# Choices and Consequences: An investigation into patient choice of provider and provider interventions for low back pain.

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**Choices and Consequences: An investigation into patient choice of provider and provider interventions for low back pain.**

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A significant portion of healthcare spending is for the treatment of low back pain (LBP). Treatment for low back pain is variable and interventions depend largely upon the provider. This dissertation sought to examine the influence of the first choice of provider, their choice of interventions and the trajectories of health care utilization and patient outcomes.

Using the database from a large insurer, we examined data for services billed from July 2015 through July 2018 and conducted a retrospective cohort analysis of patients seeking care for a new episode of LBP. We identified the first provider chosen and examined total medical utilization and LBP costs over the next year. 29,806 unique individuals were identified. Average total cost of care (TCOC) for all medical costs was lowest in those who first sought care with Chiropractic $7,761 (95% CI: $7,306, $8,218) or Physical Therapy $11,612 (95% CI: $10,586, $12,638). Highest average TCOC for all medical costs was seen in those who chose the Emergency Department, $20,028 (95% CI: $18,903, $21,154). There appears to be an association between the first choice of provider and future healthcare utilization.

Using the previously identified data, we narrowed our focus to those who chose the Emergency Department (ED) as the first choice of provider. The goal was to highlight the differences between guideline based and non-guideline based care. 2,895 individuals were analyzed. 1758 (61%) had at least one variable that met the definition of "non-concordant" care. 401 (14%) had 2 or more variables and 60 (2%) had all three variables. TCOC for all medical costs was lowest for concordant care, at an average of $18,839 (95% CI: $17,239, $20,385). Low back related spending per episode was also lowest for concordant care $2,635 (95% CI: $2,185, $3,084).

There appears to be an association between the care delivered in the ED and future healthcare utilization.

Finally, we conducted a systematic review (PROSPERO-CRD42020212006) to investigate face-to-face telehealth evaluations or interventions for LBP. 5 studies met our inclusion criteria. The studies found reinforce the existing literature; PTs can perform comparable evaluations and interventions during in-person interactions and face-to-face telehealth environments.

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## Preface

"It always seems impossible until it's done." -Mandela

It's been 8 years since I reluctantly started the journey to a PhD. Along the way I've bought and sold houses, had children, and continued to teach. Through the struggles and successes there are a few people without whom this dissertation would not have happened.

To my mentor, colleague and friend, Dr. Tony Delitto: You were there in the beginning when this was just an idea at Caribou Coffee. Your support for my teaching and then dissertation work has molded me into the researcher and academic I am today. I can never repay your kindness and wisdom but hope that I can pass on as much as possible.

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# 1.0 Introduction

Residents of the United States spend more per capita on healthcare than any other industrialized nation.[1] A significant portion of this spending is driven by the treatment of low back pain (LBP). LBP accounts for between 2.5% and 3% of all physician visits in the United States with annual expenditures estimated to be in excess of $85 billion.[2,3] Despite increased attention, the costs and utilization associated with LBP continue to rise. Treatment for low back pain is variable and interventions depend largely upon the provider from which patients seek care. Currently there is little research into the influence of the first choice of provider, their choice of interventions and the trajectories of health care utilization and patient outcomes. It is theorized that this choice affects:

- Short and long-term costs associated with the treatment of low back pain.
- The type and timing of interventions prescribed.
- Whether the interventions received are in accordance with current clinical practice guidelines and recommendations.

The results from these choices highlight the need for convenient, cost effective alternatives to "offload" the current system and better meet the needs of patients. This dissertation seeks to provide answers to these questions and actionable evidence from which payors and providers can begin to move payment incentives from volume to value.

## 1.1 Low Back Pain: Epidemiology and Resource Use

Every year, approximately 52 million individuals seek care for their LBP. This accounts for 2.5% - 3% of all physician visits.[4,5] In terms of economic impact, the direct per person costs to treat LBP are estimated at $9,035 with total aggregate direct costs estimated at $315,000,000 per year.[6] And while the cost to treat many medical disorders is staying the same, or in some cases declining, the costs of care for LBP are accelerating. The costs associated with care for LBP out-paced the overall growth of the national domestic product, with LBP expenditures almost doubling from 1996 – 2011.[6,7] This growth in direct and indirect costs has not gone unnoticed. In the period between 1994 and 2005, Deyo et al identified a 629% increase in Medicare expenditures for epidural steroid injections; a 423% increase in opioid prescriptions; a 307% increase in the number of lumbar magnetic resonance images; and a 220% increase in spinal fusion surgery rates.

None of these increases were accompanied by measurable increases in population health.[5] The Global Burden of Disease estimates there has been a 56.7% increase in the reported prevalence of LBP between 1996 and 2013.[8] As risk factors such as obesity rise and the global population ages, we must assume that the reported prevalence of LBP will continue to rise.[9,10] The rising costs have been attributed to "low value care",[11] but the impact of the first choice of provider has been largely ignored.

## 1.2 Low Back Pain: Choices and Consequences: The First Choice of Provider

Although primary care may be the intuitive first stop for patients with LBP, many patients choose specialists (rheumatology, physiatry, orthopedic surgery, neurosurgery), chiropractors, physical therapists (PT) urgent or express care and even the Emergency Department (ED) as the provider of choice for their acute episode of LBP. Each of these providers has different training and interventional paradigms pertaining to low back pain. The natural extension of this training is that each provider or subspecialty has a different view on the etiology and the optimal care pattern for this disorder. This introduces variation in the system that leads to increased cost and poor value.

As yet, there has been very little attention given to the first choice of provider. Early research has shown that the choice of first provider and the timing of interventions for LBP appear to influence subsequent healthcare utilization, with increased cost in the short and long term.[12,13] Unfortunately, studies to date have been limited by small sample sizes, the small number of providers studied, and a focus specifically on patients with private health insurance.[13] Kazis et. al completed the most recent and comprehensive study surrounding this issue but only reported on opioid use. They found that the use of non-surgical (conservative) providers of care reduced both short and long term opioid use.[14] Though this study only focused on opioids, it showed that the first choice of provider, has a significant impact on outcomes. According to Kazis, one of the more significant portals in terms of cost is the Emergency Department[14] despite the fact that almost all acute back pain is not emergent in nature.

### 1.3 Low Back Pain: The Emergency Department as a Portal of Entry

In addition to the aforementioned portals of entry, the Emergency Department (ED) is the first point of contact for many with LBP.[15] During the 2.63 million annual visits for LBP seen in the ED, 45% of patients will receive a diagnostic test, and 10% of patients will receive advanced imaging (MRI). Of greater concern is the use of opioids; in the same analysis, more than 60% of patients received a prescription for opioids during a visit to the ED for LBP.[15] This study gives an insight into the immediate treatment of patients in the ED but does little to establish "what happens next." Some research suggests that there is increased downstream utilization by patients who enter the system via the ED, but this research has been done in the occupational medicine environment which may not be generalizable to the population at large.[16–18] As such, we have little information regarding the subsequent healthcare utilization of patients seeking care in the ED or the care they are receiving.

### 1.4 Low Back Pain: Guideline Based Care and Interventions

. Recommendations for the treatment of LBP have existed since the 1994 publication of the "Acute Low Back Problems Guideline Panel: The Agency on Health Care Policy and Research."[19] In response to the unchecked rise in prevalence and expenditures for LBP, the American College of Physicians (ACP) and the American Pain Society revisited and established clinical practice guidelines.[20,21] Written in 2007 and revised in 2017, these guidelines were not specific to a clinical environment or specialty. Rather, the panel recommend that those with acute and chronic LBP receive non-pharmacologic and non-invasive interventions.[22,23] For those patients who don't improve with non-pharmacologic care, non-steroidal anti-inflammatories are recommended as the first line of pharmacologic medication; opioids should only be used as a last resort.[22,24,25] In 2016, the American College of Radiology (ACR) established imaging guidelines for LBP stating that "Most patients presenting with uncomplicated acute LBP and/or radiculopathy do not require imaging."

Adherence to these guidelines in primary care is estimated at 52%[26] and a systematic review found that "more aggressive and costly management strategies are commonly employed"[27] despite the publication of the ACP and ACR guidelines several years ago. This provides clear evidence that current strategies about dissemination and implementation of LBP guidelines are failing.[26,27] What is unclear is why, despite high levels of knowledge regarding LBP guidelines,[21] practitioners continue to provide treatment that is not in line with the guidelines.

Adherence to LBP guidelines in the primary care environment has been studied in the US and abroad with findings consistently reporting treatments contrary to established clinical guidelines.[16,21,26–29] At this time, the use of guideline based care in the ED has not been extensively studied. A single study of the National Hospital Ambulatory Medical Care Survey (NHAMCS) is frequently cited when referring to the ED care delivered for LBP. The authors found that there is a tendency toward frequent diagnostic testing and that two-thirds of patients are receiving opioids during their ED visit.[15] The inattention to guidelines is leading to low value and high cost care. The ED is already an expensive portal of entry into the system and compounded by the low value care delivered in that setting.

Patients are choosing the ED as primary care for many cases of back pain. Research into why patients choose the ED for care include: limited access to primary care; urgency; convenience; and belief that their condition requires the resources and facilities offered by a particular healthcare provider. [30,31] Solutions to treat patients outside of this high cost environment include on-site primary care, physical therapists embedded in the ED, direct referral to spine centers and the use of telehealth.

## 1.5 Low Back Pain: The Telehealth Alternative

Out of necessity, society is reconstructing how we work, how we play, and most importantly, how we stay healthy. The SARS-COV2 pandemic has altered many of the "fundamental" was in which we interact; social distancing guidelines, work from home, and quarantine mandates are just a few of the involuntary disruptions to our daily lives. In response quarantine and social distancing guidelines, healthcare has renewed its interest in virtual delivery of services. As an industry, healthcare has nibbled at the edges but never fully embraced a virtual model of care. Telehealth is not new. Historically, it has been used to provide healthcare to remote areas that have limited access to medical professionals. Modern telemedicine emerged as the video camera and television became commonplace in the 1950s. [32]

In the modern age, there are numerous examples of successful trials of "virtual" care for musculoskeletal disorders, including low back pain.[33–36] In an attempt to keep patients and providers safe , technology enabled chiropractic and physical therapy care has emerged as a mode of healthcare delivery for both evaluation and treatment. Physician visits and Some advocates feel the widespread implementation of telemedicine has potential to minimize Emergency Department (ED) or Urgent Care Clinic traffic, creating more efficient workflows in those settings.[37] And all of this was before COVID-19. Now there is a need to offload these entry points into the healthcare system for the health and safety of all. But there are still more questions than answers. Despite the availability of research, many studies about telemedicine are small and there is an enormous amount of heterogeneity, making conclusions difficult and the path forward muddy. [38–42]

## 1.6 Goals of this Dissertation

The goals of this dissertation are to seek to narrow the gaps in the literature surrounding the first choice of provider for patients seeking care for an acute episode of low back pain and the costs associated with specific providers.

The first paper is an exhaustive investigation into current access patterns, provider care practices, and resource utilization for patients seeking care for acute LBP. We performed a retrospective analysis of claims data from a large health insurer and examined the association between patient choice of first provider for the treatment of acute LBP and subsequent healthcare utilization over a period of 12 months following a visit for an acute onset or exacerbation of low back pain.

