delivery systems.

[5] 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 the prevalence and utilization patterns of manual therapy for LBP claims. We also included descriptive statistics across the states on workers' characteristics and several important environment factors. The interstate variation on patterns of manual therapy and other services are presented for all medical claims with LBP and a subset of LBP claims with neuro back conditions that had more than seven days of lost time.

Table SA.1 The Use of PT and MT by Type of LBP Claim

Measure	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Number of LBP claims[a]	1,558	38,036	4,383	593	17,221	7,703	2,114	9,609	5,228	2,117	3,906	2,206	5,598	4,051	8,007	5,052	4,204	7,086	9,830	1,869	3,149	7,117	9,187	3,107	5,784	24,115	5,854	5,012	
% of LBP claims, type of LBP																													
Neuro back claims	16%	14%	19%	24%	19%	19%	19%	18%	17%	18%	19%	19%	20%	15%	15%	21%	15%	20%	22%	13%	10%	28%	18%	18%	19%	11%	18%	21%	19%
LBP-only claims	84%	86%	81%	76%	81%	81%	81%	82%	83%	82%	81%	81%	80%	85%	85%	79%	85%	80%	78%	87%	90%	72%	82%	82%	81%	89%	82%	79%	81%
% of LBP claims, by type of claim																													
Claims with > 7DLT	15%	21%	27%	23%	21%	21%	15%	25%	12%	13%	15%	24%	34%	24%	15%	20%	16%	19%	26%	14%	12%	34%	19%	23%	16%	18%	16%	17%	19%
Claims with ≤ 7DLT	85%	79%	73%	77%	79%	79%	85%	75%	88%	87%	85%	76%	66%	76%	85%	80%	84%	81%	74%	86%	88%	66%	81%	77%	84%	82%	84%	83%	81%
% of LBP claims that had …																													
Manual therapy (MT)	5%	21%	24%	17%	15%	17%	17%	18%	10%	10%	7%	7%	11%	15%	13%	12%	18%	11%	19%	26%	28%	13%	12%	9%	12%	14%	7%	14%	13%
Non-MT PT services	34%	40%	33%	31%	39%	39%	30%	35%	31%	31%	27%	27%	28%	37%	30%	31%	34%	30%	41%	31%	35%	31%	31%	29%	35%	37%	25%	31%	32%
% of claims with PT																													
All LBP claims	39%	61%	57%	48%	54%	56%	48%	52%	41%	41%	34%	35%	39%	52%	44%	42%	52%	40%	61%	57%	64%	43%	43%	38%	47%	51%	33%	44%	46%
LBP-only claims with ≤ 7 DLT	30%	54%	44%	29%	43%	46%	37%	39%	32%	32%	23%	21%	22%	40%	35%	30%	44%	28%	47%	51%	59%	22%	33%	23%	37%	44%	21%	33%	34%
LBP-only claims with > 7 DLT	69%	76%	77%	79%	78%	80%	75%	78%	76%	75%	67%	59%	57%	77%	73%	62%	80%	68%	81%	85%	90%	66%	70%	69%	77%	71%	69%	71%	75%
Neuro back claims with ≤ 7DLT	55%	71%	71%	72%	62%	65%	68%	66%	57%	51%	49%	48%	48%	70%	60%	60%	64%	57%	76%	66%	67%	53%	53%	52%	59%	62%	47%	57%	60%
Neuro back claims with > 7 DLT	79%	91%	92%	92%	89%	89%	88%	91%	91%	85%	81%	82%	81%	92%	81%	83%	91%	87%	93%	85%	94%	86%	84%	89%	88%	85%	86%	85%	87%
% of claims with MT																													
All LBP claims	13%	34%	42%	36%	28%	30%	36%	34%	25%	24%	20%	21%	28%	29%	31%	28%	35%	26%	32%	46%	45%	29%	29%	24%	25%	27%	23%	31%	29%
LBP-only claims with ≤ 7 DLT	7%	26%	29%	20%	19%	21%	27%	21%	16%	17%	13%	12%	14%	17%	23%	19%	28%	16%	23%	41%	39%	13%	20%	13%	16%	22%	14%	22%	19%
LBP-only claims with > 7 DLT	31%	51%	62%	62%	47%	51%	58%	56%	54%	53%	41%	36%	41%	49%	54%	41%	58%	48%	45%	69%	77%	43%	48%	44%	47%	41%	52%	50%	50%
Neuro back claims with ≤ 7 DLT	22%	47%	53%	59%	40%	38%	53%	48%	37%	34%	33%	34%	39%	50%	45%	42%	44%	40%	44%	54%	52%	38%	39%	37%	39%	34%	33%	43%	40%
Neuro back claims with > 7 DLT	52%	71%	77%	76%	60%	65%	76%	74%	74%	57%	56%	55%	63%	74%	71%	63%	67%	69%	56%	67%	82%	61%	64%	64%	64%	53%	64%	67%	64%

Notes: Included are nonsurgical LBP claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. These are medical-only and indemnity claims. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

[a] The LBP claims are those that are identified as having LBP without red flag diagnoses, neurological neck, or serious comorbidities and complications. Claims with chiropractic care are also excluded. See Chapter 2 for definition.

Key: 7DLT: 7 days of lost time; LBP: low back pain; MT: manual therapy; PT: physical therapy.

Table SA.2a Utilization Patterns of MT and Other Services for All LBP Claims with MT

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Number of claims	209	13,008	1,831	214	4,861	2,318	762	3,247	1,282	508	793	473	1,558	1,176	2,445	1,414	1,469	1,864	3,150	864	1,408	2,060	2,642	737	1,438	6,444	1,335	1,545	1,454
% of LBP claims with nerve involvement	40%	23%	30%	43%	33%	31%	32%	34%	33%	30%	38%	39%	39%	33%	28%	38%	23%	39%	34%	17%	14%	49%	31%	38%	37%	17%	35%	35%	34%
% of LBP claims with > 7DLT	43%	35%	44%	43%	39%	39%	28%	46%	30%	30%	35%	50%	60%	47%	30%	37%	28%	41%	41%	21%	21%	59%	36%	49%	35%	29%	39%	33%	38%
Timing of MT from the date of first PT visit																													
% of claims with early MT (within 1 weeks of PT)	75%	67%	81%	84%	65%	72%	88%	77%	76%	80%	82%	79%	68%	76%	85%	72%	84%	75%	75%	86%	70%	81%	85%	80%	81%	72%	79%	80%	79%
% of claims with early MT (within 2 weeks of PT)	86%	81%	89%	91%	79%	83%	95%	86%	86%	90%	90%	87%	86%	86%	92%	87%	91%	86%	86%	93%	84%	89%	92%	88%	90%	88%	89%	91%	88%
Intervals of sequential events																													
From injury to 1st MT visit	40	37	28	33	41	38	25	31	33	34	30	61	38	32	22	36	24	45	28	22	21	44	25	47	36	22	41	27	33
From injury to 1st medical visit	4	8	5	9	6	6	7	7	6	7	5	7	8	6	4	8	5	6	6	5	3	10	5	6	7	5	6	7	6
From 1st medical visit to 1st PT visit	23	17	14	17	21	19	14	16	17	19	21	41	21	16	12	18	12	28	14	12	10	25	14	32	22	11	26	15	17
From 1st PT visit to 1st MT visit	12	12	8	7	14	13	4	9	9	8	6	12	9	10	6	10	6	10	8	5	7	8	6	9	8	7	9	5	8
Duration of MT treatment																													
% of claims with MT duration 6 weeks or shorter	81%	73%	72%	69%	75%	76%	77%	68%	76%	81%	81%	65%	62%	67%	80%	75%	84%	68%	77%	79%	81%	48%	74%	66%	81%	91%	68%	76%	76%
MT duration in weeks, mean	5.0	7.5	7.9	8.4	6.3	6.4	6.0	7.2	5.6	4.8	5.3	8.9	8.2	7.1	5.1	6.3	4.7	7.7	5.9	6.0	5.1	12.9	6.5	8.7	5.1	3.1	7.4	5.6	6.3
MT duration in weeks, median	2.0	3.0	3.0	4.0	3.0	3.0	3.0	4.0	3.0	2.0	3.0	4.0	4.0	4.0	2.0	3.0	2.0	3.0	3.0	2.0	2.0	7.0	3.0	4.0	3.0	2.0	4.0	3.0	3.0
Utilization of MT services, overall																													
# of MT visits, mean	5.6	5.8	6.6	10.7	5.8	5.3	6.9	9.1	7.0	5.1	5.9	9.1	8.5	8.0	6.3	5.1	5.5	6.8	7.5	5.2	5.1	14.1	9.0	7.5	5.4	3.4	7.7	5.8	6.5
# of MT visits, median	3	5	4	7	4	3	5	6	5	3	4	6	6	5	4	3	4	4	5	3	4	9	5	5	4	2	5	4	4
# of MT services, mean	6.5	7.0	8.2	12.5	7.2	6.5	8.5	11.4	9.2	6.2	7.2	11.5	10.9	9.6	8.0	6.6	6.6	9.0	9.7	6.3	5.7	15.9	11.3	9.5	7.1	3.9	10.2	8.2	8.2
# of MT services, median	4	5	4	7	4	4	6	7	5	3	4	7	7	6	4	4	4	5	6	4	4	10	6	6	4	3	6	4	5
# of services per visit, mean	1.1	1.2	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.2	1.1	1.2	1.2	1.2	1.2	1.3	1.1	1.1	1.1	1.2	1.2	1.2	1.1	1.3	1.3	1.2
# of services per visit, median	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
% of claims with MT, by the number of MT episodes[a]																													
One	91%	83%	84%	90%	85%	86%	89%	87%	88%	89%	91%	83%	88%	87%	91%	88%	90%	83%	89%	87%	88%	78%	91%	82%	89%	95%	86%	90%	88%
Two	8%	13%	12%	7%	13%	11%	10%	11%	11%	10%	7%	14%	9%	11%	8%	9%	9%	13%	9%	10%	10%	15%	7%	14%	10%	5%	11%	8%	10%
Three or more	1%	4%	4%	2%	2%	3%	1%	2%	1%	1%	2%	3%	2%	2%	1%	3%	1%	3%	1%	3%	2%	6%	2%	4%	1%	0%	3%	2%	2%
First MT episode - utilization pattern																													
# of MT visits	4.8	4.7	5.4	9.4	4.8	4.5	6.2	7.9	5.9	4.4	5.4	7.6	7.6	7.1	5.5	4.5	4.8	5.7	6.6	4.4	4.4	11.7	7.9	6.0	4.7	3.3	6.7	5.2	5.5
# of weeks for MT services	3.1	3.6	3.8	5.5	3.3	3.4	3.7	4.5	3.6	2.9	3.4	4.8	5.4	4.5	3.3	3.9	2.8	4.1	3.7	3.1	2.9	7.3	4.5	4.2	3.1	2.3	4.7	3.9	3.7
# of MT visits per week	1.5	1.4	1.5	1.7	1.5	1.4	1.7	1.7	1.6	1.5	1.6	1.6	1.4	1.5	1.7	1.3	1.7	1.4	1.7	1.5	1.6	1.6	1.7	1.5	1.6	1.5	1.5	1.4	1.5
Use of injections and opioid Rx																													
% receiving injections prior to PT	5%	1%	2%	8%	4%	5%	5%	5%	8%	4%	2%	7%	3%	5%	3%	4%	5%	7%	3%	3%	2%	7%	5%	5%	4%	1%	4%	6%	5%
% receiving injections, overall	18%	8%	15%	20%	16%	21%	14%	17%	20%	16%	10%	29%	14%	14%	10%	13%	15%	20%	16%	12%	10%	21%	15%	24%	15%	4%	18%	13%	15%
% receiving opioid Rx prior to PT	29%	14%	8%	9%	19%	23%	18%	15%	16%	19%	9%	34%	8%	14%	13%	11%	13%	25%	8%	14%	14%	9%	11%	25%	20%	20%	21%	14%	14%
% receiving opioid Rx, overall	37%	18%	12%	13%	25%	29%	21%	19%	20%	23%	13%	40%	9%	19%	16%	14%	17%	30%	10%	17%	18%	12%	15%	30%	25%	23%	25%	16%	18%
% receiving MRI prior to PT	24%	10%	12%	29%	37%	25%	16%	22%	20%	20%	21%	24%	17%	21%	14%	19%	12%	25%	22%	12%	10%	36%	26%	30%	21%	8%	20%	17%	21%
% receiving MRI, overall	43%	25%	26%	36%	53%	44%	27%	36%	34%	33%	38%	43%	27%	33%	24%	30%	26%	42%	39%	22%	23%	48%	34%	49%	39%	17%	34%	26%	34%
Questionable utilization patterns, claims with 1st medical visit within 2 weeks postinjury[b]																													
% of claims with 1st medical visit after 2 weeks postinjury	7%	12%	8%	14%	9%	10%	12%	11%	11%	11%	7%	11%	14%	10%	7%	14%	9%	11%	11%	8%	5%	20%	8%	11%	11%	7%	11%	12%	11%
% receiving X-ray at 1st visit	43%	47%	13%	29%	55%	60%	27%	47%	29%	39%	33%	51%	17%	25%	43%	23%	32%	33%	44%	35%	66%	33%	34%	39%	48%	50%	38%	22%	37%
% receiving DME at1st visit	1%	26%	1%	4%	16%	1%	0%	6%	4%	1%	2%	1%	0%	0%	4%	4%	1%	2%	13%	5%	33%	1%	1%	0%	4%	4%	0%	1%	2%
% receiving opioid at 1st visit	9%	7%	2%	2%	6%	8%	7%	4%	5%	9%	1%	6%	2%	4%	3%	5%	6%	8%	2%	6%	5%	2%	3%	6%	8%	9%	9%	5%	5%
% receiving MRI within 4 weeks of injury	10%	3%	5%	16%	21%	9%	9%	10%	9%	13%	11%	7%	6%	9%	6%	10%	8%	9%	9%	7%	4%	19%	14%	10%	11%	4%	7%	8%	9%

Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

[a] An episode of MT is defined as a set of visits or unique dates for MT treatment with less than 30 days between any two consecutive visits.

[b] The questionable practice patterns refer to those utilization patterns of medical services that are inconsistent with widely agreed-upon treatment guidelines for treating low back pain.

Key: 7DLT: 7 days of lost time; DME: durable medical equipment; LBP: low back pain; MRI: magnetic resonance imaging; MT: manual therapy; PT: physical therapy.

Table SA.2b Utilization Patterns of MT and Other Services for Neuro Back Claims with More Than 7 Days of Lost Time Receiving MT

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Number of claims	46	1,665	328	45	869	417	105	707	181	59	145	125	423	238	338	270	142	384	590	66	81	682	441	168	238	523	255	264	260
Timing of MT from the date of first PT visit																													
% of claims with early MT (within 1 weeks of PT)	57%	61%	74%	64%	61%	65%	77%	71%	65%	71%	75%	79%	64%	67%	75%	67%	82%	65%	72%	70%	59%	82%	78%	78%	74%	57%	74%	71%	71%
% of claims with early MT (within 2 weeks of PT)	76%	74%	84%	80%	74%	76%	86%	79%	76%	81%	84%	82%	85%	78%	83%	83%	88%	79%	81%	77%	85%	89%	86%	83%	82%	78%	84%	88%	82%
Intervals of sequential events																													
From injury to 1st MT visit	66	54	38	46	54	57	34	40	48	49	47	88	46	40	36	40	33	58	36	56	38	44	36	56	44	39	46	34	45
From injury to 1st medical visit	5	7	5	6	5	7	4	6	7	3	4	7	7	4	5	5	7	5	5	6	3	8	4	5	6	6	4	5	5
From 1st medical visit to 1st PT visit	39	25	22	24	28	30	21	21	25	26	32	59	27	20	20	21	19	36	17	36	26	25	21	34	26	19	29	20	25
From 1st PT visit to 1st MT visit	21	22	10	16	20	20	8	13	15	20	11	22	11	16	11	15	8	17	13	15	9	11	12	18	12	14	14	8	14
Duration of MT treatment																													
% of claims with MT duration 6 weeks or shorter	70%	50%	54%	49%	62%	57%	53%	45%	50%	66%	70%	52%	49%	49%	49%	59%	58%	51%	57%	39%	44%	36%	51%	47%	71%	77%	50%	56%	52%
MT duration in weeks, mean	8.3	13.5	13.7	15.2	9.5	9.7	11.5	11.9	10.4	8.3	8.6	12.4	11.1	10.4	11.4	10.2	8.5	11.6	9.7	14.0	11.3	16.4	12.1	14.2	7.2	5.8	11.5	9.4	11.2
MT duration in weeks, median	2.5	7.0	5.5	8.0	4.0	5.0	6.0	8.0	6.0	4.0	4.0	6.0	7.0	7.0	7.0	5.0	4.5	6.0	5.0	9.0	8.0	9.0	6.0	7.0	4.0	3.0	6.0	5.5	6.0
Utilization of MT services, overall																													
# of MT visits, mean	7.3	8.6	10.4	18.1	7.5	7.6	10.1	14.3	10.8	7.3	7.3	11.6	10.9	10.3	12.2	6.7	8.4	9.1	11.3	8.8	9.5	18.0	15.8	10.4	6.9	5.0	11.0	8.6	9.8
# of MT visits, median	4	6	6	10	5	6	8	11	9	4	5	9	8	8	9	5	6	6	8	7	7	13	9	8	5	4	7	5	7
# of MT services, mean	8.8	10.8	13.1	20.4	9.5	9.4	12.9	18.3	13.4	9.2	9.0	14.8	13.8	12.5	16.2	8.6	10.8	12.1	14.1	12.2	10.6	20.2	19.9	13.2	9.3	5.8	14.8	12.8	12.6
# of MT services, median	5	8	7	12	6	7	10	12	10	5	6	11	8	9	10	6	7	8	10	8	8	14	11	9	6	4	9	7	8
# of services per visit, mean	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.4	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.1	1.1	1.2	1.2	1.2	1.1	1.3	1.4	1.2
# of services per visit, median	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
% of claims with MT, by the number of MT episodes[a]																													
One	85%	65%	67%	78%	74%	74%	70%	76%	70%	81%	85%	77%	81%	75%	72%	79%	70%	72%	80%	52%	64%	72%	79%	65%	82%	85%	75%	76%	75%
Two	13%	25%	24%	16%	22%	20%	27%	19%	25%	15%	10%	17%	15%	21%	23%	16%	28%	22%	17%	38%	28%	19%	16%	25%	16%	14%	20%	20%	20%
Three or more	2%	10%	9%	7%	4%	6%	3%	5%	5%	3%	5%	6%	4%	4%	5%	5%	2%	6%	3%	11%	7%	9%	5%	10%	3%	1%	5%	4%	5%
First MT episode - utilization pattern																													
# of MT visits	6.0	6.1	7.5	14.0	6.0	5.8	8.0	11.3	8.3	6.1	6.3	9.5	9.3	8.4	9.0	5.6	6.5	7.0	9.4	5.8	6.7	14.6	12.3	7.2	5.5	4.4	8.9	7.1	7.1
# of weeks for MT services	3.7	4.7	5.2	8.0	4.1	4.3	4.5	6.3	4.8	4.4	4.3	6.0	6.4	5.3	5.4	5.0	3.5	5.2	5.2	4.4	4.4	8.8	6.9	5.0	3.6	3.1	6.0	5.0	5.0
# of MT visits per week	1.5	1.4	1.5	1.8	1.5	1.4	1.7	1.8	1.7	1.5	1.5	1.6	1.4	1.6	1.7	1.2	1.8	1.4	1.8	1.4	1.6	1.7	1.7	1.5	1.6	1.5	1.5	1.4	1.5
Use of injections and opioid Rx																													
% receiving injections prior to PT	15%	3%	8%	27%	10%	14%	21%	16%	28%	17%	8%	13%	9%	15%	11%	16%	16%	16%	11%	18%	10%	15%	19%	14%	10%	2%	9%	20%	15%
% receiving injections, overall	43%	31%	45%	62%	43%	57%	51%	43%	65%	53%	31%	61%	35%	38%	41%	37%	52%	47%	47%	55%	57%	40%	47%	57%	42%	26%	44%	42%	44%
% receiving opioid Rx prior to PT	39%	28%	23%	16%	35%	45%	42%	29%	30%	42%	22%	51%	15%	27%	33%	26%	24%	41%	17%	33%	27%	14%	27%	43%	33%	42%	38%	28%	30%
% receiving opioid Rx, overall	50%	40%	33%	24%	49%	60%	53%	37%	40%	51%	33%	62%	18%	35%	42%	35%	38%	50%	25%	45%	43%	20%	38%	54%	46%	54%	46%	33%	41%
% receiving MRI prior to PT	46%	32%	37%	64%	68%	57%	45%	51%	51%	54%	43%	50%	35%	46%	47%	51%	42%	58%	54%	55%	35%	59%	66%	58%	49%	34%	48%	51%	50%
% receiving MRI, overall	74%	71%	63%	80%	87%	85%	70%	75%	81%	69%	74%	78%	55%	67%	73%	70%	77%	83%	77%	85%	78%	73%	80%	86%	82%	64%	72%	66%	75%
Questionable utilization patterns, claims with 1st medical visit within 2 weeks postinjury[b]																													
% of claims with 1st medical visit after 2 weeks postinjury	7%	12%	8%	14%	9%	10%	12%	11%	11%	11%	7%	11%	14%	10%	7%	14%	9%	11%	11%	8%	5%	20%	8%	11%	11%	7%	11%	12%	11%
% receiving X-ray at 1st visit	63%	48%	17%	38%	51%	50%	29%	43%	32%	46%	37%	38%	19%	30%	42%	22%	30%	35%	43%	33%	55%	35%	37%	38%	43%	47%	38%	27%	38%
% receiving DME at 1st visit	0%	21%	1%	3%	12%	1%	0%	5%	2%	0%	0%	2%	0%	0%	2%	1%	0%	1%	11%	3%	22%	1%	1%	0%	3%	1%	0%	0%	1%
% receiving opioid at 1st visit	9%	11%	4%	3%	7%	12%	9%	5%	7%	14%	3%	7%	3%	5%	6%	8%	10%	9%	2%	7%	6%	2%	4%	9%	8%	16%	11%	6%	7%
% receiving MRI within 4 weeks of injury	23%	12%	16%	36%	44%	25%	27%	24%	25%	40%	25%	13%	12%	25%	23%	25%	35%	24%	26%	28%	14%	33%	40%	22%	28%	20%	19%	29%	25%