The second paper looked specifically at the cohort of patients who chose the ED as their first choice of provider and determined the extent to which guideline-based care was followed during the ED visit. The association between the delivery of guideline-based care (i.e., concordant) versus non-guideline-based care (i.e., non-concordant) during an ED visit and health care utilization in the 12 months following the ED visit was then examined

The third paper was a systematic review investigating the effectiveness of face-to-face, real time video telehealth interventions for low back pain. The SARS-COV2 pandemic has increased the use of tele-health. The availability and acceptability of video conferencing may well have an influence on the patient choice of provider moving forward. As we learn more about the influence of first choice of provider, this analysis will highlight the existing literature surrounding a direct influence to choice of provider and a potential solution for access to care issues.

# 2.0 The First Provider Seen for An Acute Episode of Low Back Pain: Influences on Subsequent Healthcare Utilization

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## 2.1 Introduction

Musculoskeletal disorders affect more than 1.7 billion people worldwide and are the leading cause of years lived with disability (YLD).[8] In 2012, 126.6 million US adults (54%) reported the presence of a musculoskeletal condition with the most frequent complaint being low back pain (LBP). Every year, approximately 52 million individuals seek care for their LBP. This accounts for 2.5% - 3.0% of all physician visits in the United States with annual expenditures estimated to be in excess of $85 billion.[2,3] In 2014, the direct per person costs to treat LBP were estimated at $9,035 with total aggregate direct costs estimated at $315,000,000.[6]

While the cost to treat many medical disorders is stable, or in some cases declining, the costs of care for LBP are increasing. This growth has been well documented. In the period between 1994 and 2005, Deyo et al identified a 629% increase in Medicare expenditures for epidural steroid injections; a 423% increase in opioid prescriptions; a 220% increase in spinal fusion surgery rates; and a 307% increase in the number of lumbar magnetic resonance images.[5] More current data show LBP-care costs continue to outpace increases in the overall gross domestic product, with expenditures increasing on average 6.7% per year from 1996 to 2016.[43] This growth is of particular concern with the increased attention given to inappropriate utilization surrounding the treatment of LBP, and the development of clinical practice guidelines.[4322,24,44]

Though clinical guidelines for the care of LBP exist,[23,25,45–47] uptake and adoption of these guidelines are sub-optimal at best.[21,27,48] Current guidelines for the treatment of an acute episode of LBP recommend non-pharmacologic interventions, including supervised exercise, yoga, massage, acupuncture and spinal manipulation), augmented by education to increase patients' self-efficacy. The guidelines also recommend that clinicians provide reassurance that most patients with acute LBP will recover and that their disorder will not result in permanent disability.[24,47,49,50] Poor guideline adherence results in persistent variation among healthcare providers in the evaluation and treatment of LBP.

Studies suggest that the simple availability and/or use of one test or intervention may directly influence practice patterns and drive subsequent healthcare utilization.[16,27,51–55] Webster et al. showed that the use of early imaging or opioids resulted in a cascade of avoidable medical services including additional imaging, long-term opioid use, injections, and surgical intervention.[17,28] Additionally, there is emerging data indicating that patients seeking care for LBP are at greater risk for opioid abuse. Those with LBP have three times greater odds for opioid use than those with other types of musculoskeletal pain. Opioids have also eclipsed other drugs as the most commonly prescribed medication for LBP. [27,56]

A small body of research has emerged showing that the choice of first provider and the timing of interventions for LBP influence subsequent healthcare utilization.[12,13] Studies to date have been limited by small sample sizes, a limited number of first providers studied, and a focus on patients with private health insurance.[13] This study extends previous work by increasing the sample size and the number of provider types considered as the initial point of contact for patients with LBP, as well as including patients with both public and private insurance. The objective of this study was to examine the association between patient choice of first provider and subsequent healthcare utilization in the 12 months after the index visit. Specific healthcare utilization variables of interest included high-cost imaging (MRI/CT); low-cost imaging (plane radiographs), epidural steroid injections, physician specialty referral, and surgical intervention. We also examined and described the association between the first provider seen and total LBP costs of care as well as total medical costs of care.

## 2.2 Methods

### 2.2.1 Data Source

We examined claims data extracted from a large health insurance plan serving 1.3 million beneficiaries in Pennsylvania, New York, Ohio, West Virginia, and Maryland. Products offered by this health plan included commercial insurance, Medicaid managed care, and Medicare

Advantage (i.e., Medicare managed care). We examined data for services billed during the time frame from July 2015 through July 2018.

### 2.2.2 Study Design

Using the available claims data, we conducted a retrospective cohort analysis of patients seeking care for a new episode (or acute episode) of LBP during the three-year period from 07/01/2015 to 06/30/2018.

### 2.2.3 Cohort Identification

We identified patients with an acute episode of LBP using an extensive list of ICD-9 and ICD-10 **(Appendix A)** codes related to the diagnosis of LBP. To meet the definition of an acute episode, patients needed to have no claims with an associated LBP-related ICD-9/10 code for 3 months prior to their index visit. 3 months was used as a "clean period" based on the literature suggesting that 85-97% of patients experience resolution of an acute episode of LBP within 3 months of onset.[57,58] Three months of continuous health plan enrollment prior to the index visit and 12 months of continuous enrollment after the index visit were required to allow for the identification of acute LBP episodes, and for a 12-month follow-up of healthcare utilization. Inclusion of a claim required that one of the identified LBP codes be in the primary billing position at the index visit. Claims were excluded if the patient did not meet continuous enrollment requirements (i.e., 3 months before and 12 months after the index visit) or was under the age of 18 years. We also excluded any claims that had a secondary or tertiary code at the time of the index visit which indicated pregnancy or the presence of any "red-flag" of serious pathology or disease,[59–62] such as metastatic disease, cauda equina, spinal infection, ankylosing spondylitis, or fracture. (**Appendix B)**

### 2.2.4 Study Variables

The independent variable for this study was the first point of contact each eligible patient had with the healthcare system. We termed this initial contact as the "portal of entry." We identified the following portals of entry as independent variables: (1) Emergency Department (ED), (2) Primary Care (PC), (3) Surgery (SURG) (orthopedics or neurosurgery), (4) Specialty Care (SC) (rheumatology, physiatry or pain management), (5) Chiropractic Care (CHIRO), (6) Physical Therapy (PT), or (7) Other. Those patients in the "Other" category were patients that were unattributed to a specific provider or attributed to a provider that compromised less than 1% of the final sample. A list of "Other" first contact providers can be found in **Appendix C**.

Patient demographics and covariates were identified using available data from the health plan claims database. Demographic characteristics included age, gender, and insurance coverage (Medicare Advantage, Medicaid Managed Care, or Commercial). Covariates included the mean (age-adjusted) Charlson Co-Morbidity index (CCI) score as well as indicators for the following specific co-morbid conditions listed within the CCI: congestive heart failure (CHF), peripheral vascular disease (PVD), chronic obstructive pulmonary disease (COPD), diabetes (DM), hypertension (HTN), anxiety (ANX), and depression (DEP)[63]. Additional covariates included indicators for body mass index (BMI) >30 (yes/no), serious persistent mental illness (SPMI) (yes/no) and high healthcare utilization. (yes/no). SPMI is defined as individuals diagnosed with Schizophrenic Disorders, Episodic Mood Disorders, or Borderline Personality Disorders based on ICD-9/ICD-10 codes (**Appendix D**) over the previous 12-month period. This was included as a co-variate to control for members identified with SPMI who have “high behavioral health needs” and those identified without SPMI who are likely to have “low behavioral health needs.” High utilizers were identified using internal predictive models that recognize members with increased service use. These models flag members with spending above a specific threshold or those with escalating utilization. Using a combination of claims data, pharmacy data and demographic data, the models predict whether utilization for flagged members will continue to escalate or remain above the spending threshold over the following 12 months. Members with end-stage renal disease, transplant and cancer are excluded from the models as they are expected to have high spending and utilization.

We created several dependent variables representing the amount and type of healthcare utilization that occurred in the 12 months following the index visit. We used point of service codes, diagnostic-related group (DRG) codes, and CPT-4 codes to identify different types of health care use for LBP. **(Appendix E)** We created a variable to represent the length of the episode of care in days. Episode length was operationalized as the time from the date of the index visit for LBP to the date of the last claim with a LBP diagnosis code. An episode was considered “resolved” when a patient had 90 days without a claim for LBP. We created dichotomous outcomes (yes, no) to indicate use of the following: an opioid prescription written, specialist referrals (visit to orthopedics, neurosurgery, physical medicine and rehabilitation (PM&R), and/or pain management), high tech imaging which included MRI or CT use, low tech imaging which included x-rays, spinal injections, unplanned care use defined as subsequent use of the ED, and surgery. An opioid prescription related to LBP was operationalized using pharmacy claims. When a prescription is filled, the fill date and the date the prescription was written are loaded into the claim. When the date the prescription was written coincided with a visit claim date that had a LBP related diagnosis code, that prescription was associated with the current LBP episode. We also created time-to-event variables for the healthcare utilization variables (i.e., specialist referral, low tech imaging, high tech imaging, injections, unplanned care, and surgery) defined as the time in day from the index visit to the first claim indicative of the treatment and with an associated LBP diagnosis. Total cost of care was the benefit allowed amount (BAA), including copays, for all medical claims, including pharmacy claims, for 365 days following the index visit, while LBP-related costs were the total costs of care for medical and pharmacy claims with associated LBP diagnosis codes over the same time period.

Other outcomes included: opioid prescription, specialist referral, (visit to orthopedics, neurosurgery, PM&R, and/or pain management), high tech imaging which included MRI or CT, low tech imaging which included x-ray,  spinal injection, use of unplanned care (defined as an ED visit), and progression to surgical intervention. Time to an opioid prescription was operationalized using pharmacy data from the claims database. When a prescription is filled by a patient, the date the prescription was written and the date it was filled are both entered into the claim form. When the date the prescription was written correlated with a visit claim for a LBP related code, that prescription was associated with the current LBP episode.

Time to specialist referral, low tech imaging, high tech imaging, injections, unplanned care, and surgery were all defined as the time from the index visit to the first procedure claim with an associated LBP diagnosis. All time to event variables were operationalized as "time in days from the index visit to the event". Total cost of care was calculated as the benefit allowed amount (BAA), including copays for all medical claims (including pharmacy claims), for the 12 months following the index visit. LBP-related costs were defined as the medical and pharmacy claims associated ICD-9 / ICD-10 LBP diagnosis codes over the same for the 12 months following the index visit.

## 2.3 Data Analysis

We first conducted descriptive analyses of patient demographic and clinical characteristics, episode length, and costs stratified by first choice of provider (ED, PC, SURG, SC, CHIRO, PT, OTHER). We then calculated adjusted cumulative incidence and time to event curves for each of the following outcomes: opioid prescription, high tech imaging, low tech imaging, injections, surgery, unplanned care, and specialty referral. Finally, we calculated hazard ratios for each of these outcomes using Cox proportional hazards models. As the selection of first provider can be influenced by observed and unobserved baseline characteristics, we need to account for the systematic differences in the populations that choose each provider. Traditionally, researchers have used regression adjustments or structural approaches to selection bias.[64] Recently, more contemporary methods have evolved have evolved that incorporate time to event outcomes and hazard ratios. Because our outcomes were overwhelmingly time to event outcomes, we chose inverse probability of treatment weighting. Austin et al. found that we can use survival curves to estimate each group (or in our case first provider) separately with the simple weighting and "distribution" of baseline covariates: "the use of the 'crude' Kaplan–Meier estimator can allow for an unbiased comparison of survival between treatment (or exposure) groups."[65] In our study, propensity scores were generated using a multinomial logistic regression to determine the probability of a subject choosing one provider over another. Primary Care was used as the reference group, as more than 50% of patients chose this as their primary portal of entry and many payment models use Primary Care as the preferred entry point into the healthcare system. All baseline demographics and covariates were included in the multinomial model. Use of this technique, specifically the inverse probability of treatment, results in "an artificial treatment population" where the first choice of provider remains independent from the baseline measures.[66]

## 2.4 Results

Our final sample consisted of 29,806 unique individuals who had a healthcare visit for acute LBP from July 1, 2015 – June 30, 2018 (Figure 1). The top three portals of entry, Primary Care (n=15,199; 51%), Chiropractic Care (n=4,971; 17%) and the Emergency Department (n=2,895; 10%) accounted for over 75% of all individuals seeking care for an acute episode of LBP (**Table 1**). Younger patients tended to choose Chiropractic care, while more females chose Specialty Care and Physical Therapy. Age adjusted CCI (comorbid health burden) was highest in those who chose Surgery or the Emergency Department as their first provider of choice. Comorbid health burden was lowest in the Chiropractic group. Members with mental health disorders (anxiety, depression, SPMI) were more likely to choose a surgeon or the Emergency Department. In terms of overall utilization, those who chose specialty care had increased potential (14%) for utilization over the next year compared to Chiropractic care (5.4%).

### 2.4.1 Episode Length

Patients who entered through the Emergency Department and Physical Therapy had the shortest mean episode length at approximately 58 days (95% CI: 56, 61) and 62 days (95% CI: 58, 66) respectively. Those who entered through specialty care had the longest mean length of episode at just under 111 days (95% CI: 105, 116). **(Table 2.7.2)**

### 2.4.2 Costs of Care

We considered both total medical utilization and low back related medical utilization in the subsequent year. Costs were calculated using United States Dollars (USD) and included the index visit. Average total cost of care (TCOC) for all medical costs was lowest in those who first sought care with Chiropractic $7,761 (95% CI: $7,306, $8,218) or Physical Therapy $11,612 (95% CI: $10,586, $12,638). The highest average TCOC for all medical costs was seen in those patients who chose the Emergency Department, $20,028 (95% CI: $18,903, $21,154) and those who entered through Surgery, $17,825 (95% CI: $16,794, $18,857). Similarly, when costs were limited to just those claims associated with LBP codes, the lowest average LBP related spending occurred in Chiropractic $992 (95% CI: $913, 1,072) and Physical Therapy $1,925 (95% CI: $1,689, 2,161) while the highest LBP related spending was seen in Surgery $4,346 (95% CI: $3,870, 4,821) and Emergency Department $3,382 (95% CI: $3,102, 3,661). **(Table 2.7.2)**

### 2.4.3 X-Ray (Low Tech Imaging)

Use of x-ray was highest in those members who had first contact with a surgeon or a PCP. 61% of those who saw a surgeon and 47% of those who saw their PCP would undergo an x-ray within the 30 days following the index visit. This contrasts with those who saw a PT or a Chiropractor first; 6% of those who saw a PT and 19% of those who saw a chiropractor received an x-ray in the first 30 days. During the next year just over 24% of those who sought PT or Chiropractic care would receive an x-ray compared to over 70% for those who saw a surgeon and 60% for those who saw their PCP. In terms of risk, those patients seen in the surgical setting were 1.5 times more likely to receive an x-ray than those seen by their PCP. Hazard ratios were lower than 0.5 for all other portals of entry. **(Tables 2.7.3, 2.7.4; Figure 2.8.2)**

### 2.4.4 CT/MRI (High Tech Imaging)

In the year following the index visit, about 65% of those who chose Primary Care or Surgery as their first provider received a LBP related, high tech image (CT or MRI). Additionally, of those patients who entered through Primary Care or Surgery and received an MRI, 49% would receive that MRI in the first 30 days following the index event. In contrast, only 3% of those who entered through Chiropractic and 9% of those who entered through Physical Therapy received a high tech image in the first 30 days. MRI/CT utilization was greatest in the Primary Care group, as hazard ratios for all portals of entry relative to primary care were less than 1.00. Chiropractic and Physical Therapy patients had the lowest risk of receiving an MRI/CT, at any time in the subsequent year, with hazard ratios of 0.09 (95% CI 0.08, 0.1) and 0.26 (95% CI 0.26, 0.27) respectively. **(Tables 2.7.3, 2.7.4; Figure 2.8.3)**

### 2.4.5 Injections

55% of those who entered through Specialty Care received an injection, compared with less than 5% of those entering through Chiropractic and 15% of those entering through Physical Therapy. Relative to the primary care portal of entry, the risk of receiving an injection increased 2.2 times (95% CI: 2.16, 2.26) when the portal of entry was Specialty Care. Entry through the Emergency Department increased the risk of injection by 1.2 times at any point during the next year, (95% CI: 1.21, 1.27) relative to primary care. **(Tables 2.7.3, 2.7.4; Figure 2.8.4)**

### 2.4.6 Opioid Prescribing

During the 12 months following the index visit, opioid prescription rates were highest for those who entered through the Emergency Department (55%) and Specialty Care (39%). Rates were lowest for those who entered through Chiropractic (5%) and Physical Therapy (11%). We found that, compared to first contact with Primary Care, those who entered through the Emergency Department had a 2.82 (95% CI: 2.75, 2.90) higher risk of filling an opioid prescription at any point during the year following the index visit. 21% of those prescriptions were filled on the day of the index visit (Day 1) with 33% filling a prescription in the first 30 days. Those who entered through Specialty Care were 1.35 times more likely to receive a prescription for opioids, with 18% filling that prescription on the same day of the index visit. Those who chose Surgery, Physical Therapy and Chiropractic were less likely to receive an opioid prescription, when compared to Primary Care. Hazard ratios were less than 1.0 for Physical Therapy (0.39; 95% CI: 0.37, 0.40), Chiropractic (0.13;95%CI: 0.12, 0.14) and surgery (0.90; 95%CI: 0.88, 0.92) groups. **(Tables 2.7.3, 2.7.4; Figure 2.8.5)**

### 2.4.7 Surgery

Surgery is not a common outcome in acute LBP, but has received increased attention in the recent clinical practice guidelines as a likely overused intervention for LBP.[50,67–69] In our sample, fewer than 7% of those who initiated care at Surgery and 4% of those who chose the Emergency Department progressed to surgery over the next 12 months. In contrast, those who sought care initially from a chiropractor or physical therapist had significantly lower rates of surgical intervention. Those who chose Chiropractic as their first choice of provider progressed to surgery less than 1% of the time and just over 1% of those who chose Physical Therapy as their first choice of provider required surgical intervention. Those who entered through Surgery doubled their risk (2.0; 95% CI 1.90, 2.22) of undergoing a low back related surgical procedure over the next year. Patients who used the Emergency Department had the second highest risk of surgical intervention (1.2; 95% CI: 1.10, 1.31). **(Tables 2.7.3, 2.7.4; Figure 2.8.6)**

### 2.4.8 Specialty Referral

Specialty referral was defined as a referral to orthopedic surgery, neurosurgery, physical medicine and rehabilitation, rheumatology, or pain management. Referral to a specialist at any point during the next year was highest for the surgery group (1.66; 95% CI: 1.63, 1.70) and the specialty care group (1.79; 95% CI: 1.76, 1.83). This is likely due to the fact that these portals of entry continued to manage members who chose them as their initial provider of choice. All other providers had hazard ratios less than 1.00, indicating rates of referral less than that of the reference group. **(Tables 2.7.3, 2.7.4; Figure 2.8.7)**

### 2.4.9 Unplanned Care Use

Unplanned care use was highest in those members who chose the Emergency Department as their first provider. Over 30% of those who chose the Emergency Department would have an additional LBP related visit to the Emergency Department. When compared to the Primary Care group, those members who chose the Emergency Department as their first contact provider initially were 5 times more likely to use the Emergency Department for a low back related claim at any time during the year following their index visit. (5.64; 95% CI: 5.35, 5.93) All other portals of entry (except the "Other" group) had Hazard ratios less than 1.00, indicating rates of use less than that of the Primary Care reference group. **(Tables 2.7.3, 2.7.4; Figure 2.8.8)**

## 2.5 Discussion

The purpose of this study was to investigate the impact that patient choice of first provider had on subsequent medical utilization in patients with an acute episode of LBP. As in previous studies,[13,70] the most common entry points into the system were Primary Care, Chiropractic Care, and the Emergency Department. Those who chose Chiropractic and Physical Therapy first had lower risks of overall and low back related utilization for all outcomes, when compared to Primary Care. Additionally, both Chiropractic and Physical Therapy had the lowest TCOC for total medical spending and low back related medical spending in the subsequent year. These 2 groups, while similar to other portals of entry, have some unique characteristics that make them different from other portals of entry.

First, these providers are not medical doctors. Neither has prescribing rights and only chiropractors can provide or refer for imaging. This naturally forces Physical Therapy and Chiropractic providers to choose interventions that are more consistent with non-surgical Second, many medical providers are looking for a "pathoanatomic diagnosis." The pathoanatomic diagnosis, though significant, rarely drives the interventions used by physical therapists. There also appears to be a timing element at work. Patients can seek Physical Therapy and Chiropractic care at any time during an episode of care, even while receiving care from other providers. Emerging evidence suggests that those patients who choose Physical Therapy and Chiropractic early in an episode of care have improved outcomes and lower costs when compared to other providers.[12,13,71] The argument can be made that these providers don't have prescribing rights or perform surgeries, but the data continue to suggest that these two professions, when accessed early in the course of care, continue to provide a cost-effective, non-surgical management strategy for LBP that is aligned with the clinical practice guidelines.

It was concerning to see the high number of LBP patients filling a prescription for opioids and the timing of that prescription. Over 33% of our total sample would fill at least one prescription for opioids within the year following their index visit. 38% of those who used the Emergency Department as their entry point would fill a prescription on Day 1 (the day of the index visit), with 50% of patients filling a prescription within the next 30 days. It was also concerning to see that of those patients who received an opioid prescription, 42% would fill that opioid prescription on Day 1, and 65% would fill a prescription by Day 30. Although these rates of opioid prescription seem high, this prevalence rate is in line with previously studied cohorts.[70] This high rate of opioid prescribing, however, is not in line with past and current clinical practice guidelines.[22,23,72]

The utilization rates of high cost imaging, MRIs, and CTs, was just as concerning. The American College of Physicians (ACP) and the American Pain Society (APS) joint clinical practice guideline recommends that "clinicians should not routinely obtain imaging or other diagnostic tests in patients with nonspecific LBP."[24] These guidelines also state that "diagnostic imaging and testing for patients with LBP should only be used when severe or progressive neurologic deficits are present or when serious underlying conditions are suspected on the basis of history and physical examination."[22] Since we excluded emergent LBP codes from our data set, emergent imaging should have been minimized. What we found however, was that 51% of the total population received a high cost image in the year %following their index visit. Of those who received high cost images, 29% of those images occurred on the day of the index visit and 73% would occur within the first 30 days. That equates to 36% of our entire patient population being imaged within the 30 days following their index visit. When we break this down by provider type, 65% of those members who saw their PCP or a surgeon as the first provider would get an MRI over the next year. It might be argued that this rate was appropriate for the surgery cohort, as surgeons use MRI in their decision making about those patients who are appropriate for surgery. The rates in primary care are confusing and warrant further investigation.