Note: Included are nonsurgical neuro back claims with MT services. These are claims with more than seven days of lost time, with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

[a] An episode of MT is defined as a set of visits or unique dates for MT treatemnt with less than 30 days between any two consecutive visits.

[b] The questionable practice patterns refer to those utilization patterns of medical services that are inconsistent with widely agreed-upon treatment guidelines for treating low back pain.

Key: 7DLT: 7 days of lost time; DME: durable medical equipment; LBP: low back pain; MT: manual therapy; MRI: magnetic resonance imaging; PT: physical therapy; Rx: prescriptions.

Table SA.3 Claim and Injury Characteristics and Contextual Factors for LBP Claims with MT

	AR	CA	CT	DE	FL	GA	IA	IL	IN	KS	KY	LA	MA	MD	MI	MN	MO	NC	NJ	NM	NV	NY	PA	SC	TN	TX	VA	WI	28-State Median
Number of claims	209	13,008	1,831	214	4,861	2,318	762	3,247	1,282	508	793	473	1,558	1,176	2,445	1,414	1,469	1,864	3,150	864	1,408	2,060	2,642	737	1,438	6,444	1,335	1,545	1,454
Claim characteristics																													
% of LBP claims with nerve involvement	40%	23%	30%	43%	33%	31%	32%	34%	33%	30%	38%	39%	39%	33%	28%	38%	23%	39%	34%	17%	14%	49%	31%	38%	37%	17%	35%	35%	34%
% of LBP claims that had injection prior to PT care	5%	1%	2%	8%	4%	5%	5%	5%	8%	4%	2%	7%	3%	5%	3%	4%	5%	7%	3%	3%	2%	7%	5%	5%	4%	1%	4%	6%	5%
% of LBP claims with at least one identified comorbidity	7%	4%	4%	3%	4%	4%	7%	6%	4%	5%	8%	11%	10%	6%	4%	8%	4%	6%	6%	5%	3%	6%	5%	5%	5%	3%	7%	12%	5%
% of LBP claims with multiple comorbidities	12%	6%	7%	10%	7%	7%	10%	9%	7%	6%	16%	21%	17%	10%	7%	12%	7%	10%	10%	8%	6%	9%	9%	9%	9%	5%	12%	19%	9%
% of LBP claims with > 7DLT	43%	35%	44%	43%	39%	39%	28%	46%	30%	30%	35%	50%	60%	47%	30%	37%	28%	41%	41%	21%	21%	59%	36%	49%	35%	29%	39%	33%	38%
% of LBP claims involving attorney	6%	9%	10%	16%	17%	19%	9%	19%	6%	16%	6%	20%	10%	17%	4%	5%	24%	15%	19%	2%	8%	19%	8%	24%	8%	1%	13%	3%	10%
Worker characteristics																													
Worker's age, mean	41	41	43	42	44	42	42	42	42	40	42	43	43	42	42	42	42	44	43	40	41	43	42	43	43	41	43	42	42
% female	39%	42%	41%	51%	45%	42%	42%	39%	43%	41%	45%	45%	37%	39%	46%	50%	46%	47%	36%	46%	48%	45%	38%	45%	41%	37%	44%	46%	44%
% married	36%	23%	23%	26%	31%	27%	36%	38%	30%	26%	36%	36%	30%	29%	21%	31%	27%	32%	27%	35%	24%	26%	29%	32%	32%	28%	33%	20%	30%
Preinjury average weekly wage, mean	$680	$763	$846	$739	$700	$685	$659	$752	$646	$642	$629	$718	$857	$832	$654	$740	$588	$646	$688	$593	$943	$839	$751	$660	$673	$708	$682	$724	$694
Years with preinjury employer, mean	5.7	6.2	7.1	5.8	6.6	5.4	6.8	7.4	6.2	5.3	5.6	6.0	6.7	6.3	6.4	6.8	5.9	6.8	6.3	5.1	5.3	8.0	7.4	5.8	6.5	5.0	6.0	6.3	6.2
% of LBP claims by industry group																													
Manufacturing	27%	11%	13%	9%	7%	15%	27%	17%	28%	26%	22%	7%	12%	11%	22%	15%	16%	16%	12%	9%	7%	9%	19%	23%	20%	14%	11%	27%	15%
Construction	4%	7%	5%	3%	6%	5%	5%	4%	5%	4%	5%	11%	8%	8%	4%	5%	5%	6%	6%	7%	7%	5%	5%	5%	6%	11%	7%	5%	5%
Clerical and professional	2%	7%	6%	5%	8%	5%	8%	7%	5%	4%	6%	7%	10%	7%	6%	9%	7%	5%	7%	6%	3%	8%	6%	4%	4%	8%	8%	6%	6%
High-risk industry	27%	31%	26%	29%	31%	25%	28%	31%	26%	28%	23%	27%	30%	23%	29%	33%	31%	21%	28%	35%	37%	34%	26%	31%	30%	27%	30%	30%	29%
Trade	18%	23%	19%	28%	21%	27%	16%	21%	21%	21%	19%	19%	20%	20%	17%	18%	20%	17%	29%	19%	24%	21%	23%	20%	19%	19%	20%	17%	20%
Low-risk industry	17%	11%	14%	19%	18%	17%	13%	13%	12%	14%	15%	18%	15%	21%	18%	17%	15%	22%	15%	15%	14%	18%	14%	14%	15%	14%	17%	12%	15%
Other industry	4%	8%	15%	4%	8%	5%	3%	7%	3%	2%	9%	10%	4%	10%	4%	3%	6%	11%	3%	6%	7%	4%	6%	2%	5%	7%	6%	3%	6%
Environmental factors																													
% of workers living in rural area	17%	1%	1%	5%	1%	4%	22%	2%	8%	9%	17%	8%	1%	2%	5%	11%	9%	6%	0%	2%	1%	3%	3%	6%	10%	3%	7%	13%	5%
% population with college or post-college degree	23%	32%	37%	30%	29%	32%	29%	35%	26%	31%	26%	25%	39%	37%	29%	36%	31%	32%	37%	31%	24%	35%	30%	28%	27%	30%	38%	30%	31%
% population with no health insurance coverage	10%	8%	6%	7%	16%	15%	5%	8%	9%	11%	6%	12%	3%	7%	6%	5%	10%	12%	10%	11%	13%	7%	7%	12%	11%	18%	10%	6%	9%
Median household income in the neighborhood (in $1,000)	$44	$65	$70	$61	$50	$54	$56	$62	$51	$55	$49	$48	$71	$76	$53	$67	$54	$52	$72	$49	$53	$69	$57	$49	$49	$57	$75	$55	$55
% population with physical activity	71%	80%	77%	76%	76%	76%	76%	77%	73%	75%	72%	72%	77%	77%	77%	81%	74%	76%	75%	79%	76%	76%	76%	75%	71%	75%	78%	78%	76%
Average # of PTs per 100,000 population	51.2	47.2	97.0	61.6	52.2	42.4	55.1	67.8	60.7	54.1	57.9	50.5	91.6	53.3	77.2	65.7	72.6	55.2	71.9	64.4	31.2	83.7	77.8	48.3	52.0	38.7	52.2	73.2	56.6
Average local unemployment rate	4.2	5.4	5.2	4.6	4.9	5.3	3.8	5.9	4.5	4.4	4.8	5.9	3.9	4.4	5.1	3.8	4.6	5.0	5.1	6.1	5.7	4.7	5.3	4.7	4.8	4.4	4.1	4.3	4.7

Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

Key: 7DLT: 7 days of lost time; LBP: low back pain; MT: manual therapy; PT: physical therapy.

TECHNICAL APPENDIX A

LOW BACK PAIN AND PT TREATMENT

In this technical appendix, we describe the algorithm we used for the identification of LBP claims. We also describe our approach to identifying common PT treatment patterns, which led us to develop three research topics, the first of which is the topic for this report.

LOW BACK PAIN CLAIMS

The algorithm we developed in our 2019 study identified two groups of low back claims: (1) low back pain with neurological findings and/or radiating leg pain and (1) low back pain only claims. 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 70 percent of all medical payments) and that did not have any red flag conditions or neurological neck pain. 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. 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 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 findings, 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
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

continued

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

ICD-10 Code	Description
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
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
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

continued

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

ICD-10 Code	Description
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 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.

Key: ICD: International Classification of Diseases.

Table TA.A3 provides a short list of ICD-10 codes indicating neurological neck conditions. If any low back pain claims had any of these neurological neck conditions, they 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 codes, not included in the report, cover conditions such as tumor, infectious disease, and fracture and dislocation.

Table TA.A3 ICD-10 codes Indicating 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.

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; we excluded the low back claims that had any of these ICD-10 codes, because workers with these diagnoses are not considered 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; PT: physical therapy.

In this study, we included both LBP-only claims and claims with neuro back conditions. These two types of LBP claims can be quite different in terms medical treatment indicated as well as in utilization and costs of medical services. Table TA.A5 provides a comparison of these types of LBP claims.

In the 28-state pooled sample, 83 percent of the LBP claims were identified as LBP-only claims and 17 percent were identified as LBP claims with nerve involvement. The average claim with a neuro back condition used more services with higher medical and indemnity costs (Table TA.A5). TD duration was also longer for neuro back claims. Workers with neuro back conditions were more likely to receive PT treatments (73 percent versus 46 percent for LBP-only claims) and had more visits over a longer duration. Utilization of other medical services was also higher among neuro back claims, compared with LBP-only claims. For example, 26 percent of neuro back claims received opioid prescriptions and the same figure was 9 percent for LBP-only claims. Neuro back claims were more likely to have MRI and spinal injections. It is important to control for the type of LBP condition when we look at the results for all low back claims; we did so when reporting our findings for LBP claims in the main report.

Table TA.A5 Comparing Utilization of Costs between LBP-Only Claims and Neuro Back Claims

Variables	LBP-Only Claims[a]	LBP Claims with Nerve Involvement[a]
Number of claims	168,926	34,718
% of claims with specified pattern	83%	17%
Medical costs and TD duration per claim at 18 months postinjury		
Medical payments, per medical claim	$1,502	$5,296
Indemnity payments, per claim with indemnity benefits	$863	$6,242
TD duration in weeks, per claim with indemnity benefits	1.2	7.5
% of claims with > 7 days of lost time	16%	44%
Costs and utilization of PT services at 18 months postinjury		
% of claims with PT services	46%	73%
Number of PT visits, mean	8	14
Number of PT visits, median	6	10
Duration (days) of PT treatment, mean	39	93
Duration (days) of PT treatment, median	17	46
% of medical payments that were made for PT services	82%	43%
Average paid per visit for PT	$153	$152
Utilization of other services over 18 months of treatment		
Number of office visits, mean	4	8
% of claims with emergency visit	18%	25%
% of claims with opioid Rx	9%	26%
Number of opioid Rx, per claim with opioids	1.7	3.1
% of claims with MRI	8%	48%
% of claims receiving injections	1.9%	23.6%
% of claims had surgery	0.0%	0.0%

Notes: Claims included are those with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019.

[a] LBP claims were identified based on the algorithm established by Wang, Mueller, and Lea (2019a).

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

COMMON PT TREATMENT PATTERNS FOR WORKERS WITH LBP

After publishing the early PT study, we were charged with expanding the study to cover all key aspects of PT treatments (timing of initiation; frequency, duration, and intensity; and type of PT providers and services) to identify common PT treatment patterns for workers with LBP. The purpose of this research effort was to document the common PT patterns for LBP in workers' compensation health care and evaluate costs and outcomes for these common patterns. As a result, we mapped common PT treatment patterns and identified several policy-important studies in the area of physical medicine.[1] This MT study is the first in this PT study series. In this section, we describe the identification of PT services, key considerations for common PT treatment patterns, and areas of research that may be helpful for policymakers and stakeholders.

[1] We were fortunate to have a group of experts and system practitioners who helped us to better understand policy and practical issues related to PT and specifically MT treatments. The interim results were reviewed by the advisory group members and the further discussion helped us to identify several policy-important research questions.

IDENTIFYING AND GROUPING PT SERVICES

Table TA.A6 list all the CPT4 codes that we used to identify PT services using administrative data. The PT codes are grouped by type of services, including active physical therapy services (often referred to as exercises), passive physical therapy or modalities, MT services, and other PT services not classified above.

Table TA.A6 Grouping Procedure Codes of Physical Medicine Services

Procedure Code	Description
Active physical therapy services (APT)	
Exercises	
97110	Therapeutic exercises to develop strength and endurance, range of motion
97112	Neuromuscular reeducation of movement, balance, coordination
97113	Aquatic therapy with therapeutic exercises
97116	Gait training, including stair climbing
97530	Therapeutic activities to improve functional performance
97531	Functional activities, one area
Work hardening/conditioning	
97545	Work hardening or conditioning; initial 2 hours
97546	Work hardening or conditioning; each additional hour
Education and training for exercises and self-management	
97535	Self-care/home management training, direct one-on-one
97537	Community/work reintegration, direct one on one
97542	Wheelchair management (e.g., assessment, fitting, training)
G8780	Counseling for diet and physical activity performed
4242F	Counseling for exercise program for back pain lasting longer than 12 weeks
4450F	Self-care education provided to patient
96152–96155	Health and behavior intervention (respectively for individual patient, group, with or without the patient present)
97532	Cognitive skills training
97770	Development of cognitive skills to improve attention, memory, problem solving, direct one on one
98960–98962	Education and training for patient self-management by a nonphysician provider (respectively for single patient, 2–4 patients, and 5–8 patients)
99071	Patient educational materials (e.g., books, tapes, and pamphlets)
99078	Educational services rendered to patients in a group setting
97150	Therapeutic procedure(s), group
S9454	Stress management classes
S9445, S9446	Patient education, not otherwise classified, individual or group
V65.4, Z71.8	Other specified counseling, covered in the ICD-10-CM
Passive physical therapy/modalities (PPT)	
0278T	Transcutaneous electrical modulation pain reprocessing
64550	Application of surface (transcutaneous) neurostimulator
97010, 97012, 97014, 97016, 97018, 97020, 97022, 97024, 97026, 97028, 97032, 97033, 97034, 97035, 97036, 97039	Physical modalities (hot or cold packs, mechanical traction, electrical stimulation, vasopneumatic devices, paraffin bath, microwave, whirlpool, diathermy [e.g., microwave], infrared, ultraviolet, electrical stimulation [manual], iontophoresis, contrast baths, ultrasound, hubbard tank, unlisted)
97124	Massage (e.g., stroking, compression, percussion)
97780, 97781	Acupuncture with or without electrical stimulation (old codes)
97810–97814	Acupuncture with or without electrical stimulation, initial or additional 15 minutes of treatment

continued

Table TA.A6 Grouping Procedure Codes of Physical Medicine Services (continued)

Procedure Code	Description
Passive physical therapy/modalities (PPT), continued	
S8930	Electrical stimulation of auricular acupuncture points
A4595	Electrical stimulation supplies
E0720, E0730	Transcutaneous electrical nerve stimulation (TENs) device
E0770	Functional electrical stimulator, transcutaneous stimulation of nerve and/or muscle groups, any type, complete system, not otherwise specified.
E0941	Gravity assisted traction device
G0281–G0283	Electrical stimulation, unattended
S8948	Application of a modality (requiring constant provider attendance)
S9090	Vertebral axial decompression, per session (2020 code)
Manual therapy services (MT)	
97140	Manual therapy techniques (e.g., mobilization, manipulation, manual lymphatic drainage, manual traction)
98925–98929	Osteopathic manipulative treatment (OMT), depending on the number of body regions involved
98940–98943	Chiropractic manipulative treatment (CMT), depending on the number of body regions
S8990	Physical or manipulative therapy performed for maintenance rather than restoration
Other physical medicine services, not classified above (OTH)	
97000–97004	Old evaluation-measurement code
97161–97163	Physical therapy evaluation, by level of complexity (i.e., low, moderate, and high)
97164–97165	Re-evaluation of physical therapy established plan of care; occupational therapy evaluation
G8509, G8730, G8731, G8939	Pain assessment documented
95833, 95834	Muscle testing, total evaluation of body, excluding or including hands
95851	Range of motion measurements and report
97750, 97751	Physical performance test or measurement
97752	Muscle testing with torque curves during isometric and isokinetic exercise: mechanized or computerized evaluations with print out
97755	Assistive technology assessment (e.g., to restore, augment or compensate for existing function), direct one on one contact
S9451	Exercise class by a non-physician provider
97720, 97721	Extremity for strength, dexterity, or stamina, initial or additional visit

Note: Four broad categories of physical medicine services are active physical therapy (APT), passive physical modalities (PPT), manual therapy (MT), and other services (OTH), which were identified based on the CPT4 codes and HCPCS codes. Since hospital revenue codes (i.e., R codes) do not provide specific information of service type, we excluded services that were provided in and billed for by hospitals from the analysis.

For our PT studies, we included some services that are not under the category of PT. For example, work hardening and conditioning is part of occupational therapy. We included such services because we focus on the PT/occupational therapy services that are used in practice to help workers recover from their LBP injuries and return to work. For clarity, we refer to the included services as *PT and related services* and use *PT care/services* as shorthand. Table TA.A6 also lists chiropractic manipulative treatment (CMT) services. For the MT study, we excluded claims with chiropractic care to focus on MT services provided by non-chiropractic providers (mostly physical therapists). CMT services will be addressed in a subsequent study on chiropractic care.

For manual therapy, a vast majority of the services were identified using one single CPT code, 97140. There are a small percentage of MT services identified based on the osteopathic manipulative therapy (OMT) codes.

We discuss the MT codes and related issues in Chapter 2.

IDENTIFYING COMMON PT TREATMENT PATTERNS FOR LBP

PT services include evaluation/measurement, functional assessment, passive physical therapies (e.g., hot/cold packs, electric stimulation, massage, traction, and acupuncture), manual therapy (e.g., manipulation, mobilization, soft tissue massage, manual traction, and trigger point therapy), and active physical therapies (e.g., therapeutic exercises, PT related education and training, active counseling, and work hardening).[2]

There are several key aspects of physical therapy treatments, including timing of initiation, type of provider and services, frequency, duration, and intensity of PT services. We expanded the previous study on PT timing to consider these additional dimensions in order to identify common treatment patterns of physical therapy and related services. Note that we use the term *physical therapy and related services* or *PT services* as shorthand throughout the report, recognizing that in practice, many would think of PT as only PT services provided by physical therapists.

Our key considerations for identifying PT treatment patterns are summarized as follows:

- PT services can be performed by different providers, including physical therapists, chiropractors, osteopathic physicians, and other providers.[3] We mainly focus on physical therapists and chiropractors as the predominant types of PT providers for two reasons. First, our data differentiate chiropractors from non-chiropractic providers, but do not support a consistent distinction between physical therapists and osteopathic physicians and other providers. Second, PT services by osteopathic physicians and other providers are infrequent, as we observe in our data, and a vast majority of the non-chiropractic PT services are provided by physical therapists. For simplicity and clarity, we use the terms *chiropractors* and *non-chiropractic providers* to describe the types of PT providers and use *physical therapists* interchangeably with *non-chiropractic PT providers.*
- Physical therapists and chiropractors share the same goal to achieve pain relief and function restoration without invasive procedures, with a different focus and approach. A physical therapist or physiotherapist focuses on improving the patient's ability to move and function without pain, by evaluating the patient and formulating a treatment plan that may include patient education, instructions for stretches and exercises, and physical modalities to help address pain and facilitate exercise. Many physical therapists have received specialized training for spinal mobilization and manipulation and are certified. Chiropractors primarily focus on pain relief and misalignment of the spine by performing spinal manipulation to improve healing. They also perform mobilization and other services as well as advise patients on exercise and nutrition balance. As a result, we expect to see different PT treatment patterns between chiropractors and non-chiropractic providers; and it is important to compare outcomes of PT care by different types of providers.

---

[2] Conventionally, work hardening is part of occupational therapy instead of physical therapy. We include work hardening as part of PT and related services for our PT studies because these services are an intrinsic part of the services used for treating workers and facilitating return to work. For clarity, we use the term *physical therapy and related services* or *PT services* as shorthand throughout the report.

[3] It should be noted that for many physical therapists, the terms *PT* or *PT services* refer to physical therapy services performed by licensed physical therapists. However, the CPT codes for PT services are not exclusive to physical therapists. Other clinicians can deliver similar treatments using the same CPT codes. In this study, we defined PT services to refer to PT and similar services provided by physical therapists and other non-physical therapist providers (see Chapter 2 and the glossary).

- There are four broadly-defined PT service types: active PT, passive PT, manual therapy, evaluation/assessment, and other services (Table TA.A6). Most treatment guidelines provide strong evidence that supports the use of active PT and limits the use of passive PT to initial care when necessary. As part of the identification of common PT patterns, we expanded the algorithm developed by Fritz et al. (2007) to characterize patterns of care based on the ratio of active and passive PT services at 2-week intervals and the intertemporal patterns of the ratio. Hanney et al. (2016) described in detail how both Fritz et al. (2012 and earlier studies in 2007 and 2008)[4] and Childs et al. (2015) defined guideline adherence of physical therapy for active treatment.
- However, the efficacy and cost-effectiveness of manual therapy are not as well addressed. Many guidelines allow the use of manipulation and mobilization for patients with spine pain, and some also provide a list of other MT services for consideration. There is a lack of nomenclature and coding scheme for specific types of MT services. In addition, all chiropractors may perform spinal mobilization and manipulation, and some physical therapists are certified to perform mobilization and manipulation. It is important to separate manual therapy from other types of PT services and study the cost-effectiveness of manual therapy. It is also important to examine utilization patterns of MT. Because a vast majority of MT services were coded using CPT code 97140, we are not able to examine patterns of specific MT services, but we can look at the timing of MT as a whole.
- Based on our data, we see that there is substantial variation across individuals and geographic areas in the number of PT visits and duration of PT treatment. The intensity of PT services, measured as the number of services per visit and the number of visits per week, is fairly similar, as we observed in the data. In addition, there are a considerable number of claims that exhibit an intermittent pattern of PT treatment. To capture the frequency and duration more accurately and characterize initial care, we introduce the concept of PT episodes, which we define as clusters of sequential PT visits that are separated by 30 days.[5] For each PT episode, we created utilization variables within an episode, including visits, duration, and intensity (i.e., the number of visits per week). The initial PT care we used in identifying common PT treatment patterns is the first PT episode within three months postinjury.

These considerations were the underlying principles we used in the identification of common PT treatment patterns or pathways. As an interim review, we consulted several system practitioners who are experts on PT and chiropractic care. As a result of this review, we identified three research topics that are most useful for policymakers and stakeholders who are interested in the improvement of PT care delivered for workers with low back pain.

Figure TA.A1 provides a diagram that shows the PT treatment patterns we identified, based on the key considerations discussed above, and which subset of the data we focus on for each of the three separate PT studies.

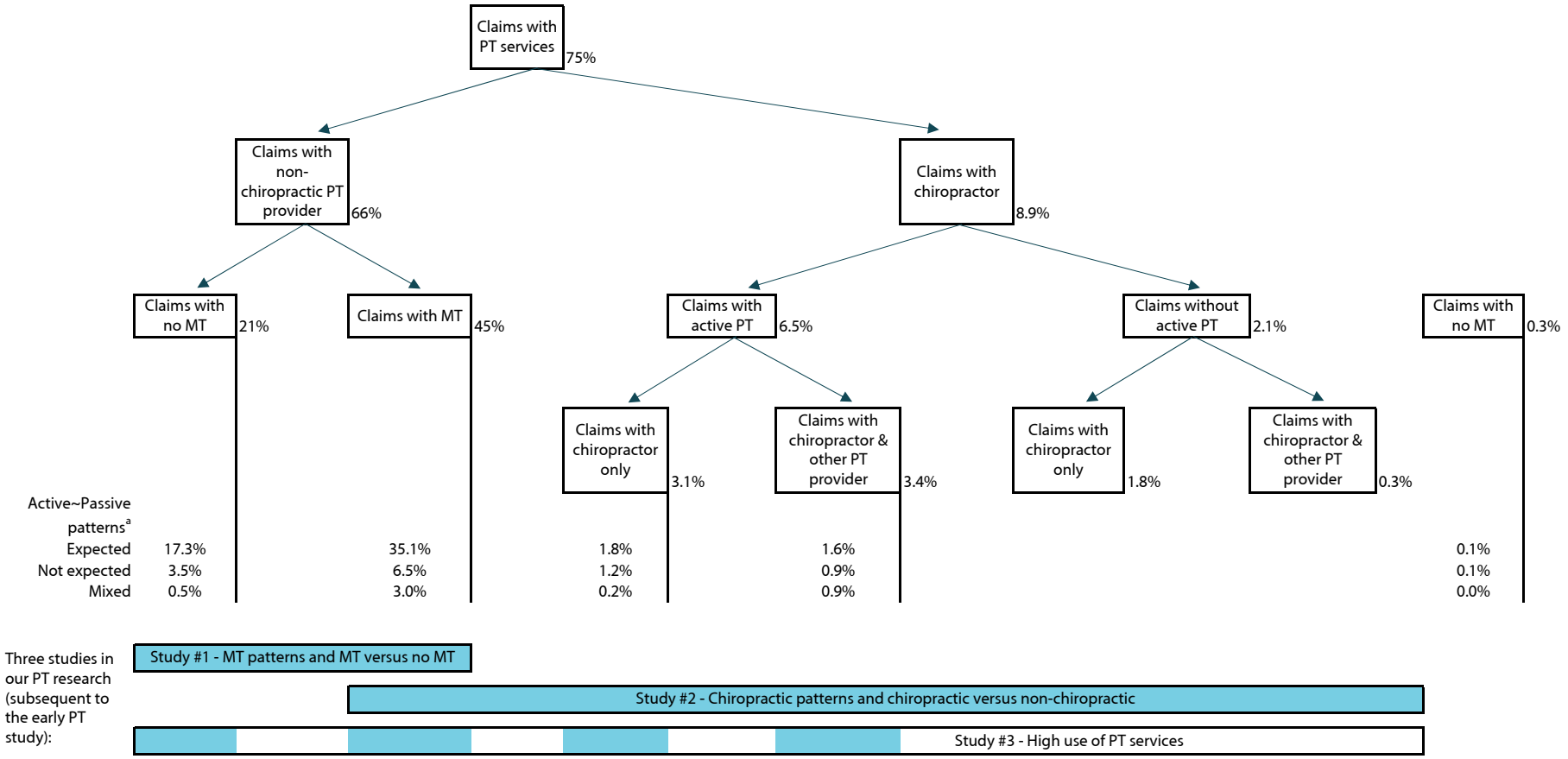
At the bottom of the diagram, we indicate, with blue highlighting, which subsets of the LBP claims with PT treatment would be used for each study in our PT series. The MT topic is the focus of this study, which

[4] Fritz et al. (2007) found that when receiving guideline-concordant care, 23 percent of patients experienced improvement in pain and disability with fewer PT visits and lower charges. Fritz et al. (2008) found lower utilization in the number of PT visits, drugs, office visits for evaluation and management, emergency, urgent care, diagnosis procedures, injections, surgery, and rehabilitation visits (chiropractors and physical therapists).

[5] We identified PT episodes for individual claims based on a 30-day threshold. If the interval between two consecutive dates of PT services for a claim was more than 30 days, a new PT episode begins on the second date of the two consecutive dates and the first date of the two consecutive dates is the last date of the current PT episode.

describes patterns of MT services and compares utilization of medical services, costs, and TD duration for claims with LBP between MT and no-MT care and for those with MT, between early and late MT, focusing on MT and PT by non-chiropractic providers. The second study will be focused on patterns of chiropractic care and how costs and TD duration compare between chiropractic care and care provided by non-chiropractic providers. The third study will be on high use of PT services.

Figure TA.A1 Common Treatment Patterns of PT Services, for Workers with Low Back Pain



Notes: The diagram describes how claims are distributed across different treatment patterns for PT services. The percentages show claim frequency of receiving specified services, with all LBP-only claims with more than seven days of lost time as the denominator. For example, 75 percent of the LBP-only claims with more than seven days of lost time received PT services—66 percent had PT by non-chiropractic providers and nearly 9 percent had services by chiropractors. At the bottom of the figure, there are three studies listed—these studies are part of our subsequent research on PT treatment patterns and outcomes after the early PT study (Wang, Mueller, and Lea, 2020).

[a] We identified active~passive patterns by expanding the algorithm developed by Fritz et al. (2007) that characterized guideline consistent patterns based on the ratio of services between active and passive PT. Active PT services include therapeutic exercises, PT-related education and training, and active counseling. We also included work hardening, which is occupational therapy with active components to help workers return to work. Passive PT services include hot/cold packs, electric stimulation, massage, traction, and acupuncture therapy.

Key: MT: manual therapy; PT: physical therapy.

TECHNICAL APPENDIX B

SEVERITY, COMORBIDITIES, AND PATIENT COMPLEXITY

One of the challenges for an observational study that examines the effect of certain interventions on outcomes is the lack of information on severity and comorbidities. This compromises the comparability of the outcomes between the treatment and comparison groups. Treating providers make medical decisions regarding what treatment would be beneficial for the patient, taking into account the medical condition being treated, comorbidities, and other characteristics of the patient that may affect the treatment and outcomes. For example, a worker with low back pain may be referred for other non-MT treatments if the treating provider is concerned about certain underlying conditions.[1] Providers may order MT services to facilitate exercise if the worker is eager to return to an active daily routine and go back to work.[2] Providers may also take into account what medical services were provided previously and how well the worker responded to the treatment. An increasing number of studies have explored the concept and measurement of patient complexity as a way to address the severity issue beyond clinical or medical severity.

We measured severity and comorbidities to the extend we could. We identified comorbidities based on a set of pre-designated ICD-10 codes and checked across multiple ICD-10 fields in the data.[3] We also used pre-PT invasive procedures as a proxy for severity.[4]

For comorbidities, we developed an ICD-10 comorbidity list specific to PT studies after reviewing the comorbidity instruments in the literature.[5] This list was used to identify LBP claims with comorbidities in the early PT study (Wang, Mueller, and Lea, 2020). Table TA.B1 provides the ICD-10 codes we used to create a comorbidity indicator for workers who received PT treatments.

---

[1] This may include diagnostic tests or an imaging study to rule in or rule out a suspected serious condition or treatment for a comorbidity such as hypertension or diabetes.

[2] Treatment choice and outcomes may also be affected by the experience, training, and practice patterns of the medical providers, but we focus on patient factors here.

[3] Although some may reflect a practice pattern that may not be in concordance with evidence-based medicine, it is conceivable that a number of such claims may represent more serious low back pain that was not properly coded in the administrative data.

[4] By doing so, we err on the conservative side in the estimation of the impact of early versus delayed PT. Wang, Mueller, and Lea (2019a) provided the CPT codes we identified for pain management injections and low back surgery.

[5] 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*	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*	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	Tabaco 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).

* 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 categories of comorbidity we identified include alcohol or drug abuse, diabetes, obesity, psychosocial factors, and smoking. We also identified chronic pain conditions and symptoms if any of the chronic conditions were mentioned in the medical services data for the initial three months of treatment after the onset of low back pain. We use the three-month time window to make sure that the chronic pain mentioned was likely due to a pre-existing condition, rather than chronic pain arising late in the treatment. Table TA.B2 shows the frequency of claims that ever had at least one of these comorbid conditions, separately for LBP-only claims and neuro back claims.

Table TA.B2 Identifying Comorbidities Using ICD-10 Codes, All LBP Claims Included for the Study

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*	1.0%	0.3%	0.2%	0.1%
Chronic pain within first 3 months	3.5%	2.0%	1.1%	0.6%
Diabetes*	2.4%	1.1%	1.1%	0.6%
Lifestyle issues (e.g., lack of physical exercise)	0.0%	0.0%	0.0%	0.0%
Obesity	2.6%	1.1%	1.0%	0.3%
Psychosocial issues*	3.1%	1.1%	1.1%	0.5%
Smoking	1.0%	0.5%	0.5%	0.3%
At least one of the above	**11.6%**	**5.6%**	**4.6%**	**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 does not add up to the percentage of claims with comorbidities because the claims with types of comorbidities are not mutually exclusive.

* 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.

Based on these identified comorbidity categories, we created two indicators. One indicates whether a claim had at least one comorbidity and the other indicates whether the claim has two or more comorbid conditions. We used these comorbidity indicators to adjust for different comorbidity mix of claims across different treatment patterns.

One may be concerned about how well we capture comorbidities in workers' compensation data since treatments of comorbidities are not covered under workers' compensation.[6] 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 when the ICD-10 codes are kept for multiple diagnoses on the bill. However, the lack of consistent recording of comorbidities and certain data system issues may result in the understatement of the prevalence of comorbidities. Nonetheless, even if we cannot fully capture comorbidities using the administrative data, we can use the relative level in the indicator between the treatment and comparison groups to adjust for the observed differences.[7] The reader who is interested in more discussion is referred to the early PT report (Wang, Mueller, and Lea, 2020, Technical Appendices B and C), where we provide a more detailed description of what we see in our data and the results of our sensitivity analysis.

In Chapter 2, we discuss the factors we controlled for in our statistical analysis in the framework of Andersen's behavioral model. The framework groups all the covariates and confounding factors into three categories: predisposing factors, need factors, and enabling factors (see Chapter 2). The need factors in

[6] This concern is shared by a number of system practitioners who believe that there is just not enough in the workers' compensation data to reasonably measure comorbidities. Since the treatments of comorbidities are normally not covered by workers' compensation, one does not expect to see that the workers' compensation data maintain ICD-10 codes indicating comorbidities for workers.

[7] The relative differences in the comorbidity indicators can be seen in Chapters 4 and 5. Technical Appendix B of the early PT study by Wang, Mueller, and Lea (2020) has a more detailed discussion about capturing comorbidities in our data.

Andersen's model are broadly defined to include patient's perceived need for medical care, evaluated need by medical providers, and the need that could be determined by how complex the patient's situation is. The concept of patient complexity, established in recent years, refines the need factors that indicate how complex the patient situation is. Several studies measured patient complexity based on patient's past experience, including pre-conditions and utilization patterns of medical services prior to the current episode of care. We were able to construct several variables to control for the type of LBP pain, lost time, pre-PT injections (a proxy for medical severity), comorbidities, and workers' demo-socio-economic characteristics. These, to some extent, may represent the level of patient complexity. However, we do not directly observe pre-conditions and prior medical utilization in the workers' compensation medical data.

It should be noted that we use both Andersen's framework and the patient complexity method as a tool to assess how well we capture the covariates and confounding factors in our statistical analysis that compared early versus late MT and MT versus no MT, which we discuss in a greater detail in Technical Appendix C.

TECHNICAL APPENDIX C

STATISTICAL ANALYSES

In Chapters 4 and 5, we report the results from our statistical analyses to address two separate but related questions regarding MT using the same statistical technique. Instead of reporting coefficient estimates of the treatment variables and other variables included in the regressions, we interpret the results by computing the average predicted values for individual claims across the entire sample to hold constant the factors we controlled for in the regression and only allow the treatment variable to vary. In this technical appendix, we describe the statistical techniques we applied to the analyses and regression results. We also discuss several technical issues and our sensitivity analyses that aimed at addressing these issues.

PROPENSITY SCORE MODELING AND INVERSE PROBABILITY TREATMENT WEIGHTING

Propensity score approaches have been used in observational studies and randomized clinical trials to achieve sample balance or comparability of outcomes between treatment and comparison groups. While some studies (e.g., Walker et al., 2017) use propensity score matching to select similar cases for treatment and comparison groups, other studies (e.g., Weeks et al., 2015 and 2016) construct weights based on the propensity scores and use the weights in the outcome regressions. Walker et al. (2017) used propensity matching to examine a number of outcome variables for acute LBP patients in Germany who were treated in one of the groups with or without SMT treatment.[1] Weeks et al. (2015 and 2016) applied an inverse probability treatment weighting (IPTW) propensity score method to compare across four treatment paths for Medicare patients with chronic LBP and multiple comorbidities. The variables included in the propensity score weighting include age, gender, race, Medicaid/Medicare enrollment, and diagnostic codes for patients with comorbidities. The study also included zip code-linked variables, such as the annual median household income, the population proportion living under the federal poverty level, per-capita supply of chiropractors, and regional carriers that were used by Medicare to process CMT claims in the region where the patient lived.