In contrast, the utilization rates of MRI in the Physical Therapy and the Chiropractic groups are significantly lower than those in other portals of entry. As previously stated, these providers do not have regular access to high cost imaging so we would expect their rates to be lower. Finally, the observed rates of CT and MRI utilization and opioid prescriptions are not aligned with the current evidence. There is a lack of concordance between current clinical practice guidelines and inappropriate choices of interventions, imaging, and specialty referrals. This indicates that despite increased attention, there is still much work to be done with dissemination and implementation of best practice standards.[22,24,73]

It is clear from the data above, that the first provider seen for an acute episode of LBP influences immediate healthcare utilization. What has been unclear to this point is the influence and impact the initial choice of provider has on utilization over time. Our data show a relationship between the initial choice of provider and the interventions used, the initial costs incurred, and those medical costs related to the treatment of LBP for the subsequent 12 months after the index visit.

We identified several strengths and limitations in this study. Although we were able to substantially increase the heterogeneity and overall sample size compared to previous studies, we were still limited by the fact that our analysis contains only administrative claims data. Our data, though robust, contains no clinical information such as severity of pain or symptomatic presentation, which could clearly influence a patient's choice of practitioner and a practitioner's choice of intervention. This results in an inability to assess specific clinical outcomes and provides insights into patient utilization trajectories rather than outcomes. Additionally, because of the administrative database queried, we cannot reliably attribute all events to any one specific provider. For example, if an individual is seen in the ED and has an MRI seven days later, we cannot determine who ordered the MRI; only that the patient received the service.

Finally, the administrative nature of our data does not allow us to consider the large under-insured and non-insured populations that are not represented in our analysis. There is information available indicating that these populations are accessing the health system, but their provider of choice may not be represented in this study.[74] These patients likely have LBP, but their behaviors may be vastly different than their fully or partially insured counterparts. Additionally, for those patients with insurance coverage, benefit structure may play a key role in their choice of first provider. Many commercial plans have large co-pays that discourage patients from accessing certain providers or services. Medicaid, on the other hand, has no co-pay but low reimbursement rates with some providers creates a financial disincentive, and many simply will not accept patients with Medicaid. Finally, access and availability of services directly influences the use of services. These influences can all be considered forms of selection bias. Despite the use of statistical methods (inverse weighted probability scoring) to control for potential bias, we cannot fully eliminate the impact that selection bias may have had on this study.

Notwithstanding these limitations, there are also substantial strengths in this study. Previous analyses were limited by their use of primarily commercial data[70,75,76] or data derived from smaller, integrated health systems.[13] We analyzed claims from a health plan that insures both public and commercial lines of business, representing a database of 1.7 million members The inclusion of all payors allows for a better representation of the type of patients who may present to specific types of providers, reducing selection bias. After consulting the literature and industry experts, we arrived at what we felt was a more comprehensive code list that included both ICD 9 and 10 code sets. The use of an exhaustive code list allowed us to capture a more inclusive picture of the impact of LBP, emergent and non-emergent, on our population and better represent coding practices that may vary from physician office to office. Finally, the size of the insurer and the number of active members allowed for specific inclusion criteria while still providing a robust sample size for cohort for analysis.

## 2.6 Conclusion

This study offers compelling evidence that the first provider seen for an acute episode of LBP influences immediate treatment decisions, the trajectory of a specific patient episode and the future healthcare choices a patient may make regarding the treatment of their LBP. Additionally, it appears that per episode costs for low back care and total medical spending for year following the index visit are also influenced by the choice of first contact provider. As healthcare resources continue to dwindle and the shortage of physicians increases, we need to consider more efficient and cost-effective strategies to manage patients with LBP. Implementation strategies should be multi-faceted, aimed at behavior change, and involve increased use of non-surgical and non-opioid interventions. Given that both Chiropractic and Physical Therapy provide non-pharmacologic and non-surgical interventions that promote behavior change, significant consideration should be given to these groups as first line providers of care for LBP, as their use appears related to a decrease in both immediate and long-term utilization of healthcare resources.

## 2.7 Tables

### Table 2.7.1 Demographics Stratified by Portal of Entry

| | PORTAL OF ENTRY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Emergency Department** | **Primary Care** | **Surgery** | **Specialty Care** | **Chiropractic** | **Physical Therapy** | **Other** | **Totals** |
| **N** | **2895 (9.7%)** | **15199 (51.0%)** | **2475 (8.3%)** | **2692 (9.0%)** | **4971 (16.7%)** | **1226 (4.1%)** | **348 (1.2%)** | **29806** |
| **Insurance Type** | | | | | | | | |
| Commercial | 1004 (34.6%) | 5984 (39.4%) | 1035 (41.8%) | 913 (33%) | 3899 (78%) | 507 (41%) | 110 (0.8%) | **13452 (45.1%)** |
| Medicaid | 973 (33.6%) | 3906 (25.7%) | 503 (20.3%) | 812 (30%) | 736 (15%) | 268 (22%) | 133 (1.8%) | **7331 (24.6%)** |
| Medicare | 918 (31.7%) | 5309 (34.9%) | 937 (37.8%) | 967 (35%) | 336 (6%) | 451 (37%) | 105 (1.2%) | **9023 (30.2%)** |
| **Age (mean, SD)** | 53.48 (17.6) | 55.83 (16.7) | 57.66 (17.1) | 55.30 (15.5) | 46.35 (14.8) | 55.36 (17.8) | 52.64 (17.9) | |
| **Gender (F)** | 1701 (58.8%) | 8916 (58.7%) | 1409 (56.9%) | 1602 (59.9%) | 2779 (55.9%) | 775 (63.2%) | 192 (55.2%) | **17374 (58.3%)** |
| **CCI - Age Adjusted (Mean, 95% CI)** | 2.9 (2.7-3.0) | 2.8 (2.7-2.9) | 3.0 (2.9-3.1) | 2.74 (2.6-2.8) | 1.7 (1.6-1.8) | 2.5 (2.4-2.7) | 2.6 (2.3-3.0) | |
| **CC- CHF** | 154 (5.3%) | 515 (3.4%) | 85 (3.44%) | 108 (4.0%) | 42 (0.8%) | 33 (2.7%) | 15 (4.3%) | **952 (3.2%)** |
| **CC - CAD** | 386 (13.3%) | 1881 (12.4%) | 312 (12.6%) | 339 (12.6%) | 189 (3.8%) | 104 (8.5%) | 34 (9.8%) | **3245 (10.9%)** |
| **CC - COPD** | 355 (12.3%) | 1496 (9.8%) | 243 (9.8%) | 336 (12.5%) | 118 (2.4%) | 76 (6.2%) | 33 (9.5%) | **2657 (8.9%)** |
| **CC - DM** | 569 (19.7%) | 2669 (17.6%) | 431 (17.4%) | 489 (18.1%) | 389 (12.3%) | 196 (12.3%) | 65 (12.3%) | **4808 (16.1%)** |
| **CC - HTN** | 1284 (44.4%) | 6696 (44.1%) | 1173 (47.4%) | 1196 (44.4%) | 1164 (23.4%) | 507 (41.4%) | 139 (39.9%) | **12159 (40.8%)** |
| **CC - ANX** | 364 (12.8%) | 1636 (10.8%) | 230 (9.3%) | 350 (11.2%) | 385 (7.7%) | 112 (9.1%) | 40 (11.5%) | **3117 (10.5%)** |
| **CC - DEP** | 271 (9.4%) | 1272 (8.4%) | 169 (6.8%) | 285 (10.6%) | 245 (4.9%) | 94 (7.7%) | 38 (10.9%) | **2374 (8.0%)** |
| **BMI >30** | 143 (4.9%) | 747 (4.9%) | 124 (5.0%) | 92 (3.4%) | 388 (7.8%) | 53 (4.3%) | 5 (1.4%) | **1552 (5.2%)** |
| **SPMI** | 417 (14.4%) | 1784 (11.7%) | 228 (9.2%) | 341 (12.7%) | 336 (6.8%) | 129 (10.5%) | 51 (14.7%) | **3286 (11.0%)** |
| **High Utilizers*** | 315 (10.9%) | 1630 (10.7%) | 272 (11.0%) | 377 (14.0%) | 268 (5.4%) | 124 (10.1%) | 38 (10.9%) | **3024 (10.2%)** |

*High Utilizers were identified using a proprietary insurer algorithm that identifies a member with rising resource utilization and predicts if a member's service utilization (i.e. the number of CPT-4 services) will increase or remain above a spending threshold over the coming 12 months.

### Table 2.7.2 Episode Length and Costs of Care

| | PORTAL OF ENTRY | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Emergency Department** | **Primary Care** | **Surgery** | **Specialty Care** | **Chiropractic** | **Physical Therapy** | **Other** |
| **N** | **2895 (9.7%)** | **15199 (51.0%)** | **2475 (8.3%)** | **2692 (9.0%)** | **4971 (16.7%)** | **1226 (4.1%)** | **348 (1.2%)** |
| Episode Length (days) (Mean, 95% CI) | 58.23 (55.64 - 60.83) | 75.77 (74.37 - 77.16) | 74.57 (71.21 - 77.93) | 110.62 (105.49 - 115.76) | 79.03 (75.66 - 82.41) | 61.81 (57.86 - 65.75) | 82.29 (72.90 - 91.68) |
| Episode Length (days) (Median) | 35 | 49 | 49 | 68 | 35 | 37 | 53.5 |
| LBP related Spend (Mean, 95% CI) | $3382.02 (3,102.06 - 3,661.99) | $2912.22 (2,789.01 - 3,035.44) | $4346.25 (3,870.92 - 4,821.47) | $2048.57 (1,863.05 - 2,234.09) | $992.37 (913.11 - 1,071.64) | $1925.34 (1,689.64 - 2,161.04) | $4030.24 (2,687.91 - 5,372.56) |
| Low Back Costs (Median) | $950.1 | $793.72 | $981.7 | $865.77 | $431.7 | $851.83 | $812.65 |
| Total Cost of Care (Mean, 95% CI) | $20028.23 (18,902.67 - 21,153.80) | $16609.48 (16,163.41 - 17,055.56) | $17825.38 (16,794.17 - 18,856.60) | $17300.99 (16,247.62 - 18,354.36) | $7761.63 (7,305.72 - 8,217.54) | $11612.13 (10,586.49 - 12,637.78) | $20294.55 (16,588.91 - 24,000.19) |
| Total Cost of Care (Median) | $9,412.01 | $7,836.44 | $8,144.52 | $8,546.22 | $3,334.08 | $5,716.24 | $8,385.46 |

## Table 2.7.3 Health Care Utilization by Portal of Entry

| | PORTAL OF ENTRY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Emergency Department | Primary Care | Surgery | Specialty Care | Chiropractic | Physical Therapy | Other | Totals |
| **N** | **2895 (9.7%)** | **15199 (51.0%)** | **2475 (8.3%)** | **2692 (9.0%)** | **4971 (16.7%)** | **1226 (4.1%)** | **348 (1.2%)** | **29806** |
| Low tech image | 1132 (39.10%) | 9302 (61.20%) | 1797 (72.61%) | 1023 (38.00%) | 1216 (24.46%) | 270 (22.02%) | 167 (47.99%) | **14899 (50.01%)** |
| High tech image | 1428 (49.33%) | 9922 (65.28%) | 1633 (65.98%) | 1233 (45.80%) | 480 (9.66%) | 338 (27.56%) | 221 (63.50%) | **14551 (51.18%)** |
| Injection | 980 (33.85%) | 5176 (34.05%) | 875 (35.35%) | 1484 (55.13%) | 245 (4.92%) | 188 (15.33%) | 113 (32.47%) | **9061 (39.40%)** |
| Opioid prescription | 1604 (55.40%) | 4259 (28.02%) | 611 (24.69%) | 1057 (39.26%) | 269 (5.41%) | 132 (10.77%) | 100 (28.74%) | **8032 (26.95%)** |
| Surgery | 122 (4.21%) | 487 (3.20%) | 164 (6.62%) | 39 (1.45%) | 18 (0.36%) | 14 (1.14%) | 10 (2.87%) | **854 (2.86%)** |
| Specialist Referral | 1456 (50.29%) | 8646 (56.88%) | 2410 (97.37%) | 2293 (85.18%) | 411 (8.27%) | 317 (25.86%) | 188 (54.02%) | **14085 (33.85%)** |
| Unplanned care | 892 (30.81%) | 1008 (6.63%) | 112 (4.52%) | 133 (4.94%) | 91 (1.83%) | 48 (3.91%) | 33 (9.48%) | **2317 (7.77%)** |