The most common propensity weighting approach is IPTW. Because this approach involves a regression of treatment choices first and, then, a regression of outcome variable weighted by the IPTW weights, it is often referred to as a two-stage IPTW method, which we used for this study. The idea is to estimate the propensity of individuals being in either the treatment or comparison group, based on the actual treatment variable and factors that may influence the treatment choice. Since the actual treatment group is not random, we would expect to see proportionally more cases in the treatment group having higher propensity scores and fewer cases in the same group having lower propensity scores. The inverse probability weights are created and applied to

[1] The outcome variables include sick leave, use of imagining studies, use of physiotherapy and acupuncture, and total medical costs. The researchers applied the propensity matching technique to adjusting for differences in age, gender, comorbidities, pre-index utilization pattern, and regional data. The study found a marginal difference in the total costs between the SMT and non-SMT groups, but SMT did not impact sick leave, may have been associated with a higher use of imaging studies, and did not replace other services (e.g., physiotherapy and acupuncture).

weigh down the likely treated and weigh up the unlikely treated so that the results for the treatment group would be balanced as if the treatment choice was random. The idea is the same for the comparison group. This method has some resemblance to the method use for stratified sampling of survey data. In all, this is a weighting technique to balance differences in the characteristics of workers, their injuries, and some provider factors between the treatment and comparison groups.

The advantage of this approach is that the results from the outcome regressions are not sensitive to specification issues that may be of a concern in a one-step regression on outcomes. The assumption for this method to yield unbiased results is that the factors controlled in the regressions represent all possible covariates and factors that may impact the results. In the presence of unmeasured confounding factors, which may compromise a study with a limited number of variables, the instrumental variable (IV) approach may provide a viable solution if a valid instrument variable can be constructed.

In the main report, we present the results from our statistical analyses for all LBP claims that received medical treatment, regardless of whether the claim had lost time or not. We also run the same analysis for LBP-only claims with more than seven days of lost time, a smaller subset of LBP claims that are more homogenous. This subset of claims is also more meaningful to check the effect of MT versus no MT since the use of manipulation, an important part of MT, is still controversial in terms of guideline recommendations. We also tested for neuro back claims.

Treatment choice between early and late MT and between MT and no MT are dependent on local access to qualified providers for the services, provider training and practice patterns, regional characteristics of the environment, and characteristics of the worker and severity of the injury. We included variables representing these factors in the first-stage regressions, separately for the propensity of having early MT and receiving MT. Table TA.C1 presents the estimates of the logistic models.

Table TA.C1 Results of First-Stage Logistic Regressions on Treatment Choice

	Likelihood of Having Early MT	Likelihood of Receiving MT
	Estimated Coefficient	**Estimated Coefficient**
Intercept	-4.427 ***	-2.864 ***
Likelihood of having early MT in local area	4.970 ***	-
Likelihood of receiving MT in local area	-	3.745 ***
Severity and comorbidity		
1 if neuro back; 0 if LBP only	-0.320 ***	0.248 ***
1 if incurred > 7 days of lost time; 0 if ≤ 7 days	-0.220 ***	0.198 ***
1 if claim has at least one comorbidity	-0.193 ***	-0.007
1 if claim has multiple comorbidities	-0.164	-0.158 **
1 if received injection before PT	-0.200 ***	0.221 ***
Worker characteristics		
Age (reference = 35–44)		
≤ 24 years old	0.115 **	-0.104 ***
25–34	0.014	-0.044 **
45–54	-0.091 **	-0.006
≥ 55 years old	-0.130 ***	-0.045 **
Missing information on age	0.149	-0.209
1 if male worker (0 = female)	0.051	-0.193 ***
1 if married (0 = single)	0.076 **	0.048 **
Other	-0.017	-0.178 ***
Missing information on marital status	0.126 ***	0.035 *
Average weekly wage in log form	-0.021 ***	0.011 ***
Tenure with preinjury employer (reference = 2–5 years)		
≤ 2 years	0.000	-0.111 ***
5–10 years	0.063	0.011
10–20 years	0.001	-0.043
> 20 years	0.052	0.021
Missing information on tenure	-0.102 **	-0.170 ***
Industry group (reference = clerical and professional)		
Manufacturing	0.020	-0.045
Construction	0.004	-0.087 **
High-risk industry	0.051	-0.071 **
Trade	0.042	-0.001
Low-risk industry	0.048	-0.005
Other industries	0.019	-0.067 *
Missing information on industry	-0.130	-0.703 ***
Claim and case management		
1 if claims involved attorney	-0.409 ***	0.111 ***
Time from injury to initial medical visit	0.001	0.002 ***
Time from initial medical visit to first PT visit	0.002 ***	0.000
1 if claim had no office visits before PT	0.195 ***	-0.019
1 if claim received PT from the same provider as office visit	-0.237 ***	-0.497 ***
1 if PT services were provided by more than one provider	-0.654 ***	0.486 ***
Local environmental factors		
1 if worker resides in a rural area	0.055	0.005
Number of physical therapists per 10,000 population	0.002 *	0.001 **
% of population in worker's county who have college or higher degree	-1.039 ***	-0.227
Median household income in $1,000	0.000 ***	0.000 ***
% of population under the federal poverty line	1.193	0.222
% of population without health insurance	1.384 **	0.326
Local unemployment rate	-0.002	-0.031 ***
% of population who engaged in physical activities	2.688 ***	1.147 ***

continued

Table TA.C1 Results of First-Stage Logistic Regressions on Treatment Choice (continued)

	Likelihood of Having Early MT	Likelihood of Receiving MT
	Estimated Coefficient	Estimated Coefficient
State-specific effect (reference = MD)		
AR	0.007	0.032
CA	-0.330 ***	0.170 ***
CT	0.058	0.137 *
DE	0.148	0.160
FL	-0.133	0.057
GA	-0.162	0.076
IA	0.709 ***	0.324 ***
IL	0.008	0.106 *
IN	0.006	0.175 **
KS	0.171	0.205 **
KY	0.361 **	0.274 ***
LA	-0.035	0.205 **
MA	-0.090	0.022
MI	0.111	0.240 ***
MN	-0.159	0.082
MO	0.328 **	0.142 **
NC	-0.009	0.069
NJ	0.016	-0.115 **
NM	0.276	0.763 ***
NV	-0.283 **	0.536 ***
NY	0.190	0.014
PA	0.270 **	0.175 ***
SC	0.105	0.015
TN	0.254 *	0.158 **
TX	-0.169	0.373 ***
VA	-0.017	0.039
WI	0.192	0.243 ***

Notes: Included are nonsurgical LBP claims with MT services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

*** statistically significant at the 1 percent level, ** statistically significant at the 5 percent level, * statistically significant at the 10 percent level.

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

The results in Table TA.C1 are based on LBP (LBP-only and neuro back) claims that received medical treatment regardless of whether the workers had lost time. We controlled for neuro back and seven-day lost time status. We constructed a variable and used it as a proxy for local access to manual physical therapists; this variable captures individual worker's likelihood of receiving MT or early MT treatment, based on the experience of all other workers in the same hospital referral region but independent of the worker's own experience. It indicates how likely an individual worker is to be referred to and attend MT treatment in the local area. Table TA.C1 suggests that several factors had large and significant effects on the likelihood of having early MT and receiving MT:

- Local access to manual physical therapists had a large and significant effect on the propensity of having early MT (estimated coefficient 4.970, $p < 0.0001$) and the propensity of receiving MT (3.745, $p < 0.0001$). The effect of the supply of physical therapists was small although significant at the 10 percent level—the smaller effect might be due to the inclusion of the local MT access variable. The county-level variable indicating the level of physical activeness had a significant effect on the likelihood of having early MT (estimated coefficient 2.688, $p < 0.0001$) and MT (1.147, $p < 0.0029$).
- Severity and comorbidity indicators also had considerable effects on treatment choice. Workers with neuro back conditions were more likely to receive MT but less likely to have it early. This may suggest that it takes more time to diagnose (including tests) and some providers believe the serious condition indicates for MT. Similar effects are seen for claims with more than seven days of lost time. Having one or more comorbidities reduced the likelihood of receiving MT and receiving it early. Pre-PT injections, a measure we used to approximate for severity, delayed the initiation of MT but increased the likelihood of receiving MT.
- Several provider factors appear to be significant. Claims with same-billing-entity PT providers were less likely to have MT and those who had MT were less likely to have it early. This result may suggest that MT treatments were not widely available in larger health care entities and systems. Claims with late MT (or receiving MT) were more likely to involve multiple PT providers.
- The effect of demo-socio-economic characteristics on the likelihood of receiving MT or early MT appeared to be less significant and small. In general, middle aged, married workers tended to be more likely to have MT and early MT.
- Claims with attorney involvement were more likely to receive MT, but when they received it, MT services were more likely to be initiated late. Attorneys are likely to be involved when there are delays in or disputes regarding care.
- Access to medical care and PT referrals, indicated by the variables on time from injury to initial medical visit and time from initial visit to first PT visit, did not have a significant effect of the likelihood of having MT and having it early. Rural/urban differences also had no effect. The effect of local unemployment rate was significant but the magnitude was small.

In the main report, we describe our findings based on all medical claims that were identified as LBP claims, including LBP-only and neuro back claims. We tested the robustness of the results by running the same analysis on different subsets of claims. The two subsets are (1) all LBP claims, including those with neuro back conditions, with more than seven days of lost time; and (2) LBP-only claims with more than seven days of lost time. The test is most relevant for LBP-only claims because MT is recommended for this set of conditions. For neuro back patients, guidelines do not seem to converge as to whether MT is indicated for patients with

neurological pain. For example, it is still questionable whether manipulation should be recommended for patients with neuro back or herniated disc conditions. Some providers believe that manipulation is beneficial for such patients. We ran the first-stage analysis for treatment choice for these two subsets of LBP claims and found that the results were similar (data not presented in this report).

The second stage of the two-stage analysis is to run regressions of outcomes on the covariates and factors that impact the outcomes, weighted by the IPTW weights. Tables TA.C2 through C5 provide results of our second-stage weighted regression analysis.

Table TA.C2 Estimated Effect of Early Relative to Late MT on Medical Utilization and Costs, All LBP Claims

	Log (medical cost)	Likelihood of Having MRI	Likelihood of Having Opioids	Likelihood of Having Injections
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Intercept	7.578 ***	-2.434 ***	-1.972 ***	-4.062 ***
1 if MT initiated within 2 weeks of PT care; 0 if MT after 2 weeks	-0.314 ***	-0.800 ***	-0.328 ***	-0.505 ***
Severity and comorbidity				
1 if neuro back; 0 if LBP only	0.456 ***	1.637 ***	0.793 ***	1.797 ***
1 if incurred > 7 days of lost time; 0 if ≤ 7 days	0.402 ***	0.844 ***	0.645 ***	0.637 ***
1 if claim has at least one comorbidity	0.363 ***	0.605 ***	0.497 ***	0.920 ***
1 if claim has multiple comorbidities	0.161 ***	-0.035	0.098	0.521 ***
1 if received injection before PT	0.597 ***	0.971 ***	0.634 ***	19.232
Worker characteristics				
Age (reference = 35–44)				
≤ 24 years old	-0.121 ***	-0.248 ***	-0.521 ***	-0.406 ***
25–34	-0.065 ***	-0.113 ***	-0.172 ***	-0.342 ***
45–54	0.037 ***	-0.021	0.000	0.010
≥ 55 years old	0.083 ***	-0.026	-0.066 *	0.002
Missing information on age	-0.106	-0.142	0.086	-0.346
1 if male worker (0 = female)	-0.041 ***	-0.046	-0.103 ***	0.089 **
1 if married (0 = single)	0.010	0.100 ***	-0.050 *	0.066 *
Other	-0.039 ***	0.061 *	-0.105 ***	0.049
Missing information on marital status	-0.038 ***	-0.008	-0.125 ***	-0.011
Average weekly wage in log form	0.026 ***	0.082 ***	0.043 ***	0.136 ***
Tenure with preinjury employer (reference = 2–5 years)				
≤ 2 years	-0.019 **	-0.017	0.119 ***	-0.092 *
5–10 years	-0.001	-0.002	-0.031	0.022
10–20 years	0.016	0.071 *	-0.062	0.051
> 20 years	0.001	0.121 **	-0.001	0.128 *
Missing information on tenure	0.047 ***	0.125 ***	0.143 ***	0.260 ***
Industry group (reference = clerical and professional)				
Manufacturing	-0.008	0.073	0.124 **	0.108
Construction	0.021	0.132 **	0.117 *	0.168 *
High-risk industry	-0.071 ***	-0.150 ***	-0.057	-0.220 ***
Trade	-0.041 ***	-0.043	0.086	-0.023
Low-risk industry	-0.034 **	-0.079	-0.021	-0.018
Other industries	-0.012	-0.060	0.039	0.080
Missing information on industry	0.008	0.135	0.430 **	0.331
Claim and case management				
1 if claims involved attorney	0.602 ***	1.047 ***	0.532 ***	0.748 ***
Time from injury to initial medical visit	0.000	0.007 ***	-0.010 ***	0.005 ***
Time from initial medical visit to first PT visit	0.001	0.004	0.005 *	0.005 **
1 if claim had no office visits before PT	-0.273 ***	-0.369 ***	-0.437 ***	-0.101
1 if claim received PT from the same provider as office visit	-0.088 ***	-0.192 ***	-0.236 ***	-0.045
1 if PT services were provided by more than one provider	0.268 ***	0.399 ***	0.163 ***	0.143 ***
Local environmental factors				
1 if worker resides in a rural area	-0.070 ***	0.036	-0.029	0.025
Number of physical therapists per 10,000 population	0.001 ***	0.002 **	0.002 ***	0.001
% of population in worker's county who have college or higher degree	-0.201 ***	-1.016 ***	-1.141 ***	-1.270 ***
Median household income in $1,000	0.000 ***	0.000 ***	0.000 *	0.000
% of population under the federal poverty line	-0.017	-0.015	-1.608 *	-0.515
% of population without health insurance	1.062 ***	2.173 ***	-2.422 ***	0.113
Local unemployment rate	0.023 ***	0.075 ***	0.059 ***	0.004
% of population who engaged in physical activities	-0.452 ***	-0.098	0.715	-0.053

continued

Table TA.C2 Estimated Effect of Early Relative to Late MT on Medical Utilization and Costs, All LBP Claims (continued)

	Log (medical cost)	Likelihood of Having MRI	Likelihood of Having Opioids	Likelihood of Having Injections
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
State-specific effect (reference = MD)				
AR	-0.059	0.620 ***	0.890 ***	0.459 *
CA	-0.042 *	-0.163 *	0.113	-0.014
CT	0.038	-0.275 ***	-0.618 ***	0.579 ***
DE	0.265 ***	0.146	-0.595 ***	0.356
FL	0.107 ***	1.042 ***	0.417 ***	0.496 ***
GA	0.200 ***	0.599 ***	0.754 ***	0.978 ***
IA	0.426 ***	0.090	0.217	0.288
IL	0.298 ***	0.026	-0.220 **	0.313 **
IN	0.613 ***	0.350 ***	0.053	0.876 ***
KS	0.066	0.407 ***	0.398 ***	0.781 ***
KY	0.229 ***	0.637 ***	-0.581 ***	-0.067
LA	0.552 ***	0.272 *	0.963 ***	1.250 ***
MA	-0.400 ***	-0.435 ***	-1.084 ***	0.053
MI	0.080 ***	0.039	-0.177	0.088
MN	0.132 ***	0.127	-0.338 ***	0.158
MO	0.314 ***	-0.115	-0.100	0.581 ***
NC	0.163 ***	0.439 ***	0.603 ***	0.632 ***
NJ	0.195 ***	0.129	-0.876 ***	0.317 **
NM	0.274 ***	0.091	0.209	0.922 ***
NV	0.111 ***	0.180	0.338 ***	0.846 ***
NY	-0.481 ***	0.265 ***	-0.922 ***	0.082
PA	0.276 ***	0.340 ***	-0.465 ***	0.345 **
SC	0.121 ***	0.693 ***	0.519 ***	0.963 ***
TN	-0.026	0.546 ***	0.418 ***	0.441 ***
TX	-0.025	-0.328 ***	0.978 ***	-0.346 **
VA	0.512 ***	0.130	0.534 ***	0.695 ***
WI	0.756 ***	-0.111	-0.255 **	0.038

Notes: Included are nonsurgical LBP claims with MT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

*** statistically significant at the 1 percent level, ** statistically significant at the 5 percent level, * statistically significant at the 10 percent level.

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

Table TA.C3 Estimated Effect of Early Relative to Late MT on Indemnity Payments and TD Duration, All LBP Claims

	Likelihood of Receiving Indemnity Payments	Log (indemnity payments) Claims with Indemnity Payments	Likelihood of Having Lost Time	Log (TD weeks) Claims with Lost Time
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Intercept	-6.616 ***	6.421 ***	-7.045 ***	1.241 ***
1 if MT initiated within 2 weeks of PT care; 0 if MT after 2 weeks	-0.250 ***	-0.331 ***	-0.054	-0.241 ***
Severity and comorbidity				
1 if neuro back; 0 if LBP only	0.497 ***	0.647 ***	0.139 ***	0.440 ***
1 if incurred > 7 days of lost time; 0 if ≤ 7 days	7.366 ***	1.278 ***	6.627 ***	1.005 ***
1 if claim has at least one comorbidity	0.462 ***	0.406 ***	0.451 ***	0.305 ***
1 if claim has multiple comorbidities	0.463 **	0.038	0.308	0.156 ***
1 if received injection before PT	0.633 ***	0.437 ***	0.443 ***	0.324 ***
Worker characteristics				
Age (reference = 35–44)				
≤ 24 years old	-0.235 **	-0.383 ***	-0.105	-0.138 ***
25–34	-0.058	-0.162 ***	0.058	-0.076 ***
45–54	-0.085	0.034	-0.072	0.013
≥ 55 years old	0.033	0.059 **	0.049	0.040 **
Missing information on age	-0.620	-0.019	0.234	-0.124
1 if male worker (0 = female)	-0.026	0.258 ***	-0.052	0.030 *
1 if married (0 = single)	0.109 *	-0.019	0.257 ***	-0.024 *
Other	0.116	0.003	0.047	0.001
Missing information on marital status	-0.382 ***	-0.050 *	-0.258 ***	-0.047 ***
Average weekly wage in log form	0.389 ***	0.160 ***	0.403 ***	-0.010 *
Tenure with preinjury employer (reference = 2–5 years)				
≤ 2 years	0.166 **	-0.044 *	0.148 **	0.040 **
5–10 years	-0.118	0.054	-0.141 *	-0.019
10–20 years	-0.231 **	0.138 ***	-0.187 **	-0.014
> 20 years	-0.124	0.225 ***	-0.334 ***	0.027
Missing information on tenure	0.093	0.106 ***	-0.305 ***	0.053 **
Industry group (reference = clerical and professional)				
Manufacturing	0.243 **	-0.048	0.146	-0.043
Construction	0.144	0.321 ***	0.206	0.146 ***
High-risk industry	0.327 ***	-0.024	0.474 ***	-0.004
Trade	0.302 ***	-0.081 *	0.470 ***	0.015
Low-risk industry	0.378 ***	0.039	0.443 ***	0.020
Other industries	0.638 ***	0.143 ***	0.859 ***	0.083 **
Missing information on industry	0.019	0.201	1.131 **	0.162
Claim and case management				
1 if claims involved attorney	1.553 ***	1.247 ***	-1.535 ***	0.564 ***
Time from injury to initial medical visit	0.000	0.005 ***	-0.008 ***	0.004 ***
Time from initial medical visit to first PT visit	0.000	0.002 *	0.002	0.001 **
1 if claim had no office visits before PT	-0.150	-0.051	-0.143	-0.069 **
1 if claim received PT from the same provider as office visit	-0.088	-0.170 ***	-0.091 *	-0.087 ***
1 if PT services were provided by more than one provider	0.179 **	0.273 ***	0.124 *	0.162 ***
Local environmental factors				
1 if worker resides in a rural area	0.100	-0.011	0.274 **	0.034
Number of physical therapists per 10,000 population	-0.001	0.001	-0.004 **	0.001
% of population in worker's county who have college or higher degree	-1.459 **	-0.330	-1.375 **	-0.285 *
Median household income in $1,000	0.000	0.000	0.000	0.000
% of population under the federal poverty line	-1.115	-0.341	2.069	-0.616
% of population without health insurance	1.734	-0.664	-0.356	-0.422
Local unemployment rate	0.012	0.008	-0.001	0.023 ***
% of population who engaged in physical activities	3.547 ***	-1.199 **	2.443 **	-0.315

continued

Table TA.C3 Estimated Effect of Early Relative to Late MT on Indemnity Payments and TD Duration, All LBP Claims (continued)

	Likelihood of Receiving Indemnity Payments	Log (indemnity payments) Claims with Indemnity Payments	Likelihood of Having Lost Time	Log (TD weeks) Claims with Lost Time
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
State-specific effect (reference = MD)				
AR	-1.342 **	-0.303 *	-0.507	0.104
CA	-0.279	0.117 *	-0.210	0.206 ***
CT	0.894 ***	-0.002	1.521 ***	0.026
DE	-0.523	-0.145	0.391	0.009
FL	-1.496 ***	-0.203 ***	-2.021 ***	0.091 *
GA	-1.054 ***	0.530 ***	-1.666 ***	0.462 ***
IA	-0.517 **	-0.195 *	-0.362	-0.144 **
IL	-0.779 ***	-0.058	-0.319 *	0.049
IN	-1.838 ***	-0.140	-1.546 ***	0.112 *
KS	-1.312 ***	-0.018	-1.351 ***	0.145 *
KY	-1.127 ***	0.133	-0.563 *	0.307 ***
LA	-1.011 ***	0.570 ***	-0.064	0.760 ***
MA	0.095	-0.113	0.805 ***	0.235 ***
MI	-1.808 ***	-0.290 ***	-0.655 ***	0.066
MN	-0.286	-0.326 ***	0.185	-0.161 ***
MO	-1.544 ***	-0.269 ***	-1.783 ***	-0.264 ***
NC	-0.999 ***	0.507 ***	-1.522 ***	0.519 ***
NJ	-1.076 ***	-0.107	-0.475 **	-0.113 **
NM	-1.175 ***	0.063	-1.551 ***	0.324 ***
NV	-0.848 ***	0.083	-0.056	-0.058
NY	-1.771 ***	-0.183 **	-0.365 *	0.107 **
PA	-1.347 ***	0.124	-1.012 ***	0.117 **
SC	-0.818 ***	0.650 ***	-1.656 ***	0.488 ***
TN	-1.669 ***	-0.114	-1.458 ***	0.070
TX	-2.157 ***	-0.184 **	-1.472 ***	0.057
VA	-1.969 ***	-0.052	-0.857 ***	0.179 ***
WI	0.025	-0.456 ***	0.986 ***	-0.207 ***

Notes: Included are nonsurgical LBP claims with MT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

*** statistically significant at the 1 percent level, ** statistically significant at the 5 percent level, * statistically significant at the 10 percent level.

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

Table TA.C4 Estimated Effect of MT Relative to No MT on Medical Utilization and Costs, All LBP Claims

	Log (medical cost)	Likelihood of Having MRI	Likelihood of Having Opioids	Likelihood of Having Injections
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Intercept	6.975 ***	-2.870 ***	-2.198 ***	-5.380 ***
1 if had MT; 0 if had PT but did not have MT	0.302 ***	0.307 ***	0.114 ***	0.198 ***
Severity and comorbidity				
1 if neuro back; 0 if LBP only	0.487 ***	1.703 ***	0.812 ***	1.896 ***
1 if incurred > 7 days of lost time; 0 if ≤ 7 days	0.447 ***	0.897 ***	0.692 ***	0.722 ***
1 if claim has at least one comorbidity	0.385 ***	0.619 ***	0.519 ***	0.939 ***
1 if claim has multiple comorbidities	0.171 ***	0.011	0.096	0.416 ***
1 if received injection before PT	0.660 ***	0.995 ***	0.613 ***	19.647
Worker characteristics				
Age (reference = 35–44)				
≤ 24 years old	-0.121 ***	-0.288 ***	-0.498 ***	-0.484 ***
25–34	-0.059 ***	-0.138 ***	-0.163 ***	-0.350 ***
45–54	0.048 ***	0.003	0.043	0.015
≥ 55 years old	0.087 ***	0.014	-0.035	-0.005
Missing information on age	-0.130 ***	-0.167	-0.089	-0.644
1 if male worker (0 = female)	-0.052 ***	-0.045 *	-0.115 ***	0.004
1 if married (0 = single)	0.010	0.031	-0.071 ***	0.061 *
Other	-0.051 ***	0.027	-0.119 ***	-0.004
Missing information on marital status	-0.039 ***	-0.078 ***	-0.100 ***	-0.071 *
Average weekly wage in log form	0.023 ***	0.081 ***	0.042 ***	0.135 ***
Tenure with preinjury employer (reference = 2–5 years)				
≤ 2 years	-0.033 ***	-0.024	0.128 ***	-0.128 ***
5–10 years	-0.012	-0.021	-0.045	0.022
10–20 years	-0.006	0.001	-0.069 *	0.031
> 20 years	-0.028 **	0.029	-0.049	0.027
Missing information on tenure	0.016 *	0.095 ***	0.141 ***	0.227 ***
Industry group (reference = clerical and professional)				
Manufacturing	0.009	0.073 *	0.096 **	0.120 *
Construction	0.011	0.070	0.071	0.081
High-risk industry	-0.055 ***	-0.154 ***	-0.066	-0.168 ***
Trade	-0.029 **	-0.067 *	0.104 **	-0.015
Low-risk industry	-0.033 ***	-0.088 **	-0.048	0.039
Other industries	0.003	-0.021	0.046	0.138 *
Missing information on industry	-0.067	-0.099	0.324 *	0.144
Claim and case management				
1 if claims involved attorney	0.628 ***	1.086 ***	0.561 ***	0.802 ***
Time from injury to initial medical visit	0.000	0.006 ***	-0.010 ***	0.006 ***
Time from initial medical visit to first PT visit	0.000	0.002 **	0.023 ***	0.003
1 if claim had no office visits before PT	-0.353 ***	-0.366 ***	-0.383 ***	-0.090
1 if claim received PT from the same provider as office visit	-0.123 ***	-0.229 ***	-0.257 ***	-0.047
1 if PT services were provided by more than one provider	0.300 ***	0.455 ***	0.222 ***	0.091 **
Local environmental factors				
1 if worker resides in a rural area	-0.057 ***	0.042	0.000	0.027
Number of physical therapists per 10,000 population	0.001 ***	0.002 **	0.002 ***	0.001
% of population in worker's county who have college or higher degree	-0.194 ***	-1.247 ***	-1.358 ***	-1.124 ***
Median household income in $1,000	0.000 ***	0.000 ***	0.000 **	0.000
% of population under the federal poverty line	-0.069	0.409	-1.194	0.319
% of population without health insurance	1.100 ***	1.859 ***	-2.797 ***	-0.099
Local unemployment rate	0.025 ***	0.064 ***	0.053 ***	0.027 *
% of population who engaged in physical activities	-0.438 ***	-0.673	0.566	0.631

continued

Table TA.C4 Estimated Effect of MT Relative to No MT on Medical Utilization and Costs, All LBP Claims (continued)

	Log (medical cost)	Likelihood of Having MRI	Likelihood of Having Opioids	Likelihood of Having Injections
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
State-specific effect (reference = MD)				
AR	0.006	0.543 ***	0.810 ***	0.413 **
CA	0.044 **	-0.038	0.141 *	-0.081
CT	0.080 ***	-0.290 ***	-0.557 ***	0.421 ***
DE	0.241 ***	0.302 *	-0.336 *	0.482 **
FL	0.146 ***	1.087 ***	0.503 ***	0.538 ***
GA	0.232 ***	0.536 ***	0.727 ***	0.920 ***
IA	0.402 ***	-0.114	0.216 *	0.181
IL	0.275 ***	-0.019	-0.223 ***	0.271 **
IN	0.556 ***	0.238 **	0.110	0.799 ***
KS	0.081 ***	0.349 ***	0.424 ***	0.612 ***
KY	0.236 ***	0.519 ***	-0.547 ***	0.088
LA	0.494 ***	0.281 **	0.940 ***	1.098 ***
MA	-0.342 ***	-0.404 ***	-1.146 ***	0.011
MI	0.081 ***	-0.047	-0.205 **	0.010
MN	0.190 ***	0.095	-0.348 ***	-0.012
MO	0.345 ***	-0.142	-0.080	0.459 ***
NC	0.159 ***	0.414 ***	0.670 ***	0.594 ***
NJ	0.184 ***	0.146 **	-0.772 ***	0.332 ***
NM	0.296 ***	0.145	0.408 ***	0.677 ***
NV	0.122 ***	0.162	0.465 ***	0.652 ***
NY	-0.405 ***	0.302 ***	-0.928 ***	0.127
PA	0.277 ***	0.287 ***	-0.366 ***	0.270 **
SC	0.124 ***	0.661 ***	0.602 ***	0.834 ***
TN	0.030	0.449 ***	0.479 ***	0.394 ***
TX	0.037 *	-0.310 ***	1.022 ***	-0.316 **
VA	0.531 ***	0.179 **	0.514 ***	0.527 ***
WI	0.752 ***	-0.239 **	-0.225 **	0.003

Notes: Included are nonsurgical LBP claims with MT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

*** statistically significant at the 1 percent level, ** statistically significant at the 5 percent level, * statistically significant at the 10 percent level.

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

Table TA.C5 Estimated Effect of MT Relative to No MT on Indemnity Payments and TD Duration, All LBP Claims

	Likelihood of Receiving Indemnity Payments	Log (indemnity payments) Claims with Indemnity Payments	Likelihood of Having Lost Time	Log (TD weeks) Claims with Lost Time
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Intercept	-6.192 ***	6.115 ***	-6.358 ***	0.921 ***
1 if had MT; 0 if had PT but did not have MT	0.007	0.142 ***	-0.007	0.076 ***
Severity and comorbidity				
1 if neuro back; 0 if LBP only	0.515 ***	0.694 ***	0.160 ***	0.458 ***
1 if incurred > 7 days of lost time; 0 if ≤ 7 days	7.459 ***	1.211 ***	6.785 ***	0.953 ***
1 if claim has at least one comorbidity	0.333 ***	0.397 ***	0.290 ***	0.294 ***
1 if claim has multiple comorbidities	0.410 **	0.033	0.531 ***	0.100 ***
1 if received injection before PT	0.675 ***	0.491 ***	0.369 ***	0.337 ***
Worker characteristics				
Age (reference = 35–44)				
≤ 24 years old	-0.303 ***	-0.340 ***	-0.089	-0.115 ***
25–34	-0.081	-0.118 ***	0.008	-0.052 ***
45–54	-0.096 *	0.069 ***	-0.080	0.034 **
≥ 55 years old	0.065	0.083 ***	0.104 *	0.057 ***
Missing information on age	-0.099	-0.154	0.187	-0.060
1 if male worker (0 = female)	-0.027	0.242 ***	-0.082	0.018
1 if married (0 = single)	0.049	0.016	0.196 ***	-0.012
Other	0.038	0.007	-0.092 *	-0.002
Missing information on marital status	-0.404 ***	-0.053 **	-0.314 ***	-0.060 ***
Average weekly wage in log form	0.385 ***	0.141 ***	0.415 ***	-0.008
Tenure with preinjury employer (reference = 2–5 years)				
≤ 2 years	0.141 **	-0.066 ***	0.137 **	0.031 **
5–10 years	-0.102	0.016	-0.182 **	-0.016
10–20 years	-0.154 **	0.083 ***	-0.197 ***	-0.037 **
> 20 years	-0.197 **	0.151 ***	-0.336 ***	-0.025
Missing information on tenure	0.118	0.064 **	-0.260 ***	0.015
Industry group (reference = clerical and professional)				
Manufacturing	0.274 ***	-0.046	0.265 ***	-0.029
Construction	0.022	0.309 ***	0.290 ***	0.112 ***
High-risk industry	0.304 ***	-0.049	0.534 ***	-0.014
Trade	0.298 ***	-0.080 **	0.514 ***	0.013
Low-risk industry	0.320 ***	0.050	0.498 ***	0.038
Other industries	0.543 ***	0.094 **	0.889 ***	0.057 **
Missing information on industry	0.383	0.120	1.157 ***	0.106
Claim and case management				
1 if claims involved attorney	1.510 ***	1.287 ***	-1.614 ***	0.576 ***
Time from injury to initial medical visit	0.002	0.007 ***	-0.007 ***	0.005 ***
Time from initial medical visit to first PT visit	0.001	0.003 *	0.004	0.003 **
1 if claim had no office visits before PT	-0.057	-0.035	-0.189 **	-0.067 ***
1 if claim received PT from the same provider as office visit	-0.107 **	-0.157 ***	-0.113 ***	-0.086 ***
1 if PT services were provided by more than one provider	0.154 **	0.281 ***	-0.016	0.138 ***
Local environmental factors				
1 if worker resides in a rural area	0.104	-0.026	0.299 ***	0.032
Number of physical therapists per 10,000 population	-0.002	0.000	-0.003 ***	0.001 **
% of population in worker's county who have college or higher degree	-1.047 **	-0.295	-0.881 **	-0.335 ***
Median household income in $1,000	0.000	0.000 *	0.000	0.000
% of population under the federal poverty line	0.220	-0.529	1.943	0.016
% of population without health insurance	1.842 *	0.149	-0.767	0.018
Local unemployment rate	0.014	0.016 **	0.011	0.020 ***
% of population who engaged in physical activities	2.509 **	-1.400 ***	1.238	-0.402

continued

Table TA.C5 Estimated Effect of MT Relative to No MT on Indemnity Payments and TD Duration, All LBP Claims (continued)

	Likelihood of Receiving Indemnity Payments	Log (indemnity payments) Claims with Indemnity Payments	Likelihood of Having Lost Time	Log (TD weeks) Claims with Lost Time
	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
State-specific effect (reference = MD)				
AR	-1.850 ***	-0.239 **	-1.207 ***	0.066
CA	-0.240 *	0.138 **	-0.076	0.227 ***
CT	1.027 ***	-0.058	1.684 ***	0.020
DE	-0.577 *	-0.067	0.583 *	0.093
FL	-1.580 ***	-0.226 ***	-2.079 ***	0.087 **
GA	-1.258 ***	0.475 ***	-1.775 ***	0.426 ***
IA	-0.214	-0.184 *	0.133	-0.107 *
IL	-0.759 ***	-0.081	-0.254 *	0.056
IN	-2.072 ***	-0.108	-1.536 ***	0.136 **
KS	-1.725 ***	-0.278 ***	-1.578 ***	0.042
KY	-1.273 ***	0.243 ***	-0.693 ***	0.393 ***
LA	-0.787 ***	0.486 ***	0.035	0.686 ***
MA	0.053	-0.097	0.688 ***	0.246 ***
MI	-1.915 ***	-0.272 ***	-0.742 ***	0.073
MN	-0.170	-0.305 ***	0.259	-0.111 **
MO	-1.330 ***	-0.283 ***	-1.530 ***	-0.272 ***
NC	-1.163 ***	0.451 ***	-1.633 ***	0.473 ***
NJ	-1.114 ***	-0.130 **	-0.397 ***	-0.124 ***
NM	-1.426 ***	-0.004	-1.708 ***	0.351 ***
NV	-0.776 ***	0.045	0.064	-0.101 *
NY	-1.845 ***	-0.162 ***	-0.392 **	0.126 ***
PA	-1.372 ***	0.163 **	-1.028 ***	0.144 ***
SC	-0.848 ***	0.558 ***	-1.754 ***	0.437 ***
TN	-1.840 ***	-0.184 **	-1.416 ***	0.049
TX	-2.205 ***	-0.279 ***	-1.324 ***	0.037
VA	-1.875 ***	-0.042	-0.822 ***	0.168 ***
WI	0.191	-0.414 ***	1.074 ***	-0.185 ***

Notes: Included are nonsurgical LBP claims with MT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

*** statistically significant at the 1 percent level, ** statistically significant at the 5 percent level, * statistically significant at the 10 percent level.

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

For the binary dependent variables on the likelihood of receiving MRI, opioids, and injections, we used logistic regressions, and for continuous variables, we used the log form of medical costs in linear regressions. For all LBP claims regardless of whether a claim has lost time, we ran (1) two-part regressions to estimate the likelihood of receiving indemnity payments based on all LBP claims and (2) linear regressions with the log form of the dependent variable for LBP claims with indemnity payments. The estimated average indemnity payments and TD duration per claim reported in the main report were computed using the predicted likelihood of receiving payment and estimated the amount received holding other variables constant throughout the whole sample, separately for the binary values of the treatment variable (i.e., early versus late MT and MT versus no MT).

For the second-stage analysis, we ran the same set of regressions on the two subsets of LBP claims: (1) all LBP claims, including neuro back claims, that had more than seven days of lost time; and (2) LBP-only claims with more than seven days of lost time.

Table TA.C6a summarizes the estimated effect of early MT and MT on medical costs and the likelihood of receiving MRI, opioids, and spinal injections, separately for all LBP claims, LBP claims with more than seven days of lost time, and LBP-only claims with more than seven days of lost time. Table TA.C6b shows the effect for indemnity payments and TD duration.

Table TA.C6a Estimated Effect of MT and Early MT on Utilization and Costs of Medical Services, All LBP Claims and Subsets

	Log (medical cost)	Likelihood of Having MRI	Likelihood of Having Opioids	Likelihood of Having Injections
Estimated effect of early MT (within 2 weeks of PT care) relative to late MT				
All LBP claims, regardless of lost time	-0.314 ***	-0.800 ***	-0.328 ***	-0.505 ***
LBP claims with > 7 days of lost time	-0.257 ***	-0.614 ***	-0.260 ***	-0.317 ***
LBP-only claims with > 7 days of lost time	-0.318 ***	-0.785 ***	-0.351 ***	-0.532 ***
Estimated effect of MT relative to no MT				
All LBP claims, regardless of lost time	0.302 ***	0.307 ***	0.114 ***	0.198 ***
LBP claims with > 7 days of lost time	0.205 ***	0.213 ***	0.066 **	0.094 **
LBP-only claims with > 7 days of lost time	0.236 ***	0.240 ***	0.041	0.196 ***

Notes: Included are nonsurgical LBP claims with MT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

** statistically significant at the 5 percent level; *** statistically significant at the 1 percent level.

Key: LBP: low back pain; MRI: magnetic resonance imaging; MT: manual therapy.