## Table 2.7.4 Adjusted Cumulative Incidence and Hazard Ratios for Health Care Utilization

| | Day 1 | Day 30 | Day 60 | Day 90 | Day 365 | Hazard Ratio (95% CI) |
|---|---|---|---|---|---|---|
| **X-Ray (Low Tech)** | | | | | | |
| ED | 6.80% | 23.90% | 29.50% | 32.78% | 39.10% | 0.48 (0.47 - 0.50) |
| PCP | 36.44% | 47.57% | 52.69% | 55.67% | 61.20% | 1.00 |
| Surgery | 51.39% | 61.49% | 65.62% | 68.20% | 72.61% | 1.46 (1.43 - 1.49) |
| Specialty Care | 9.70% | 21.25% | 26.75% | 29.68% | 38.00% | 0.46 (0.45 - 0.47) |
| Chiropractic | 15.27% | 18.55% | 19.90% | 20.82% | 24.46% | 0.26 (0.26 - 0.27) |
| Physical Therapy | 0.73% | 6.20% | 9.87% | 12.48% | 22.02% | 0.23 (0.23 - 0.24) |
| Other | 21.26% | 29.31% | 35.06% | 38.22% | 47.99% | 0.48 (0.47 - 0.50) |
| **MRI/CT (High Tech)** | | | | | | |
| ED | 8.01% | 33.33% | 40.97% | 44.28% | 49.33% | 0.61 (0.59 - 0.62) |
| PCP | 25.39% | 49.33% | 56.60% | 60.43% | 65.28% | 1.00 |
| Surgery | 3.39% | 49.29% | 57.45% | 60.48% | 65.98% | 0.90 (0.88 - 0.92) |
| Specialty Care | 2.56% | 27.41% | 33.66% | 36.85% | 45.80% | 0.52 (0.51 - 0.53) |
| Chiropractic | 0.10% | 2.92% | 4.61% | 5.65% | 9.66% | 0.09 (0.09 - 0.10) |
| Physical Therapy | 0.82% | 9.30% | 15.01% | 18.68% | 27.57% | 0.27 (0.26 - 0.27) |
| Other | 39.94% | 51.15% | 56.32% | 59.20% | 63.50% | 1.13 (1.11 - 1.15) |
| **Injection** | | | | | | |
| ED | 11.02% | 19.86% | 24.35% | 27.39% | 33.85% | 1.24 (1.21 - 1.28) |
| PCP | 3.99% | 12.41% | 19.79% | 24.81% | 34.05% | 1.00 |
| Surgery | 3.47% | 14.26% | 22.63% | 27.47% | 35.35% | 1.04 (1.02 - 1.07) |
| Specialty Care | 15.42% | 34.14% | 43.87% | 47.73% | 55.13% | 2.21 (2.16 - 2.26) |
| Chiropractic | 0.04% | 0.82% | 1.71% | 2.33% | 4.93% | 0.13 (0.12 - 0.14) |
| Physical Therapy | 0.08% | 2.37% | 5.79% | 7.75% | 15.33% | 0.39 (0.37 - 0.40) |
| Other | 6.03% | 11.21% | 19.54% | 24.71% | 32.47% | 1.04 (1.01 - 1.07) |
| **Opioid Script Filled** | | | | | | |
| ED | 38.17% | 49.64% | 51.33% | 52.37% | 55.41% | 2.82 (2.75 - 2.90) |
| PCP | 10.01% | 16.86% | 20.19% | 22.40% | 28.02% | 1.00 |
| Surgery | 8.97% | 14.22% | 16.81% | 19.43% | 24.69% | 0.90 (0.85 - 0.90) |
| Specialty Care | 18.39% | 27.34% | 30.94% | 33.14% | 39.26% | 1.58 (1.54 - 1.63) |
| Chiropractic | 0.34% | 2.29% | 3.02% | 3.44% | 5.41% | 0.19 (0.18 - 0.20) |
| Physical Therapy | 0.57% | 4.24% | 5.71% | 6.53% | 10.77% | 0.35 (0.34 - 0.37) |
| Other | 7.47% | 13.51% | 17.53% | 22.13% | 28.74% | 0.95 (0.93 - 0.98) |
| **Surgery** | | | | | | |
| ED | 1.11% | 2.28% | 2.73% | 2.97% | 4.21% | 1.20 (1.10 - 1.31) |
| PCP | 0.06% | 0.42% | 0.91% | 1.37% | 3.20% | 1.00 |
| Surgery | 0.36% | 1.09% | 2.10% | 3.56% | 6.63% | 2.05 (1.90 - 2.22) |
| Specialty Care | 0.00% | 0.00% | 0.04% | 0.11% | 1.45% | 0.44 (0.40 - 0.50) |
| Chiropractic | 0.00% | 0.04% | 0.06% | 0.10% | 0.36% | 0.15 (0.12 - 0.18) |
| Physical Therapy | 0.00% | 0.00% | 0.33% | 0.41% | 1.14% | 0.36 (0.34 - 0.42) |
| Other | 0.29% | 0.57% | 1.44% | 1.72% | 2.87% | 0.70 (0.64 - 0.77) |
| **Specialist Referral** | | | | | | |
| ED | 5.60% | 30.16% | 38.96% | 43.42% | 50.29% | 0.88 (0.86 - 0.90) |
| PCP | 10.32% | 30.32% | 42.50% | 49.04% | 56.88% | 1.00 |
| Surgery | N/A | 41.01% | 59.72% | 66.02% | 72.73 % | 1.66 (1.63 – 1.70) |
| Specialty Care | N/A | 40.71% | 59.99% | 69.35% | 75.48 % | 1.79 (1.76 – 1.83) |
| Chiropractic | 0.06% | 2.09% | 3.56% | 4.61% | 8.27% | 0.12 (0.11 - 0.12 |
| Physical Therapy | 0.24% | 6.20% | 11.50% | 15.33% | 25.86% | 0.36 (0.35 - 0.37) |
| Other | 2.87% | 26.15% | 39.94% | 46.84% | 54.02% | 0.84 (0.83 - 0.86) |
| **Unplanned Care Use** | | | | | | |
| ED | 11.30% | 23.87% | 26.08% | 27.47% | 30.81% | 5.64 (5.35 – 5.93) |
| PCP | 1.03% | 3.21% | 4.01% | 4.65% | 6.63% | 1.00 |
| Surgery | 0.48% | 1.58% | 2.42% | 3.03% | 4.52% | 0.70 (0.65 - 0.74) |
| Specialty Care | 0.48% | 1.67% | 2.12% | 2.56% | 4.94% | 0.71 (0.66 - 0.75) |
| Chiropractic | 0.14% | 0.84% | 1.01% | 1.15% | 1.83% | 0.35 (0.32 -0.39) |
| Physical Therapy | 0.16% | 0.82% | 1.39% | 1.71% | 3.91% | 0.63 (0.56 - 0.67) |
| Other | 2.87% | 5.75% | 6.90% | 7.47% | 9.48% | 1.58 (1.50 - 1.67) |

## 2.8 Figures

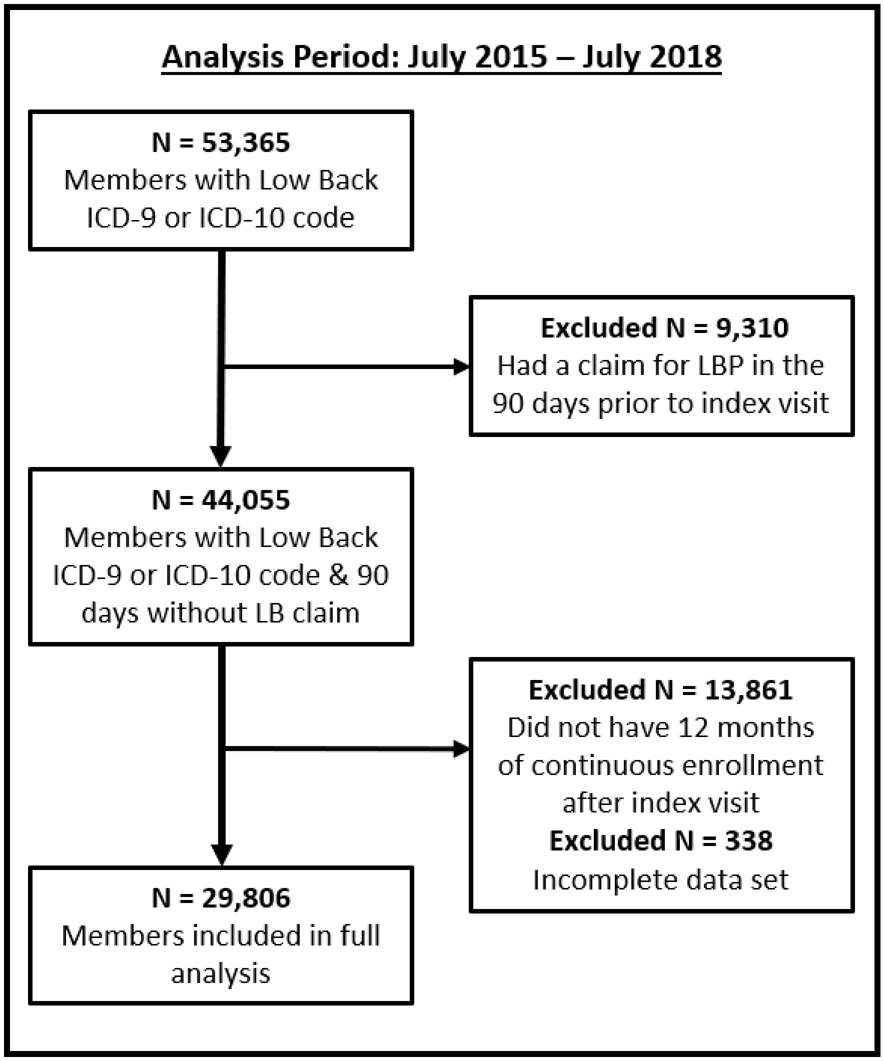


**Figure 2.8.1 Sample Selection**

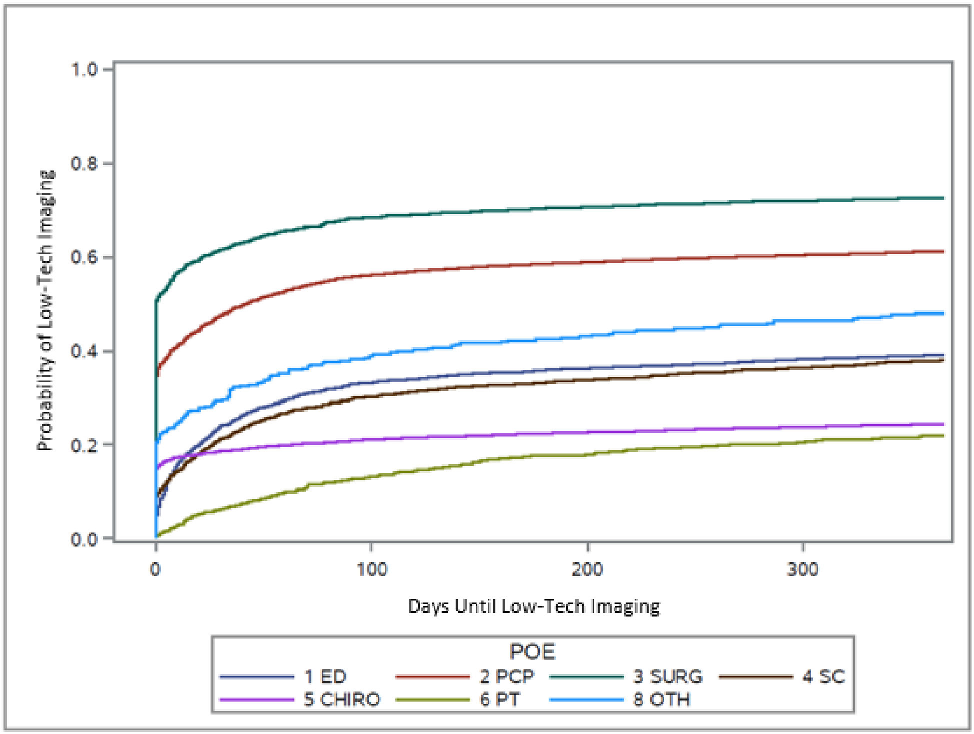


**Figure 2.8.2 Probability of Low Cost Imaging**

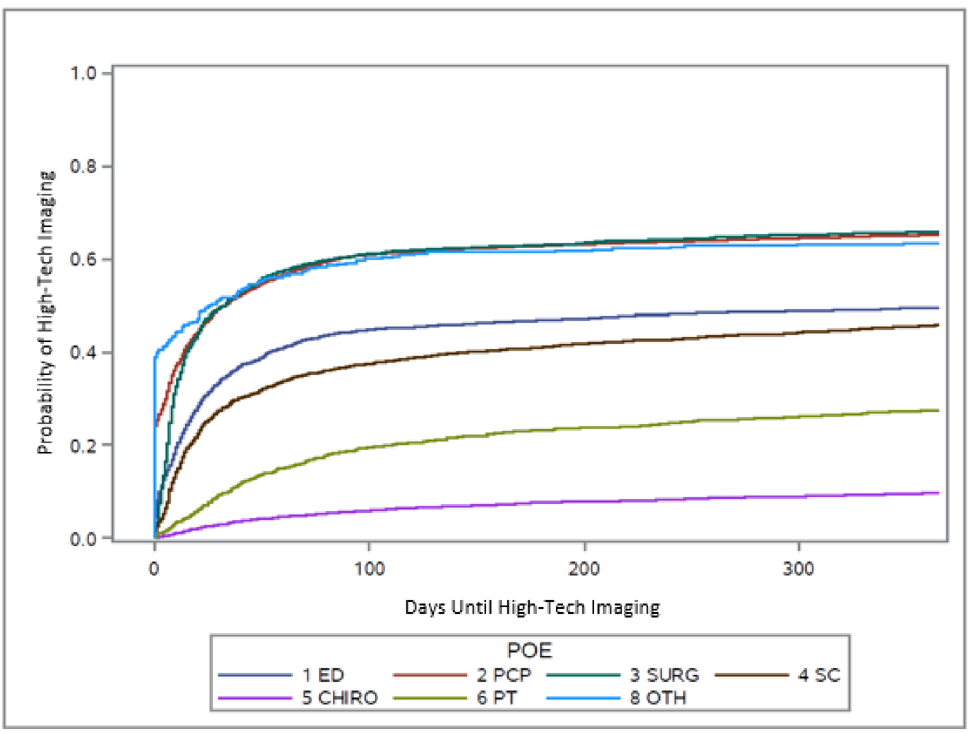


**Figure 2.8.3 Probability of High Cost Imaging**

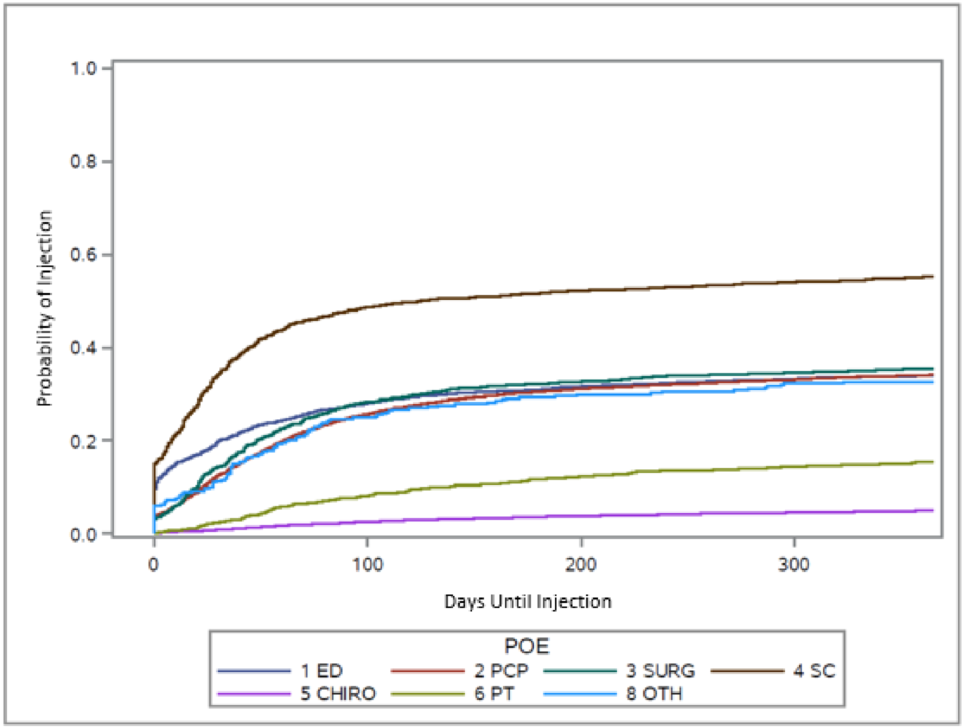


**Figure 2.8.4 Probability of Injections**

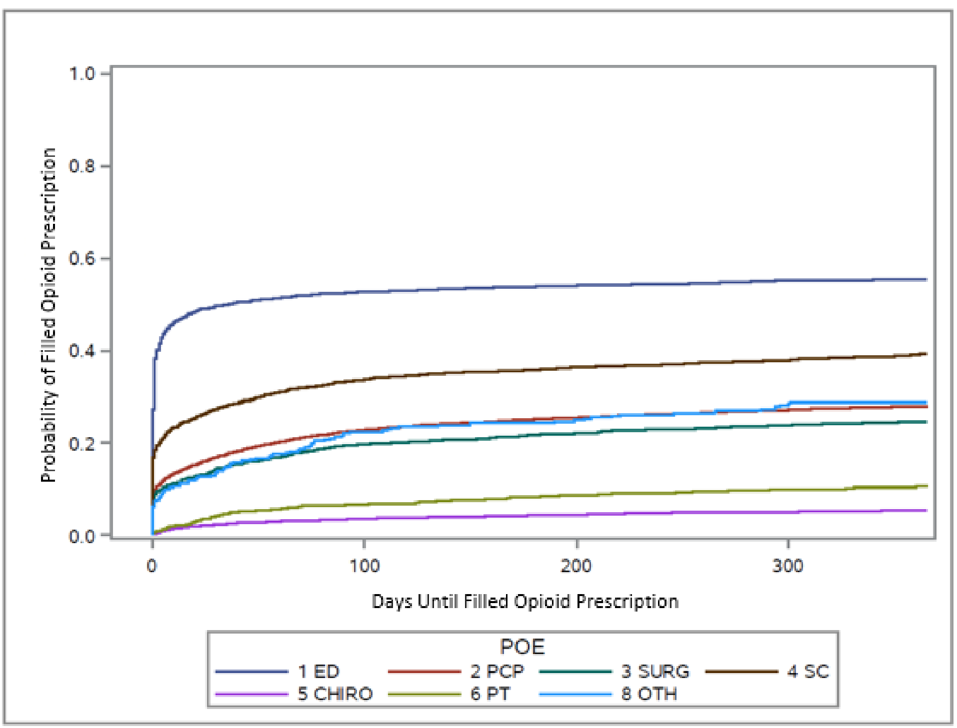


**Figure 2.8.5 Probability of Filled Opioid Prescription**

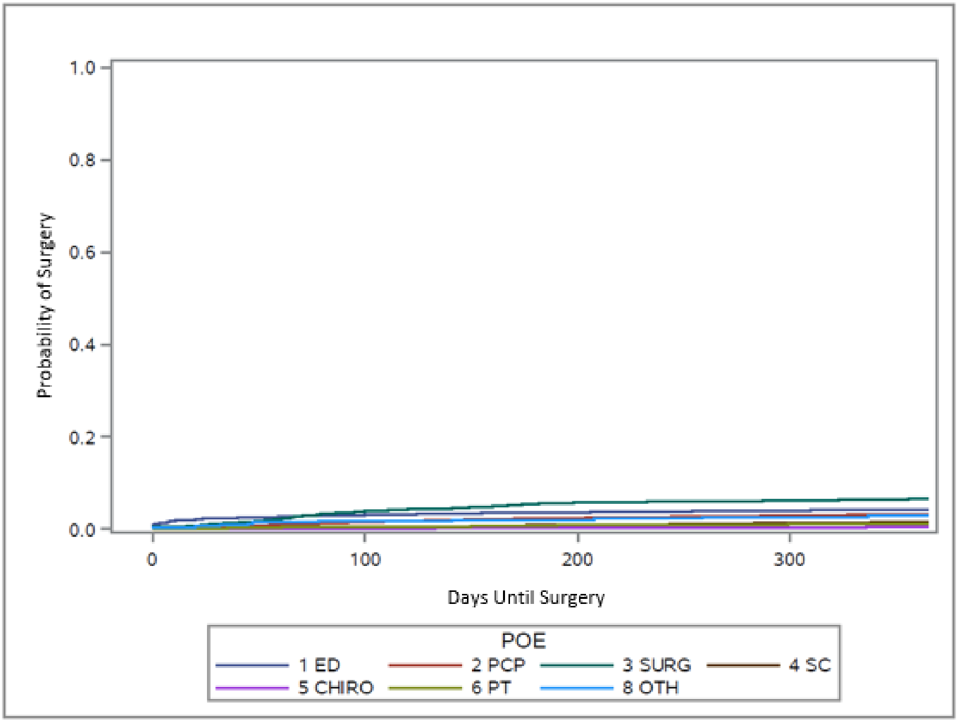


**Figure 2.8.6 Probability of Surgical Intervention**

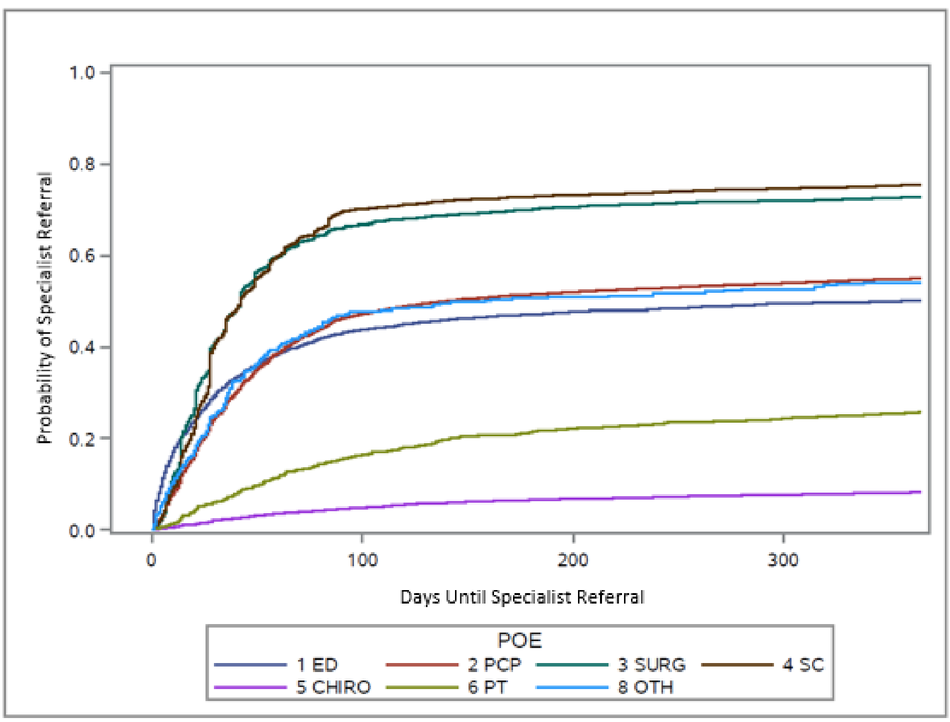


**Figure 2.8.7 Probability of Specialist Referral**

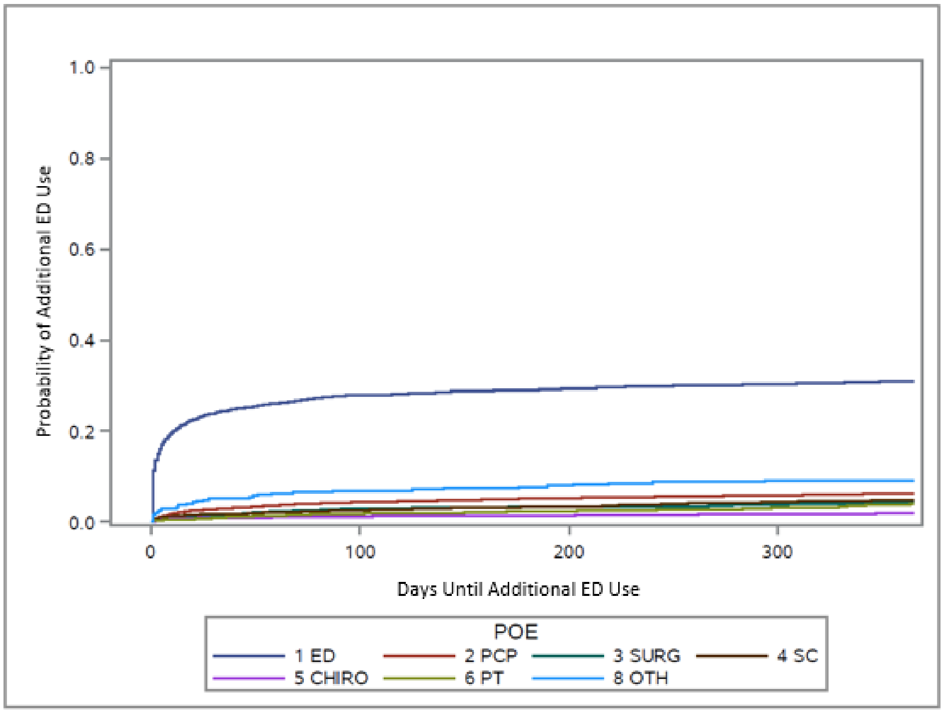


**Figure 2.8.8 Probability of Unplanned Care Use**

# 3.0 Emergency Department Use for an Acute Episode of Low Back Pain: A Trajectory and Utilization Analysis

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## 3.1 Introduction

52 million individuals seek care for their LBP every year. These patients account for almost 3.0% of all physician visits in the United States and have annual expenditures in excess of $85 billion.[2,3] In 2014, the direct per person costs to treat LBP were estimated at $9,035 with total aggregate direct costs estimated at $315,000,000 per year with many of these costs associated with poor quality or non-evidence based care.[6] The emergency department (ED) has been identified as a portal of entry for a significant number of patients seeking care for acute low back pain (LBP).

Yet rarely is acute LBP an emergent condition. An analysis of the National Hospital Ambulatory Medical Care Survey (NHAMCS) found that many patients initially seek care for LBP through the ED, with 2.63 million visits occurring annually[15] A recent systematic review estimates that 4.3% of all ED visits are for LBP.[77] Barriers to access care and changes in insurance coverage are some of the underlying factors for why patients with LBP seek care in the ED. [14,78]

Information on the quality of care for the treatment of LBP in the ED is limited. Existing evidence shows a tendency toward frequent diagnostic testing and medication use, with two-thirds of patients receiving an opioid during their ED visit.[15] This is in stark contrast to the current American College of Physician (ACP) clinical practice guidelines which recommend non-pharmacologic interventions as first line treatments. If pharmacologic intervention is needed, non-steroidal anti-inflammatories or skeletal muscle relaxants are recommended as first line medications. Clinicians are advised to only consider opioids when these other first line interventions have failed.[22,24]

Some research suggests that there is increased downstream utilization by patients who enter the system via the ED, but this research has been conducted in the occupational medicine environment which limits generalizability to the population at large.[16–18] As such, we have little information regarding the trajectory of care for patients following an ED visit for LBP.

The objectives of this study were to: 1) investigate the care being delivered in the ED for patients with LBP; 2) highlight the differences between guideline based and non-guideline based ED care; and 3) examine the association between guideline-based care (i.e., concordant) during an ED visit and subsequent health care utilization within the following 12 months. Findings from this study will fill gaps in our understanding of current practice patterns in the ED and their alignment with best practice recommendations. This study will also provide a better understanding of the potential effects of concordant and non-concordant care on subsequent health care utilization. Such information is useful for understanding and improving the quality of care for acute LBP.

## 3.2 Methods

### 3.2.1 Data Source

We examined claims data from a large health insurance plan serving 1.3 million beneficiaries in Pennsylvania, New York, Ohio, West Virginia, and Maryland. Products offered by this health plan included Commercial insurance, Medicaid managed care, and Medicare Advantage. We examined data from April 2015 through June 2018.

### 3.2.2 Study Design

Using the available data, we conducted a retrospective cohort analysis of patients seeking care in the ED for acute LBP defined as a visit for LBP preceded by a 3-month period without a low back related claim. 3 months was used as a "clean period" based on the literature suggesting that 85-97% of patients experience resolution of an acute episode of LBP by 3 months.[57,58] We specifically identified index visits for LBP from Oct 1, 2015 – June 30, 2017 to meet our definition of acute LBP and to allow for a 12-month follow-up period.