Table TA.C6b Estimated Effect of MT and Early MT on Indemnity Payments and TD Duration, All LBP Claims and Subsets

	Likelihood of Receiving Indemnity Payments		Log (indemnity payments)		Likelihood of Having TD	Log (TD weeks)	
Estimated effect of early MT (within 2 weeks of PT care) relative to late MT							
All LBP claims, regardless of lost time	-0.250	***	-0.331	***	-0.054	-0.241	***
LBP claims with > 7 days of lost time			-0.320	***		-0.233	***
LBP-only claims with > 7 days of lost time			-0.407	***		-0.279	***
Estimated effect of MT relative to no MT							
All LBP claims, regardless of lost time	0.007		0.142	***	-0.007	0.076	***
LBP claims with > 7 days of lost time			0.167	***		0.082	***
LBP-only claims with > 7 days of lost time			0.218	***		0.101	***

Notes: Included are nonsurgical LBP claims with MT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

** statistically significant at the 5 percent level; *** statistically significant at the 1 percent level.

Key: LBP: low back pain; MT: manual therapy; TD: temporary disability.

There may be a concern about how well the first stage predicts the propensity of receiving treatment and how effective the IPTW weights are at balancing the mix of cases between the treatment and comparison groups. Tables TA.C7 and TA.C8 provide a comparison of aggregated characteristics of the treatment and comparison groups, before and after the weighting.

Table TA.C7 Aggregate Characteristics of Early and Late MT Groups before and after the IPTW Weighting

	Early Initiation of MT Treatment			After IPTW Weighting		
	Early MT	Late MT	% or % Point Difference	Early MT	Late MT	% or % Point Difference
Intercept						
Likelihood of having early MT in local area	84.7%	82.7%	2.0	84.3%	84.3%	0.0
Severity and comorbidity						
1 if claim has at least one comorbidity	5%	7%	-1.8	5%	5%	-0.1
1 if claim has multiple comorbidities	1%	2%	-1.0	1%	1%	-0.1
1 if received injection before PT	2%	3%	-0.5	2%	2%	0.1
Worker characteristics						
Age (reference = 35–44)						
≤ 24 years old	9%	9%	0.2	9%	8%	0.3
25–34	25%	23%	1.6	25%	25%	-0.2
45–54	24%	24%	0.4	25%	24%	0.1
≥ 55 years old	18%	20%	-2.2	18%	18%	0.1
Missing information on age	0%	0%	-0.1	0%	0%	0.0
1 if male worker (0 = female)	58%	55%	3.2	59%	59%	-0.6
1 if married (0 = single)	29%	26%	3.6	30%	31%	-1.0
Other	16%	18%	-2.2	17%	17%	0.0
Missing information on marital status	19%	19%	-0.4	17%	16%	0.2
Average weekly wage in log form	6.3	6.3	0.8%	6.3	6.3	0.0%
Tenure with preinjury employer (reference = 2–5 years)						
≤ 2 years	40%	41%	-0.9	42%	43%	-0.5
5–10 years	11%	11%	0.2	11%	12%	-0.3
10–20 years	11%	10%	0.6	11%	11%	0.2
> 20 years	6%	6%	0.4	6%	6%	0.4
Missing information on tenure	16%	17%	-1.3	13%	12%	0.5
Industry group (reference = clerical and professional)						
Manufacturing	11%	11%	0.0	11%	11%	0.2
Construction	6%	7%	-1.1	6%	6%	-0.2
High-risk industry	32%	31%	0.2	31%	31%	-0.3
Trade	22%	20%	1.6	22%	22%	0.2
Low-risk industry	15%	14%	1.0	15%	15%	-0.1
Other industries	9%	10%	-0.5	9%	9%	0.2
Missing information on industry	1%	1%	-0.3	0%	0%	0.0
Claim and case management						
1 if claims involved attorney	16%	23%	-7.0	17%	17%	0.0
Time from injury to initial medical visit	5.8	5.5	5.4%	5.6	5.9	-4.0%
Time from initial medical care to first PT	18.1	16.7	8.4%	17.9	19.4	-7.6%
1 if claim had no office visits before PT	5.4%	4.0%	1.4	5.2%	5.6%	-0.4
1 if claim received PT from the same provider as office visit	29.8%	37.6%	-7.8	27.2%	26.8%	0.4
1 if PT services were provided by more than one provider	12.1%	21.6%	-9.5	13.4%	13.5%	0.0
Local environmental factors						
1 if worker resides in a rural area	3.7%	3.5%	0.3	3.7%	3.9%	-0.2
Number of physical therapists per 10,000 population	59.3	53.7	10.5%	58.2	58.2	0.0%
% of population in worker's county who have college or higher degree	32.0%	30.7%	1.3	31.8%	31.9%	-0.1
Median household income in $1,000	$60,536	$58,467	3.5%	$60,146	$60,353	-0.3%
% of population under the federal poverty line	6.6%	6.9%	-0.3	6.6%	6.6%	0.0
% of population without health insurance	10.0%	10.6%	-0.6	10.2%	10.2%	0.0
Local unemployment rate	5.0	5.2	-4.5%	5.0	5.0	0.5%
% of population who engaged in physical activities	77%	76%	0.3	77%	77%	0.0

continued

Table TA.C7 Aggregate Characteristics of Early and Late MT Groups before and after the IPTW Weighting (continued)

	Early Initiation of MT Treatment			After IPTW Weighting		
	Early MT	Late MT	% or % Point Difference	Early MT	Late MT	% or % Point Difference
State-specific effect (reference = MD)						
AR	0%	0%	0.0	0%	0%	-0.1
CA	20%	28%	-7.9	21%	21%	0.2
CT	4%	3%	1.2	4%	4%	0.0
DE	0%	0%	0.4	0%	0%	0.4
FL	7%	12%	-4.5	8%	9%	-0.1
GA	4%	4%	-0.7	4%	3%	0.2
IA	1%	0%	0.7	1%	1%	0.1
IL	6%	6%	0.3	6%	6%	0.2
IN	2%	2%	-0.1	2%	1%	0.1
KS	1%	1%	0.2	1%	1%	-0.2
KY	1%	1%	0.3	1%	1%	-0.1
LA	1%	1%	0.1	1%	1%	0.1
MA	4%	3%	0.6	4%	4%	-0.2
MI	3%	2%	1.2	2%	2%	0.1
MN	2%	2%	0.2	2%	2%	-0.1
MO	2%	1%	0.6	2%	2%	0.2
NC	3%	3%	-0.2	3%	3%	0.0
NJ	5%	5%	0.9	6%	6%	-0.1
NM	1%	1%	0.2	1%	1%	0.0
NV	2%	2%	-0.7	2%	2%	0.1
NY	6%	4%	2.0	4%	5%	-0.3
PA	4%	2%	2.1	4%	4%	0.0
SC	1%	1%	0.0	1%	2%	-0.2
TN	2%	2%	0.5	2%	2%	-0.2
TX	11%	9%	1.6	11%	11%	-0.6
VA	2%	2%	0.3	2%	2%	-0.1
WI	2%	1%	0.6	2%	2%	0.2

Notes: Included are nonsurgical LBP claims with MT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

Key: IPTW: inverse probability treatment weighting; LBP: low back pain; MT: manual therapy.

Table TA.C8 Aggregate Charateristics of MT and No-MT Groups before and after the IPTW Weighting

	Early Initiation of MT Treatment			After IPTW Weighting		
	MT	No MT	% or % Point Difference	MT	No MT	% or % Point Difference
Intercept						
Likelihood of receiving MT in local area	66.5%	61.8%	4.7	64.8%	64.8%	0.0
Severity and comorbidity						
1 if claim has at least one comorbidity	5%	5%	-0.3	5%	5%	0.0
1 if claim has multiple comorbidities	1%	1%	-0.3	1%	1%	0.0
1 if received injection before PT	2%	2%	0.6	2%	2%	0.0
Worker characteristics						
Age (reference = 35–44)						
≤ 24 years old	9%	10%	-0.7	9%	9%	0.0
25–34	25%	26%	-1.5	25%	25%	0.0
45–54	24%	22%	2.0	24%	24%	0.0
≥ 55 years old	18%	18%	-0.1	18%	18%	-0.1
Missing information on age	0%	0%	0.0	0%	0%	0.0
1 if male worker (0 = female)	58%	62%	-3.7	60%	61%	-0.1
1 if married (0 = single)	29%	27%	2.2	29%	29%	-0.3
Other	16%	20%	-3.6	18%	18%	0.1
Missing information on marital status	19%	18%	0.2	16%	16%	0.2
Average weekly wage in log form	6.3	6.2	1.2%	6.3	6.3	0.1%
Tenure with preinjury employer (reference = 2–5 years)						
≤ 2 years	41%	43%	-2.6	43%	43%	0.0
5–10 years	11%	10%	1.0	11%	11%	-0.1
10–20 years	11%	9%	1.4	11%	11%	0.0
> 20 years	6%	5%	1.0	6%	6%	0.0
Missing information on tenure	16%	18%	-2.3	13%	13%	0.1
Industry group (reference = clerical and professional)						
Manufacturing	10%	11%	-0.7	11%	11%	-0.1
Construction	6%	8%	-1.4	6%	6%	0.1
High-risk industry	32%	32%	0.0	31%	31%	0.0
Trade	21%	20%	1.6	22%	22%	-0.1
Low-risk industry	15%	15%	0.7	15%	15%	0.0
Other industries	9%	9%	0.2	9%	9%	0.1
Missing information on industry	1%	1%	-0.5	0%	0%	0.0
Claim and case management						
1 if claims involved attorney	17%	17%	0.2	17%	17%	0.1
Time from injury to initial medical visit	5.7	5.9	-4.2%	5.7	5.7	-1.1%
Time from initial medical care to first PT	17.7	18.5	-4.4%	17.9	18.1	-1.0%
1 if claim had no office visits before PT	5.2%	4.3%	0.9	4.9%	4.9%	0.0
1 if claim received PT from the same provider as office visit	30.8%	38.7%	-7.9	29.8%	29.6%	0.2
1 if PT services were provided by more than one provider	13.6%	10.7%	2.9	12.4%	12.2%	0.2
Local environmental factors						
1 if worker resides in a rural area	3.7%	4.1%	-0.3	3.9%	4.0%	-0.1
Number of physical therapists per 10,000 population	58.628	54.030	8.5%	56.776	56.766	0.0%
% of population in worker's county who have college or higher degree	31.8%	30.1%	1.8	31.2%	31.2%	0.0
Median household income in $1,000	$60,322	$57,327	5.2%	$59,236	$59,185	0.1%
% of population under the federal poverty line	6.6%	7.0%	-0.4	6.7%	6.7%	0.0
% of population without health insurance	10.1%	11.1%	-1.0	10.5%	10.6%	0.0
Local unemployment rate	5.0	5.2	-3.7%	5.1	5.1	0.0%
% of population who engaged in physical activities	77%	76%	0.9	76%	76%	0.0

continued

Table TA.C8 Aggregate Charateristics of MT and No-MT Groups before and after the IPTW Weighting (continued)

	Early Initiation of MT Treatment			After IPTW Weighting		
	MT	No MT	% or % Point Difference	MT	No MT	% or % Point Difference
State-specific effect (reference = MD)						
AR	0%	1%	-0.5	0%	0%	0.0
CA	21%	17%	4.3	19%	19%	0.2
CT	4%	2%	1.8	3%	3%	-0.2
DE	0%	0%	0.2	0%	0%	0.0
FL	8%	11%	-2.9	9%	9%	0.0
GA	4%	5%	-0.9	4%	4%	0.0
IA	1%	1%	0.3	1%	1%	0.0
IL	6%	5%	1.4	6%	6%	-0.1
IN	2%	1%	0.2	1%	1%	0.0
KS	1%	1%	0.1	1%	1%	0.0
KY	1%	1%	-0.2	1%	1%	0.0
LA	1%	1%	-0.3	1%	1%	0.0
MA	4%	3%	0.9	4%	4%	0.0
MI	3%	2%	1.0	2%	2%	0.0
MN	2%	2%	-0.2	2%	2%	0.0
MO	2%	2%	0.4	2%	2%	0.0
NC	3%	2%	0.3	3%	3%	0.0
NJ	5%	8%	-2.4	7%	7%	0.0
NM	1%	0%	0.5	1%	1%	0.0
NV	2%	0%	1.2	1%	1%	0.0
NY	6%	7%	-1.3	5%	5%	0.0
PA	4%	3%	0.5	4%	4%	0.0
SC	1%	2%	-0.4	2%	2%	0.0
TN	2%	2%	-0.5	2%	2%	0.0
TX	11%	15%	-4.6	13%	13%	-0.1
VA	2%	1%	0.6	2%	2%	0.0
WI	2%	1%	0.5	2%	2%	0.0

Notes: Included are nonsurgical LBP claims with PT services that were provided by non-chiropractic providers. These claims had injuries occurring from October 1, 2015, to September 30, 2017, with medical treatments received during the first 18 months after the date of injury, up through March 31, 2019. We excluded LBP claims with chiropractic care. See Chapter 2 and Technical Appendix A for more details.

Key: IPTW: inverse probability treatment weighting; LBP: low back pain; MT: manual therapy; PT: physical therapy.

As mentioned previously, the key assumption that the propensity score method yields unbiased estimates of treatment effects is that all confounding factors are measured and controlled for in the two-stage regression analyses. It is important to consider how well we capture those factors that influence treatment choice and outcomes, and whether there is an unmeasured factor that may affect the results. Although we cannot rule out the existence of such a factor, we believe that the set of factors we included in our analysis is among the most complete sets of controls in the empirical studies using administrative data. We compared the set of factors we controlled for with those that have been addressed in the relevant literature under the conceptual framework initially developed by Andersen and used in a number of studies in health services research. Several examples are summarized below:

- Shraim et al. (2017) examined the impact of regional socioeconomic factors on medical costs and disability duration for occupational low back pain, using a payor's data for workers' compensation claims. The authors concluded that regional disparities in medical costs and disability duration exist even when health insurance, health care availability, and indemnity benefits are similar. According to the study, medical costs were higher in more urban, more racially diverse, and lower education neighborhoods; and longer disability duration is associated with lower neighborhood household income and higher unemployment rate. We controlled for these regional factors by including county-level data from external sources (described in Chapter 2).
- Steenstra et al. (2017) provide a summary of factors in their systematic review of 78 studies, which include 16 for chronic pain, 6 for subacute pain, and 37 for acute pain. According to the review, delayed return to work or prolonged disability is associated with higher compensation and treatment costs (we control for more than seven days of lost time). Few studies have examined factors affecting individual care-seeking behavior with respect to the type of providers initially seen and the relationship between initial provider and subsequent use of medical services.
- Blanchette et al. (2016) found several key factors that most likely influence the decision on choosing initial providers, including age, gender, job tenure, wage, size of employer, rural and urban area, and the size of community. Our study does not directly examine the choice of initial providers, but medical decision making on the specific type of service is strongly associated with the type of provider and provider practice.
- Chevan and Riddle (2011) found that increased age, female sex, lower self-health rating, and presence of at least one disability day were all significantly associated with physician/physical therapist care over chiropractor care. Kazis et al. (2019) examined the association between initial provider and opioid prescriptions and controlled for age, gender, ethnicity, insurance, and comorbidities identified using ICD-9 codes.
- Babitsch et al. (2012) provide a systematic review of studies that applied Andersen's model. The review found that the 1995 version of Andersen's behavioral model was the version most frequently applied in the studies investigating the use of health care services. Although there are substantial differences in the variables used, those that were used most include age, marital status, gender, education, and ethnicity as predisposing factors; and income/financial situation, health insurance, and having a usual source of care/family doctor were used as enabling factors. As need factors, most of the studies included evaluated health status and self-reported/perceived health as well as a very wide variety of diseases. The authors also noted that there was a lack of consistency in the factors examined in the studies.
- The International Classification of Functioning, Disability, and Health (ICF) factors explicitly include

demographics (e.g., age and gender), psychosocial issues, the intensity of pain, functional capacity, mental health, fear factor, and clinical factors (e.g., delayed referrals for intervention).

Some of these studies used Andersen's framework as a guide in their choice of variables to control for confounding factors (Chevan and Riddle, 2011; Babitsch et al., 2012; Blanchette et al., 2016). More recently, a number of studies have explored the measurement of patient complexity, with the intention to capture the characteristics of individual patients that likely influence their behavioral responses to medical care. According to Tonelli et al. (2018), patient complexity can be defined as an interaction between the personal, social, and clinical aspects of the patient's experience that complicates patient care, which go beyond medical severity and comorbidities. The study compared the complexity of patients across different types of physicians in a Universal Health Care system (Tonelli et al., 2018). Another example is Park (2016), which reviewed studies addressing patient complexity in primary care settings. In these studies, the key components of patient complexity included disease diagnoses, number of comorbidities, presence of mental illness, medication counts, emergency department visits, hospitalization, and several established groupers such as Charlson Comorbidity Index (CCI) and Chronic Disease Score (CDS), which were measured based on patient experience prior to the episode of care studied.

In this study, we were able to control for most of these factors, including demo-socio-economic characteristics of workers; variables that measure or approximate the severity and comorbidities; regional or neighborhood factors in terms of general level of education, median household income, health insurance coverage, local economic conditions, and unemployment rate; and provider factors such as availability of providers, access to qualified MT providers, organization structure, etc. However, we are limited in our ability to capture variables that capture the part of patient complexity based on prior experience of the patient. Because of this, we do not rule out the possibility of omitting certain factors that may affect the likelihood of receiving MT and early MT as well as outcomes. Our findings provide evidence of association, not causation, between the MT treatment patterns and outcomes.

OTHER POTENTIAL CONCERNS AND SENSITIVITY TEST

Several other potential concerns should be addressed to make sure that our results are not sensitive to these concerns. The main issues include the following:

- Measurement and use of attorney involvement as a proxy for pending compensability or other issues arising from the claims administrative process.
- Large states may be dominating the results.
- Differences in cost of living may affect medical costs.
- Potential impact of the exclusions of surgical LBP claims and LBP claims with chiropractic care.
- Impact of additional control of severity and complexity.
- Comparing outcomes between no MT and early MT.

ATTORNEY INVOLVEMENT

Pending compensability issues often have the effect of delaying care or choice of certain types of care.[2] 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 from our statistical analyses. 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, our sensitivity analyses suggested that the results we presented in the main report were not sensitive to the omission of the worker attorney involvement indicator, which is partially because of a strong correlation between the defense and worker attorney involvement variables.[3]

While the attorney indicators help approximate compensability issues that might have occurred in the claims, both defense and worker attorney indicators may under- or over-identify claims with pending compensability issues.[4] For example, 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 formal 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. In the 2020 study on early PT, we addressed this concern by performing two sensitivity analyses (Wang, Mueller, and Lea, 2020). The first analysis was to create an attorney indicator so that the value is 1 if either defense or worker attorneys were involved and 0 if neither defense nor worker attorneys were involved. By doing so, we could maximize the capture of pending issues with the available data and see if the results were sensitive for this change. The second analysis was to run the same regressions based on a subset of claims that had neither defense nor worker attorney involvement to eliminate possible differences in the prevalence of pending compensability issues between treatment and comparison groups. Based on these two analyses, we concluded that the results from analyses including defense attorneys are unlikely to change in a material way that affects the findings. See Technical Appendix C of the 2020 report for the results of the sensitivity analyses and more detailed discussion.

---

[2] In some states, medical care is less likely to be affected by compensability issues. 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.

[3] See Wang, Mueller, and Lea (2020) and Yang, Rothkin, and Dolinschi (2017).

[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.

MITIGATING THE INFLUENCE OF LARGE STATES ON THE RESULTS

States are different in size, workers' compensation policies, and other factors. As mentioned previously, one way to address this is to control for state fixed effects. Because the numbers of claims in our data are substantially different across the states, the states with large numbers of claims could dominate the descriptive statistics without weighting the data. In the 2020 report on early PT, we addressed this concern by creating a set of weights that equalize the importance of the individual states (i.e., a smaller weight was assigned to claims in a large state depending on the actual proportion of claims across states) and comparing the results with and without the equal-state weights. The results led to the same conclusion regarding the association between PT timing and outcomes. The reader is referred to that report for more detail (Wang, Mueller, and Lea, 2020).