### 3.2.3 Cohort Identification

We identified claims data from patients with an acute episode of LBP using an extensive list of ICD-9 and ICD-10 **(Appendix A)** codes related to the diagnosis of LBP. Data were included in the sample if one of the identified LBP codes was in the primary billing position on the claim form at the index visit, there were no other claims with an associated LBP diagnosis for 3 months prior to the patient's index visit, the patient had 3 months of continuous health plan enrollment prior to the index visit, and 12 months of continuous enrollment after the index visit. Patients were excluded if they did not meet continuous enrollment requirements or were under the age of 18 years. We also excluded any claims that had a secondary or tertiary code at the time of the index visit which indicated pregnancy or the presence of any "red-flag" of serious pathology or disease,[59–62] such as metastatic disease, cauda equina, spinal infection, ankylosing spondylitis, or fracture. (**Appendix B)**

### 3.2.4 Study Variables

Using the clinical practice guidelines established by the American Academy of Physicians[22,24,79] we created variables for concordant and non-concordant care. Concordant care was defined as the ED physician taking any one of the following steps during the index visit: a) referral to a physical therapist; b) referral to a chiropractor; c) prescription for non-steroidal anti-inflammatories and/or skeletal muscle relaxants; d) referral to a primary care physician; or e) referral to physical medicine and rehabilitation AND not having any non-concordant care. Because referrals are not part of claims data, we attributed referrals to the ED physician if there was a visit to the provider (e.g., physical therapist) for LBP (based on ICD-9/ICD-10 codes) in the next 30 days, without an intervening LBP visit to another physician or primary care provider. Prescriptions and attribution came directly from pharmacy tables and data. The available claims data has prescriber information and the date filled.

The independent variable for this study was the use of "non-concordant care" to treat an acute episode of LBP in the ED. Non-concordant care was defined as the occurrence of any one of the following events regardless of any concordant care: a) a filled opioid prescription in the ED or a prescription for opioids filled outside the ED that can be attributed to the ED physician; b) diagnostic imaging in the ED or a claim within the first 30 days of the ED visit for an MRI; c) surgical consultation (orthopedics or neurosurgery). If the patient was seen by a PCP or other non-surgical physician (PM&R, Rheumatology etc.) prior to a surgical referral or MRI, care was attributed to that provider.

Patient demographics and comorbidities were identified using available data from the health plan claims database. Demographic characteristics included age, gender, and type of insurance coverage (Medicare Advantage, Medicaid Managed Care, or Commercial). Comorbidities included the age-adjusted total Charlson Co-Morbidity Index (CCI) score and the following specific co-morbid conditions found within the CCI: congestive heart failure (CHF), peripheral vascular disease (PVD), chronic obstructive pulmonary disease (COPD), diabetes (DM), hypertension (HTN), anxiety (ANX), and depression (DEP)[63]. Additional covariates included indicators for body mass index (BMI) serious persistent mental illness (SPMI) and high utilizers. SPMI is defined as individuals diagnosed with Schizophrenic Disorders, Episodic Mood Disorders, or Borderline Personality Disorders based on ICD-9/ICD-10 codes. (**Appendix D**) This was included as a co-variate as those members identified with SPMI have "high behavioral health needs;" those not identified with SPMI likely have "low behavioral health needs."

High utilizers were identified using proprietary, internal predictive models that identify members with increased service use and the potential for continued high service use. These models flag members with spending above a specific threshold or those with escalating utilization. Using a combination of claims data, pharmacy data and demographic data, the models predict whether utilization for flagged members will continue to escalate or remain above the spending threshold over the following 12 months. Members with end-stage renal disease, a transplant, or cancer are excluded from the models as they are expected to have high spending and utilization.

We created several dependent variables representing healthcare utilization that occurred in the 12 months following the index visit. Outcomes were identified using point of service codes, diagnostic-related group (DRG) codes, CPT-4 codes, and dates of service. **(Appendix E)** Continuous outcome variables included the length of the episode of care in days, total cost of medical care over the next 365 days, and the total episode cost for LBP-related care. Dichotomous outcomes included low-tech imaging (radiographs), high-tech imaging (MRI/CT), use of injections, opioid prescribing, surgery, specialist referral, and subsequent ED use. Episode length was defined as the time from the date of the first index visit for LBP to the date of the last claim in the 12-month follow-up period with a LBP diagnosis code (Appendix 1). An episode was considered "resolved" when a patient had 90 days without a claim for LBP. In the rare case where a patient had more than one episode of care in the 12-month follow-up period, each was treated as an independent episode if each episode met the inclusion criteria.