DIFFERENCES IN COST OF LIVING MAY AFFECT MEDICAL COSTS

Since medical prices vary widely across states, one may be concerned that the variation in "cost of living" may affect the results of our statistical analysis. This is a valid concern because if proportionally more claims from states with high prices are in the MT group or late MT group, the average medical costs per claim would be higher for these group relative to the no-MT group and the early MT group, respectively. However, we believe that the adjustment for state fixed effect should address this concern because by controlling for state fixed effect, we are effectively looking within states at the impact of MT and early MT in a way that the state dummies absorb the impact of average price effects. We tested the sensitivity of the results using the WCRI Medical Price Index for Workers' Compensation to adjust the medical payments for individual claims and compared the average medical payment per claim. The results suggest that, at least at the state level, the difference in prices was not a factor in the difference in the medical payments per claim.

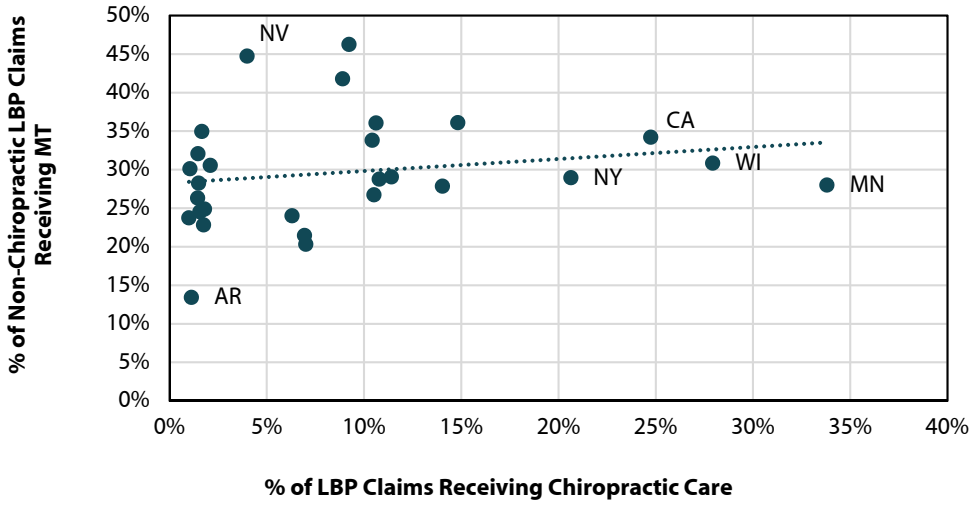
POTENTIAL IMPACT OF THE EXCLUSIONS OF SURGICAL LBP CLAIMS AND LBP CLAIMS WITH CHIROPRACTIC CARE

For this study, we excluded surgical LBP claims and LBP claims with chiropractic care. While these exclusions are necessary for clarity and meaningful results, it is valid concern that these exclusions might have introduced variations in severity which may affect the comparative results. The concern of potential selection bias is especially valid for the interstate comparisons in the prevalence and patterns of MT services and for the comparison of outcomes between MT and no MT.

For the exclusion of surgical LBP claims, because only a small percentage of LBP claims (Table 2.1) were excluded from the analysis, we believe that the potential bias would be small if it exists.

There exists a large variation in the percentage of LBP claims with chiropractic care, ranging from nearly none to 34 percent in Minnesota. In 12 of the 28 states, the percentage of LBP claims with chiropractic care was below 5 percent, and chiropractors were involved in more than 20 percent of the LBP claims in California, Minnesota, New York, and Wisconsin. It is a valid concern that the exclusion of LBP claims with chiropractic care may affect the interstate comparison of the prevalence of MT treatment. To address this concern, we examined the correlation between the percentage of LBP claims with chiropractic care and the percentage of nonsurgical, non-chiropractic LBP claims that received MT (Figure TA.C1). We did not see a strong correlation between higher use of chiropractic care and lower use of MT among non-chiropractic providers—in fact, the correlation suggests that a state with more chiropractic care tends to have a slightly higher use of MT while for most states, the use of MT appeared to be independent of prevalence of chiropractic care.

Figure TA.C1 Analysis: Potential Impact of Chiropractic Exclusions on MT Use



Note: Included are nonsurgical LBP claims. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment received during the first 18 months after the date of injury, up through March 31, 2019.

Key: LBP: low back pain; MT: manual therapy.

IMPACT OF ADDITIONAL CONTROL OF SEVERITY AND PATIENT COMPLEXITY

Other possible ways to control for additional severity and complexity is to include ICD-10 codes and an indicator of mobility issues in our statistical analysis. To do so, we derived the primary ICD-10 codes for individual claims and identified LBP claims that had one of the ICD-10 codes indicating mobility issues.

The primary ICD-10 codes based on our derivation are the ICD-10 codes that capture most of the payments for services rendered in treating the diagnosis. We kept the first 5 characters of the ICD-10 codes that would be sufficient to differentiate severity based on the ICD-10 hierarchical coding structure.[5] Among the LBP claims we studied, for example, the most common primary ICD-10 codes include S39.0 (injury of muscle, fascia and tendon of low back and pelvic), M54.5 (low back pain), S33.5 (sprains of ligaments of lumbar spine), M54.1 (radiculopathy), M54.4 (lumbago with sciatica), and S30.0 (contusion of low back and pelvis). These codes accounted for more than 75 percent of the claims. Based on our analysis, we concluded that the ability to control for severity using these ICD-10 codes is limited; the results did not change after we included these derived variables in the analysis. Our data show that the claim distribution of these primary ICD-10 codes were not drastically different between early and late MT and between MT and no MT; and there was large within-code variation in medical costs and TD duration, suggesting limited usefulness of this additional control.

The clinical practice guidelines for low back pain, by the American Physical Therapy Association (APTA),

[5] The first 5 characters refer to the first 3 characters, the dot, and the 4th character of the ICD-10 codes (as shown in Table TA.C9). By design, an ICD-10 code can have 3 to 7 characters, with a dot after the first 3 characters. The first 3 characters indicate categories (for injuries and body region). The next 3 characters indicate anatomic site and severity. For back conditions, severity is indicated on the 4th character and the 5th character is for specific regions of the spine. The 7th character indicates episode of care (e.g., initial or subsequent visits), which usually goes with the S codes.

linked care to the International Classification of Functioning, Disability, and Health (ICF). The ICF guidelines established a comprehensive list of codes, referred to as the ICF codes, which would be helpful to indicate severity, functional status, and level of disability. Unfortunately, the ICF codes are not present in our data. We were able to identify several ICD-10 codes that indicate mobility issues, including R26 (for abnormalities of gait and mobility), R268 and R2689 (for other abnormalities of gait and mobility), R269 (unspecified abnormalities of gait and mobility, Z740 (reduced mobility), and Z7409 (other reduced mobility). However, only a small number of claims were identified having at least one of these mobility codes.

We tested the sensitivity of the results to the additional control of these ICD-10 codes. Based on our analysis, we concluded that the ability to control for severity and complexity by using these ICD-10 codes is limited; the results did not change after we included these derived variables in the estimations of treatment choice and outcomes (as discussed below).

One additional approach we tested to further address severity and complexity was to repeat the statistical analysis using a subset of LBP claims with 3 or more PT or MT visits. This method was used in the 2020 study on early PT to make sure the LBP-only claims included in that study were comparable across different PT timing groups.[6] Tables TA.C9 and TA.C10 provide the results we reported in Chapter 4 and Chapter 5, respectively; the results from our sensitivity analysis controlling for common primary ICD-10 codes and the indicator for mobility issues; and the results further restricting the set of claims with 3 or more PT or MT visits.

[6] This was mainly because claims with 1 or 2 PT visits are more likely to have LBP that is relatively less severe and the initial PT visits may well be just for evaluation/assessment and instructions for home exercises (Wang, Mueller, and Lea, 2020).

Table TA.C9 Comparing Outcomes between Early and Late MT—Sensitivity Tests of Adjusted Results

Outcome Measures	LBP Claims with MT (any PT) (reported in Chapter 4)			Adding Control for Top Primary ICD-10 and Mobility Indicator, LBP Claims with MT (any PT)			Adding Control for Top Primary ICD-10 and Mobility Indicator, Subset of LBP Claims with MT and 3+ PT visits		
	Claims with Early MT in 2 Weeks of PT	Claims with MT after 2 Weeks	% or % Point Difference	Claims with Early MT in 2 Weeks of PT	Claims with MT after 2 Weeks	% or % Point Difference	Claims with Early MT in 2 Weeks of PT	Claims with MT after 2 Weeks	% or % Point Difference
Medical payments per claim	$4,192	$5,741	-27% ***	$4,196	$5,709	-27% ***	$4,500	$5,825	-23% ***
Indemnity payments per claim	$3,387	$4,731	-28% ***	$3,396	$4,681	-27% ***	$3,658	$4,970	-26% ***
TD duration in weeks per claim	4.6	5.8	-22% ***	4.6	5.8	-21% ***	4.9	6.1	-20% ***
% of claims that received MRI	30.3%	43.4%	-13.0 ***	30.4%	43.1%	-12.7 ***	32.6%	45.0%	-12.4 ***
% of claims that received opioid Rx	18.6%	23.3%	-4.7 ***	18.6%	23.2%	-4.6 ***	19.4%	23.8%	-4.4 ***
% of claims that received injections	12.6%	16.5%	-3.9 ***	12.6%	16.3%	-3.7 ***	13.6%	17.2%	-3.6 ***

Note: Included are nonsurgical LBP claims that received MT and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury.

*** statistically significant at the 1 percent level.

Key: ICD: International Classification of Diseases; LBP: low back pain; MT: manual therapy; PT: physical therapy; Rx: prescriptions; TD: temporary disability.

Table TA.C10 Comparing Outcomes between MT and No MT—Sensitivity Tests of Adjusted Results

Outcome Measures	LBP Claims with Any PT (reported in Chapter 5)			Adding Control for Top Primary ICD-10 and Mobility Indicator, LBP Claims with Any PT			Adding Control for Top Primary ICD-10 and Mobility Indicator, Subset of LBP Claims with 3+ PT Visits		
	Claims with MT	Claims with No MT	% or % Point Difference	Claims with MT	Claims with No MT	% or % Point Difference	Claims with MT	Claims with No MT	% or % Point Difference
Medical payments per claim	$4,193	$3,099	35% ***	$4,182	$3,112	34% ***	$4,485	$3,880	16% ***
Indemnity payments per claim	$3,140	$2,723	15% ***	$3,134	$2,735	15% ***	$3,549	$3,285	8% ***
TD duration in weeks per claim	4.1	3.8	8% ***	4.1	3.8	7% ***	4.7	4.5	4% ***
% of claims that received MRI	29.4%	25.2%	4.2 ***	29.3%	25.4%	3.9 ***	32.7%	30.6%	2.1 ***
% of claims that received opioid Rx	18.1%	16.7%	1.4 ***	18.1%	16.8%	1.3 ***	19.4%	18.6%	0.8 ***
% of claims that received injections	11.3%	10.2%	1.1 ***	11.3%	10.2%	1.1 ***	12.8%	12.3%	0.5 ***

Note: Included are nonsurgical LBP claims that received MT and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury.

*** statistically significant at the 1 percent level.

Key: ICD: International Classification of Diseases; LBP: low back pain; MT: manual therapy; PT: physical therapy; Rx: prescriptions; TD: temporary disability.

As can be seen in the tables, the additional control of the ICD-10 codes and the mobility indicator did not change the results. The subsetting of LBP claims with 3 or more MT visits did not change the comparative results for the early versus late MT analysis. However, after excluding LBP claims with 1–2 PT visits, the percentage difference in the outcome measures decreased considerably between the MT and no-MT groups, but the direction remained the same.

While the exclusion of LBP claims with 1–2 PT visits may help address the severity concern to some extent, there is value in providing a broader picture of treatment patterns based on LBP claims with any PT or MT services. In the main report, we presented the data based on LBP claims with any PT/MT services when discussing the prevalence and patterns of MT treatment (Chapter 3). We also reported the results for LBP claims with any MT services in Chapter 4 when comparing outcomes between early and late MT treatment. The results did not change when excluding LBP claims with 1–2 MT visits. In Chapter 5, we included the results for LBP claims with 3 or more PT visits and discussed major findings based on this set of results.

COMPARING OUTCOMES BETWEEN NO MT AND EARLY MT

The results reported in Chapter 5 and the sensitivity analysis above suggest that LBP claims with MT had higher medical costs on average, and indemnity payments and TD duration were also slightly higher than LBP claims that received PT but did not have MT services. Since early MT is associated with lower costs and shorter TD duration, it is logical to ask how the outcomes compare between LBP claims with early MT and those with no MT. Table TA.C11 provides two sets of results for LBP claims with 3 or more PT visits. The set of results on the right compares outcomes between early MT and no MT, and the set of results on the left compares the same outcomes between MT and no MT, which is the same as Table 5.4.

Table TA.C11 Comparing Utilization, Costs, and TD Duration between MT and No MT and between Early MT and No MT, All LBP Claims with 3+ PT Visits to Non-Chiropractors

Outcome Measures	MT versus No-MT (adjusted)[a]			Early MT versus No-MT (adjusted)[b]		
	Claims with MT	Claims with No MT	% or % Point Difference	Claims with Early MT	Claims with No MT	% or % Point Difference
Medical payments	$4,524	$3,902	16% ***	$4,375	$3,865	13% ***
Indemnity payments	$3,628	$3,353	8% ***	$3,441	$3,266	5% ***
TD duration in weeks per claim	4.8	4.6	4% ***	4.6	4.5	2% ***
% of claims that received MRI	33.0%	30.6%	2.4 ***	31.3%	30.2%	1.0 ***
% of claims that received opioid Rx	19.1%	18.3%	0.8 ***	18.7%	18.3%	0.4
% of claims that received pain management injections	12.9%	12.2%	0.7 ***	12.5%	12.1%	0.3 *

Notes: Included are nonsurgical LBP claims that received PT (including MT) and other medical services. These are medical-only and indemnity claims with injuries occurring from October 1, 2015, to September 30, 2017, with medical treatment and benefit payments observed in the first 18 months after the date of injury. Note that the claims with MT in this analysis are a subset of those in the early versus late MT analysis. We excluded 3 percent of the claims with MT to make sure that the MT and no-MT groups are comparable in terms of the presence of other PT services. See Technical Appendix A for more details regarding common PT patterns.

[a] The adjusted results are the average values for the MT and no-MT groups, holding all other variables constant. The LBP claims included were those that had 3 or more PT visits. Results from Chapter 5.

[b] The adjusted results are the average values for the early MT and no-MT groups, holding all other variables constant. The LBP claims included were those that had 3 or more PT visits.

*** statistically significant at the 1 percent level, * statistically significant at the 10 percent level.

Key: LBP: low back pain; MT: manual therapy; MRI: magnetic resonance imaging; PT: physical therapy; Rx: prescriptions; TD: temporary duration.

As can be seen in Table TA.C11, the comparative results between early MT and no MT were slightly different from those between MT and no MT—the sizes of the differences in the outcomes were slightly reduced but the direction remained the same.

GLOSSARY

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* or *neuro back claims.*

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.

Manual therapy (MT) services: Manual therapy is a broad term we used to describe a wide range of services that are billed for manual therapy (i.e., CPT code 97140). MT services include manipulation, mobilization, deep tissue massage and myofascial techniques, manual traction, and trigger point release. For LBP, performing spinal mobilization and manipulation requires specialized training for manual techniques and MT providers should be certified to perform these services.

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.

non-chiropractic (PT or MT) provider: In this report, non-chiropractic providers refer to medical providers who are not chiropractors by training and licensing. These include physical therapists, physicians, and other medical providers. We use the term *non-chiropractic PT/MT providers* for non-chiropractors who performed PT or MT services.

physical therapy (PT) services: In this study, we define PT services as those indicated by the CPT4 codes (presented in Table TA.A6) that may or may not be billed by physical therapists. For many physical therapists, the term *PT* may specifically refer to services that can only be fulfilled by licensed physical therapists. However, the CPT codes for PT services are not exclusive to physical therapists. Other clinicians can deliver similar treatments using the same CPT codes. In this study, we defined the term *PT services* to refer to physical therapy services prescribed and performed by licensed physical therapists and similar services by other non-physical therapist providers. We define this term in Chapter 2 and use it consistently throughout the report.

reimbursement rules: A set of criteria specified by a workers' compensation jurisdiction that determines what services should or should not be considered for reimbursements. Some jurisdictions, for example, consider all medical services within the parameters of state-adopted treatment guidelines as medically necessary, and therefore they should be reimbursed by the payor.

types of PT services: There are four broad types of PT services defined for this study, including evaluation/functional assessment/measurement, passive physical therapies (e.g., hot/cold packs,

electronic stimulation, traction, as well as acupuncture—often referred to as passive modalities), manual therapies (e.g., manipulation, mobilization, deep tissue massage and myofascial techniques, manual traction, and trigger point release), and active physical therapies (e.g., therapeutic exercises, PT-related education and training, active counseling, and work hardening). Note that conventionally, work hardening is part of occupational therapy instead of physical therapy. We include work hardening as part of PT services for this study because these services are an intrinsic part of the services used for treating workers and facilitating return to work.

REFERENCES

American Physical Therapy Association (APTA) Public Policy, Practice, and Professional Affairs Unit. 2014. *Billing of dry needling by physical therapists.* Official Statement.

Andersen, R. 1995. Revisiting the behavioral model and access to medical care: Does it matter? *J Health Soc Behav* 36 (1): 1–10.

Andersen, S., R. Brogård, M. Andersen, L. Carreon, A. Coulter, H. Hon, and K. Steffensen. 2019. Factors affecting patient decision-making on surgery for lumbar disc herniation. *Spine* 44 (2): 143–149.

Andersen, R., and P. Davidson. 2001. Improving access to care in America: Individual and contextual indicators. In R. Andersen, T. Rice, and E. Kominski (eds.), *Changing the U.S. healthcare system: Key issues in health services, policy, and management* (pp.3–30). San Francisco, CA: Jossey-Bass.

Alrwaily, M., M. Timko, M. Schneider, J. Stevans, C. Bise, K. Hariharan, A. Delitto. 2016. Treatment-based classification system for low back pain: Revision and update. *Phys Ther.* 96 (7): 1,057–1,066.

Babitsch, B., D. Gohl, and T. von Lengerk. 2012. Re-revisiting Andersen's behavioral model of health services use: A systematic review of studies from 1998–2011. *GMS Psycho Soc Med*, 9.

Blanchette, M., M. Rivard, C. Dionne, S. Hogg-Johnson, and I. Steenstra. 2016. Workers' characteristics associated with the type of healthcare provider first seen for occupational back pain. *BMC Musculoskelet Disord* 17 (1): 428.

Butler, R., and W. Johnson. 2010. Adjusting rehabilitation costs and benefits for health capital: The case of low back occupational injuries. *J Occup Rehabil* 20: 90–103.

Chang, E., B. Silver, A. Goldstein, and B. Landon. 2019. *In-depth literature review of downstream spending and service use following five low-value services.* A report by staff from RTI International and Harvard Medical School for the Medicare Payment Advisory Commission.

Charlson, M., P. Pompei, K. Ales, and C. MacKenzie. 1987. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *Journal of Chronic Diseases* 40 (5): 373–383.

Chevan, J., and D. Riddle. 2011. Factors associated with care seeking from physicians, physical therapists, or chiropractors by persons with spinal pain: A population-based study. *J Orthop Sports Phys Ther.* (41) 467–476.

Childs, J., J. Fritz, S. Wu, T. Flynn, R. Wainner, E. Robertson, F. Kim, and S. George. 2015. Implications of early and guideline adherent physical therapy for low back pain on utilization and costs. *BMC Health Services Research* 15, Article number: 150.

Chou, R., R. Deyo, J. Friedly, A., Skelly, R. Hashimoto, M., Weimer, R. Fu, T. Dana, P. Kraegel, J. Griffin, S. Grusing, and E. Brodt. 2017. Nonpharmacologic therapies for low back pain: A systematic review for an American College of Physicians clinical practice guideline. *Annals of Internal Medicine* 166 (7): 493–505.

Cifuentes M., J. Willetts., and R. Wasiak. 2011. Health maintenance care in work-related low back pain and its association with disability recurrence. *J Occup Environ Med* 53: 396–404.

Cochrane, L., C. Olson, S. Murray, M. Dupuis, T. Tooman, and S. Hayes. 2007. Gaps between knowing and doing: Understanding and assessing the barriers to optimal health care. *Journal of Continuing Education in the Health Professions* 27 (2): 94–102.

Coulter, I., C. Crawford, E. Hurwitz, R. Khorrsan, M. Suttorp Booth, and P. Herman. 2018. Manipulation and mobilization for treating chronic LBP – sys review and meta analysis. *The Spine Journal* 18 (5): 866–879.

Daul, R. 2006. *Specific manual physical therapy techniques.* Retrieved from https://www.spine-health.com/treatment/physical-therapy/specific-manual-physical-therapy-techniques (accessed May 17, 2021).

Delitto, A., S. George, L. Dillen, J. Whitman, G. Sowa, P. Shekelle, T. Denninger, and J. Godges. 2012. Low back pain: Clinical practice guidelines linked the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther* 42 (4): A1–A57.

Demian, C., B. Barron, and A. Almudevar. 2018. Effects of the New York State Workers Compensation Board medical treatment guidelines on return to work. *Journal of Occupational and Environmental Medicine* 60 (7): 617–621.

Elixhauser, A., C. Steiner, D. Harris, and R. Coffey. 1998. Comorbidity measures for use with administrative data. *Med Care* 36 (8): 8–27.

Fatoye, F., T. Gebrye, and I. Odeyemi. 2019. Real-world incidence and prevalence of low back pain using routinely collected data. *Rheumatology International* 39: 619–626.

Fritz, J., J. Cleland, and G. Brennan. 2007. Does adherence to the guideline recommendation for active treatments improve the quality of care for patients with acute low back pain delivered by physical therapists? *Med Care* 45: 973–980.

Fritz, J., J. Cleland, M. Speckman, G. Brennan, and S. Hunter. 2008. Physical therapy for acute low back pain: Associations with subsequent healthcare costs. *Spine (Phila Pa 1976)* 33 (16): 1,800–1,805.

Fritz, J., R. Wainner, and T. Flynn. 2012. Primary care referral of patients with low back pain to physical therapy: Impact on future health care utilization and costs. *Spine* 37 (25): 2,114–2,121.

Gellhorn, A., L. Chan, B. Martin, and J. Friedly. 2012. Management patterns in acute low back pain: The role of physical therapy. *Spine* 37 (9): 775–782.

Gilkey, D., L. Caddy, T. Keefe, G. Wahl, R. Mobus, B. Enebo, et al. 2008. Colorado workers' compensation: Medical vs chiropractic costs for the treatment of low back pain. *J Chiropr Med* 7: 127–133.

Glass, L., R. Blink, M. Bean, M. Erdil, J. Rosenthal, and T. Taylor, ACOEM Utilization Review Task Force. 2017. Current status and opportunities for improvement. ACOEM Position Statement. Utilization Review in Workers' Compensation. *Journal of Occupational and Environmental Medicine* 59 (10): 1,024–1,026.

Graves, J., D. Fulton-Kehoe, J. Jarvik, and G. Franklin. 2014. Health care utilization and costs associated with adherence to clinical practice guidelines for early magnetic resonance imaging among workers with acute occupational low back pain. *Health Services Research* 49: 645–665.

———. 2018. Impact of an advanced imaging utilization review program on downstream health care utilization and costs for low back pain. *Medical Care* 56 (6): 520–528.

Graves, J., D. Fulton-Kehoe, D. Martin, J. Jarvik, and G. Franklin. 2012. Factors associated with early magnetic resonance imaging utilization for acute occupational low back pain: A population-based study from Washington State workers' compensation. *Spine (Phila Pa 1976)* 37: 1,708–1,718.

Groeneweg, R., L. van Asse, H. Kropman, H. Leopold, J. Mulder, B. Smits-Engelsman, R. Ostelo, R. Oostendorp, and M. van Tulder. 2017. Manual therapy compared with physical therapy in patients with non-specific neck pain: A randomized controlled trial. *Chiropractic & Manual Therapies* 25: 12.

Hanney, W., M. Masaracchio, X. Liu, and M. Kolber. 2016. The influence of physical therapy guideline adherence on healthcare utilization and costs among patients with low back pain: A systematic review of the literature. *PLoS One* 11: e0156799.

Harris, J., C. Ossler, R. Crane, and A. Swedlow. 2005. *Utilization review & the use of medical treatment guidelines in California workers' compensation: A comparison of ACOEM and AAOS on medical testing and service utilization for low back pain.* A Report to the Industry. Oakland, CA: California Workers' Compensation Institute.

Hass, M., R. Sharma, and M. Stano. 2005. Cost-effectiveness of medical and chiropractic care for acute and chronic low back pain. *J Manipulative Physiol Ther* 28(8): 555–563.

Hidalgo, B., C. Detrembleur, T. Hall, P. Mahaudens, and H. Nielens. 2014. The efficacy of manual therapy and exercise for different stages of non-specific low back pain: An update of systematic reviews. *J Manual Manipulative Ther* 22 (2): 59–74.

Hoy, D., L. March, P. Brooks, A. Woolf, F. Blyth, T. Vos, and R. Buchbinder. 2010. Measuring the global burden of low back pain. *Best Practice & Research: Clinical Rheumatology* 24 (2): 155–165.

Hudon, A., M. Hunt, and D. Feldman. 2018. Physiotherapy for injured workers in Canada: Are insurers' and clinics' policies threatening good quality and equity of care? Results of a qualitative study. *BMC Health Services Research* 18 (1): 682.

Hunt, D., J. Tower, R. Artuso, J. White, C. Bilinski, J. Rademacher, X. Tao, and E. Bernacki. 2016. A new method of assessing the impact of evidence-based medicine on claims outcomes. *Journal of Occupational and Environmental Medicine* 58 (5).

Iben, A., H. Lise, and L. Charlotte. 2019. Chiropractic maintenance care – What's new? A systematic review of the literature. *Chiropractic and Manual Therapies* 27: 63.

Jarvis, K., R. Phillips, and C. Danielson. 1997. Managed care preapproval and its effect on the cost of Utah worker compensation claims. *J Manipulative Physiol Ther* 20: 372–376.

Johnson, W., M. Baldwin, and R. Butler. 1999. The costs and outcomes of chiropractic and physician care for workers' compensation back claims. *J Risk Insur* 66: 185–205.

Katz, J. 2006. Lumbar disc disorders and low back pain: Socioeconomic factors and consequences. *Journal of Bone and Joint Surgery American Volume* 88 Suppl 2: 21–24.

Kazis, L., O. Ameli, J. Rothendler, B. Garrity, H. Cabral, C. McDonough, K. Carey, M. Stein, D. Sanghavi, D. Elton, J. Fritz, and R. Saper. 2019. Observational retrospective study of the association of initial healthcare provider for new-onset low back pain with early and long-term opioid use. *BMJ Open* (9): e028633.

Kominiski, G., K. Heslin, H. Morgenstern, E. Hurwitz, and O. Harber. 2005. Economic valuation of four treatments for low-back pain: Results from a randomized controlled trial. *MedCare* 43 (5): 428–435.

Kredo, T., S. Bernhardsson, S. Machingaidze, T. Young, Q. Louw, E. Ochodo, and K. Grimmer. 2016. Guide to clinical practice guidelines: The current state of play. *International Journal for Quality in Health Care* 28 (1): 122–128.

Lea, R., and K. Schifferdecker. 2016. *Medical provider responses to MTG in Louisiana: A qualitative pilot study* (Internal Report 2016).

Liu, X, W. Hanney, M. Masaracchio, M. Kolber, M. Zhao, A. Spaulding, and M. Gabriel. 2018. Immediate physical therapy initiation in patients with acute low back pain is associated with a reduction of downstream health care utilization and costs. *Phys Ther* 98: 336–347.

Lurie, J., J. Bell, and J. Weinstein. 2009. What rate of utilization is appropriate in musculoskeletal care?

Clinical Orthopaedics and Related Research 467: 2,506–2,511.

Medi-Span®. 2005. *Master drug data base (MDDB®) v2.5: Documentation manual.* Indianapolis, IN: Wolters Kluwer Health, Inc.

Michaleff, Z., C. Lin, C. Maher, and M. van Tulder. 2012. Spinal manipulation epidemiology: Systematic review of cost effective studies. *J. Electromyography and Kinesiology* 22: 655–662.

Nordeman, L., B. Nilsson, M. Moller, and R. Gunnarsson. 2006. Early access to physical therapy treatment for subacute low back pain in primary health care: A prospective randomized clinical trial. *The Clinical Journal of Pain* 22 (6): 505–511.

Orozco, T., D. Feldman, B. Mazer, G. Chilingaryan, M. Hunt, B. William-Jones, and M. Laliberte. 2017. Low back pain: Current patterns of Canadian physiotherapy service delivery. *Physiotherapy Canada* 69 (1): 49–56.

Paige, N., I. Miake-Lye, M. Booth, J. Beroes, A. Mardian, P. Dougherty, R. Branson, B. Tang, S. Morton, and P. Shekelle. 2017. Association of spinal manipulative therapy with clinical benefit and harm for acute low back pain. *JAMA* 317 (14): 1,451–1,460.

Park, S. 2016. *Patient complexity in primary care: A literature review on grouping systems with a special focus on validity and applications in primary care settings.* Providence Health Care. Department of family medicine. Retreived from http://maap-bc.ca/wp-content/uploads/2018/08/Patient-Complexity-in-Primary-Care-Literature-Review-of-Grouping-Systems-_Med-Student-Project.pdf (May 19, 2021).

Phelan, S., R. Armstrong, D. Knox, M. Hubka, and D. Ainbinder. 2004. An evaluation of medical and chiropractic provider utilization and costs: Treating injured workers in North Carolina. *J Manipulative Physiol Ther* 27: 442–448.

Pransky, G., G. Foley, M. Cifuentes, and B. Webster. 2015. Geographic variation in early MRI for acute work-related low back pain and associated factors. *Spine* 40 (21).

Quan, H., V. Sundararajan, P. Halfon, A. Fong, B. Burnand, J. Luthi, L. Saunders, C. Beck, T. Feasby, and W. Ghali. 2005. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 43 (11): 1,130–1,139.

Rasmussen-Barr, E., L. Nilsson-Wikmar, and I. Arvidsson. 2003. Stabilizing training compared with manual treatment in sub-acute and chronic low-back pain. *Man Ther* 8 (4): 233–241.

Roberts, E., E. DuGoff, S. Heins, D. Swedler, R. Castillo, D. Feldman, S. Wegener, V. Canudas-Romo, and G. Anderson. 2016. Evaluating clinical practice guidelines based on their association with return to work in administrative claims data. *Health Services Research* 51 (3): 953–980.

Robinson, T. 2015. *Understanding geographic variation in the use of treatment guidelines for occupational injuries.* Retrieved from https://www.lexisnexis.com/LegalNewsRoom/workers-compensation/b/recent-cases-news-trends-developments/posts/understanding-geographic-variation-in-the-use-of-treatment-guidelines-for-occupational-injuries#sthash.X5UtRO7H.dpf (accessed September 5, 2018).

Rothkin, K., and R. Tanabe. 2018. *Workers' compensation medical cost containment: A national inventory, 2018.* Cambridge, MA: Workers Compensation Research Institute.

Rubinstein, S., C. Terwee, W. Assendelft, M. de Boer, and M. van Tulder. 2012. Spinal manipulative therapy for acute low-back pain. *Cochrane Database Syst Rev* 2012 (9): CD008880.

Rubinstein, S., A. de Zoete, M. van Middelkoop, W. Assendelft, M. de Boer, and M. van Tulder. 2019. Benefits and harms of spinal manipulative therapy for the treatment of chronic low back pain: Systematic review and meta-analysis of randomized controlled trials. *BMJ* 364: l,689.

Saragiotto, B., C. Maher, T. Yamato, L. Costa, and R. Ostelo. 2016. Motor control exercise for chronic non-specific low-back pain. *Cochrane Database of Syst Rev* 2016 (1): CD012004.

Savych, B., D. Neumark, and R. Lea. 2018. *The impact of opioid prescriptions on duration of temporary disability*. Cambridge, MA: Workers Compensation Research Institute.

Shraim, M., M. Cifuentes, J. Willetts, H. Marucci-Wellman, and G. Pransky. 2017. Regional socioeconomic disparities in outcomes for workers with low back pain in the United States. *Am J Ind Med* 60 (5): 472–483.

Steenstra, I., C. Munhall, E. Irvin, N. Oranye, S. Passmore, D. Van Eerd, Q. Mahood, and S. Hogg-Johnson. 2017. Systematic review of prognostic factors for return to work in workers with sub acute and chronic low back pain. *J Occup Rehabil* 27: 369–381.

Taba, P., M. Rosenthal, J. Habicht, H. Tarien, M. Mathiesen, S. Hill, and L. Bero. 2012. Barriers and facilitators to the implementation of clinical practice guidelines: A cross-sectional survey among physicians in Estonia. *BMC Health Services Research* 12: 455.

Thumula, V., D. Wang, and T. Liu. 2019. *Interstate variations in dispensing of opioids, 5th edition*. Cambridge, MA: Workers Compensation Research Institute.

Tonelli, M., N. Wiebe, B. Manns, S. Klarenbach, M. James, P. Ravani, N. Pannu, J. Himmelfarb, and B. Hemmelgarn. 2018. Comparison of the complexity of patients seen by different medical subspecialists in a universal health care system. *JAMA Network Open* 1 (7): e184852.

Trujillo, A., S. Heins, G. Anderson, and R. Castillo. 2014. Geographic variability of adherence to occupational injury treatment guidelines. *Journal of Occupational and Environmental Medicine* 56 (12): 1,308–1,312.

U.S. Burden of Disease Collaborators. 2013. Burden of diseases, injures, and risk factors. *Journal of the American Medical Association* 310 (6): 591–606.

Volinn, E., J. Fargo, and P. Fine. 2009. Opioid therapy for nonspecific low back pain and the outcome of chronic work loss. *Pain* 142: 194–201.

Vos, T., C. Allen, M. Arora, R. Barber, Z. Bhutta, et al. 2016. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: A systematic analysis for the Global Burden of Disease Study 2015. *Lancet* (London, England) 388: 1,545–1,602.

Walker, J., U. Mertens, C. Schmidt, and J. Chenot. 2017. Effect on healthcare utilization and costs of spinal manual therapy for acute low back pain in routine care: A propensity score matched cohort study. *Plos One* 12 (5): e0177255.

Wang, D., K. Mueller, D. Hashimoto, S. Belton, and X. Zhao. 2008. *Interstate variations in medical practice patterns for low back conditions*. Cambridge, MA: Workers Compensation Research Institute.

Wang, D., K. Mueller, and R. Lea. 2019a. *Do treatment guidelines influence early MRI and decompression surgery for low back pain?* Cambridge, MA: Workers Compensation Research Institute.

_____. 2019b. *State policies on treatment guidelines and utilization management: A national inventory*. Cambridge, MA: Workers Compensation Research Institute.

_____. 2020. *The timing of physical therapy for low back pain: Does it matter in workers' compensation?* Cambridge, MA: Workers Compensation Research Institute.

Wasiak, R., J. Kim, and G. Pransky. 2006. Work disability and costs caused by recurrence of low back pain: Longer and more costly than in first episodes. *Spine* 31 (2): 219–225.

_____. 2007. The association between timing and duration of chiropractic care in work-related low back pain and work-disability outcomes. *J Occup Environ Med* 49 (10): 1,124–1,134.

Wasiak, R., and E. McNeely. 2006. Utilization and costs of chiropractic care for work-related low back injuries: Do payment policies make a difference? *Spine J* 6 (2): 146–153.

Wasiak, R., S. Verma, G. Pransky, and B. Webster. 2004. Risk factors for recurrent episodes of care and work disability: Case of low back pain. *J Occup Environ Med* 46 (1): 68–76.

Wayne, P., J. Buring, D. Eisenberg, K. Osypiuk, B. Gow, R. Davis, C. Witt, and T. Reinhold. 2019. Cost-effectiveness of a team-based integrative medicine approach to the treatment of back pain. *J. Altern Complement Med* 25 (S1): S138–S146.

Webster, B., A. Bauer, Y. Choii, M. Cifuentes, and G. Pransky. 2013. Iatrogenic consequences of early magnetic resonance imaging in acute, work-related, disabling low back pain. *Spine* 38 (22): 1,939–1,946.

Webster, B., Y. Choi, A. Bauer, M. Cifuentes. G. Pransky. 2014. The cascade of medical services and associated longitudinal costs due to nonadherent magnetic resonance imaging for low back pain. *Spine* 39 (10): 1,433–1,440.

Webster, B., and M. Cifuentes. 2010. Relationship of early magnetic resonance imaging for work-related acute low back pain with disability and medical utilization outcomes. *Journal of Occupational and Environmental Medicine* 52: 900–907.

Webster, B., S. Verma, and R. Gatchel. 2007. Relationship between early opioid prescribing for acute occupational low back pain and disability duration, medical costs, subsequent surgery and late opioid use. *Spine* 32: 2,127–2,132.

Webster, B., S. Verma, J. Willetts, K., Hopcia, and R. Wasiak. 2011. Association of disability duration with physical therapy services provided after meniscal surgery in a workers' compensation population. *Archives of Physical Medicine and Rehabilitation* 92: 1,542–1,551.

Weeks, W., B. Leininger, J. Whedon, J. Lurie, and T. Tosteson. 2016. The association between use of chiropractic care and costs of care among older Medicare patients with chronic low back pain and multiple comorbidities. *J Manipulative Physiol Ther* 39 (2): 63–75.e2.

Weeks, W., T. Tosteson, J. Whendon, B. Leininger, and J. Lurie. 2015. Comparing propensity score methods for creating comparable cohorts of chiropractic users and non-users in older, multiply comorbid Medicare patients with chronic low back pain. *J Manipulative Physiol Ther* 38 (9): 620–628.

Wynn, B., G. Bergamo, R. Shaw, S. Mattke, and A. Dembe. 2007. *Medical care provided to California's injured workers: An overview of the issues.* Santa Monica, CA: RAND Institute for Civil Justice and RAND Health.

Yang, R., K. Rothkin, and R. Dolinschi. 2017. WCRI FlashReport—*Worker attorney involvement: A new measure.* Cambridge, MA: Workers Compensation Research Institute.

Yee, C., S. Pizer, and O. Fomenko. 2012. *Why surgery rates vary*. Cambridge, MA: Workers Compensation Research Institute.

Zigenfus, G., J. Yin, G. Giang, and W. Fogarty. 2000. Effectiveness of early physical therapy initiation in patients with acute low back musculoskeletal disorders. *J Occup Environ Med* 42: 35–39.

OTHER WCRI PUBLICATIONS

For a list of WCRI's other publications, please click here.