Total cost of care was the benefit allowed amount (BAA), including copays, for all medical claims, including pharmacy claims, for 12 months following the index visit. LBP-related costs were the costs of care for medical and pharmacy claims that were linked with an ICD-9 / ICD-10 code for LBP in the 12 months following the index visit.

We created several time to event variables for the following: opioid prescriptions; specialist referrals; (visit to orthopedics, neurosurgery); high tech imaging which included MRI or CT; low tech imaging which included radiographs; spinal injections; additional use of the ED for back pain; and surgical intervention. When a prescription is filled by a patient, the date the prescription was written and the date it was filled are both entered into the claim form. When the date the prescription was written correlated with a visit claim for a ICD-9 / ICD-10 LBP related code, that prescription was associated with the current LBP episode. Time to specialist referral, low tech imaging, high tech imaging, spinal injections, additional ED use, and surgery were defined as the difference (in days)between the date of the index visit and the date of the first procedure claim with an associated LBP diagnosis.

### 3.3 Data Analysis

We conducted descriptive analyses of patient demographics, clinical characteristics, episode length, and costs stratified by concordant and non-concordant care. We then calculated cumulative incidence and time to event curves (Kaplan Meier) using adjusted models, for each of the following variables: opioid prescription, high tech imaging, low tech imaging, injections, surgery, unplanned care, and specialty referral. Finally, we calculated hazard ratios for each outcome using Cox proportional hazards models. Because the choice of concordant vs non-concordant care has the potential for selection bias by the provider, we attempted to control for this choice by using inverse probability of treatment weights. We first generated propensity scores using logistic regression to determine the probability of a subject receiving concordant vs. non-concordant care, while controlling for demographics, comorbidities, and other covariates. The propensity scores were then used to calculate the treatment weights which were used in our regression models. Use of this technique, specifically the inverse probability of treatment weights, results in "an artificial treatment population" where the potential to receive concordant care remains independent from the baseline measures.[66]

## 3.4 Results

The final sample consisted of claims from 2,895 individuals who used the Emergency Department for acute LBP from Oct 1, 2015 – June 30, 2017 (**Figure 1**). In that group, 1758 (61%) had at least one of the variables that met the definition of "non-concordant" care. 401 (14%) had 2 or more variables and 60 (2%) of subjects met the definition of non-concordant care on all three variables. **(Table 1)**

Patients receiving non-concordant care were more likely to be female, have commercial insurance and a higher prevalence of the individual comorbidities except for CHF. The non-concordant group also had increased rates of obesity, as well as more mental health issues including anxiety, depression, and severe persistent mental illness. Those receiving concordant care had a slightly higher age adjusted CCI score. **(Table 2)**

### 3.4.1 Episode Length

The episode of care for patients whose type of ED care met our definition of non-concordant care had longer episodes of care than those who received concordant care. Patients classified as receiving non-concordant care had a mean episode length of approximately 60 days

(95% CI: 57, 64); those who received concordant care had a mean episode length of 55 days (95% CI: 59, 68). **(Table 3)**

### 3.4.2 Costs of Care

Total cost of care for all medical costs was lowest in those who received concordant care, at an average of $18,839 (95% CI: $17,239, $20,385). Low back related spending per episode was also lowest in those who received concordant care $2,635 (95% CI: $2,185, $3,084). In contrast, those who met the definition of non-concordant spent an average of $20,797 (95% CI: $19,236, $22,358) in total medical costs over the 12 months following their initial visit to the ED. Low back per episode sending was also elevated in this group at a mean cost of $3,865 (95% CI: $3,509, $4,222). (**Table 3)**

### 3.4.3 X-Ray (Low Tech Imaging)

Patients treated with concordant care received more radiographs on the day following the index visit to the ED, although 365-day utilization was highest in patients who received non-concordant care (41% vs 36%). **(Table 5)** In the 12 months following the index visit, the non-concordant group had a higher odds of receiving a radiograph, HR = 1.16 (95% CI: 1.06, 1.26). **(Table 5; Appendix Figure 1)**

### 3.4.4 CT/MRI (High Tech Imaging)

High tech imaging rates at 12 months for those receiving non-concordant care were significantly higher (54% vs. 42%) than those who received concordant care in the ED. The odds of receiving a high-tech image (CT or MRI) in the 12 months following the index visit was also higher for patients who received non-concordant care, with a RR of 1.49 (95% CI: 1.38, 1.61) **(Table 5; Appendix Figure 2)**

### 3.4.5 Injections

33% of patients who used the ED for acute management of LBP would receive an injection over the next year. Rates for those who met the criteria for non-concordant care were higher (37% vs. 29%) with rates increasing in both groups over the course of the next year. The risk of receiving an injection over the next year increased to 1.30 (95% CI: 1.18, 1.42). **(Table 4,5; Figure 4)**

### 3.4.6 Opioid Prescribing

55% of patients who chose the ED as their first contact point for an acute episode of LBP received an opioid prescription. Of those patients who received a prescription for opioids, 64% would fill that prescription while in the ED or on the day immediately following the index visit. 88% would fill a prescription for opioids by day 30. Rates and risk ratios for those who received non-concordant care in the ED were significantly higher than those treated with concordant care. Over the 12 months following the index visit, 28% of those treated with concordant care filled a prescription for an opioid. This is in stark contrast to the 73% who filled a prescription for opioids and were treated with non-concordant care. Additionally, patients treated with non-concordant care were 5 times more likely to receive an opioid at any time over the next year. (HR=5.22; 95% CI: 4.80, 5.66). **(Table 4,5; Figure 5)**

### 3.4.7 Surgery

Recent research and clinical practice guidelines have identified surgery as an overutilized intervention for acute LBP.[67–69] In the identified cohort, just over 4% of patients would progress to surgery in the year following their index visit to the ED. Surgical rates were significantly higher for patients treated with non-concordant care (4% versus 2%). The potential to undergo surgery in the year following the index visit to the ED was significantly increased in the non-concordant group, at a RR of 1.82 (95% CI: 1.35, 2.45). **(Table 4,5; Figure 6)**

### 3.4.8 Specialty Referral

Referral to orthopedic surgery, neurosurgery, physical medicine and rehabilitation, rheumatology, or pain management over the year following the index visit met the definition of "specialist referral". 50% of patients who presented to the ED with an acute episode of LBP would see a specialist over the next year. The referral rate was 58% for those treated with non-concordant care versus 36% for those treated with concordant care. The relative risk of a specialty visit was higher in the non-concordant group (RR=2.20; 95% CI: 2.04, 2.38). **(Table 4,5; Figure 7)**

### 3.4.9 Additional ED Use

30% of those seen first in the ED for their low back pain returned to the ED for additional care. There was no difference in the 2 groups after 12 months, and the rates of ED re-utilization were similar at all time points. Risk on additional unplanned care use was minimally higher in the non-concordant group (RR=1.09; 95% CI: 1.0, 1.2). **(Table 4,5; Figure 8)**

## 3.5 Discussion

The objectives of this study were to: 1) investigate the care being delivered in the ED for patients with LBP; 2) highlight the differences between guideline based and non-guideline based care; and 3) examine the association between guideline-based care (i.e., concordant) during an ED visit and subsequent health care utilization in the following 12 months. In our sample, only 39% of patients received some degree of concordant care. When broken down by procedure or treatment, 1,083 (37%) cases met the definition for opioid non-concordance, 711 (25%) met the definition for imaging non-concordance, and 483 (17%) met the definition of surgical non-concordance. **(Table 1)** Despite the availability of guidelines from multiple organizations,[22,44,79,80] it appears that there has not been widespread adoption of these guidelines in the ED.

In our cohort, line of business or insurance type did not influence whether a patient received concordant or non-concordant care. Total co-morbid burden, as represented by the age adjusted Charlson Comorbidity Index also appeared similar between the 2 groups. **(Table 2)** Of interest, however, were the higher rates of anxiety, depression and persistent mental illness in those patients who received non-concordant care. The literature shows that many who seek care in the ED have higher rates of mental health diagnoses.[81,82] Unfortunately there is a paucity of literature providing insight into why those with mental health diagnoses receive a greater share of non-concordant care.

Unsurprisingly, patients who received non-concordant care had longer episodes of care (60 days vs. 55 days) and greater low back related and total medical expenditures over the year following their ED visit. **(Table 2)** This was supported by our analysis of the individual outcomes which found that those patients who received non-concordant, LBP-related care in the ED, had significantly higher rates of utilization in all outcomes except for additional ED use over the next year. Additionally, we noted elevated hazard ratios for all outcomes. Of particular concern was the number of patients filling opioid prescriptions. 38% of those who used the ED as their initial contact point with the medical system would fill a prescription on Day 1 (the day of the index visit), with 50% filling a prescription within the next 30 days. When we overlay the definition of non-concordant care, we find 61% would fill an opioid prescription at the index visit and 71% by day 30. This is in stark contrast to those receiving concordant care of which only 3% would fill a prescription on the day following the index visit and 17% would fill a prescription by day 30. As shown by the hazard ratio of 5.22 (95%CI: 4.80, 5.66) at any time over the next 12 months, patients who received non-concordant care had more than 5 times greater risk for filling a low back related opioid script than those who received concordant care in the ED. This high rate of opioid prescribing is not in alignment with past and current clinical practice guidelines, which do not recommend opioids as a first line of clinical management for acute LBP.[22,23,72]

The high utilization rate of advanced diagnostic imaging, such as MRI and CT, was just as concerning. In 2007 and 2017, the American College of Physicians and the American Pain Society recommended in a joint clinical practice guideline that "clinicians should not routinely obtain imaging or other diagnostic tests in patients with nonspecific LBP." The guidelines also state that "diagnostic imaging and testing for patients with LBP should only be used when severe or progressive neurologic deficits are present, or when serious underlying conditions are suspected on the basis of history and physical examination."[22] Since we excluded emergent LBP codes **(Appendix 2)** from our data set, emergent imaging should have been minimized. However, 49% of those patients who arrived at the ED seeking care for an acute episode of LBP would receive an MRI or CT scan in the subsequent 12 months. 8% would receive that scan on the day of their visit to the ED or the following day. 33% would undergo advanced diagnostic imaging by day 30. When we look at this in the context of concordance with guidelines, 40% of our cohort met the definition of imaging non-concordance. By day 30, 40% of those patients treated with non-concordant care would undergo imaging compared to 23% in the concordant care group. Over the next year, 42% of those treated with concordant care would undergo advanced diagnostic imaging. Rates for those treated with non-concordant care spiked to 54% in the subsequent year. Overall, the risk of receiving an MRI or CT in the next year was 1.5 times higher for those receiving non-concordant care. Though we would expect some variation in imaging rates between the groups, the elevated numbers in both groups are significantly higher than we would expect with the availability of guidelines and the increased recognition of the increased future costs associated with early imaging.[16,28,79]

In addition to imaging and opioids, we were curious about the rate of surgical referrals and how early surgical specialty referral from the ED might influence the future use of surgery. As with previous outcomes we attempted to reduce the influence of emergent conditions on our cohort by excluding the codes listed in Appendix 2. We found that 483 of individuals in our cohort (27%) met the definition of non-concordance for surgical referral, which means that 27% received a referral or consult from a neurosurgeon or orthopedic surgeon in the ED or within the first 30 days after the index visit, without an intervening PCP visit. In contrast, current clinical guidelines recommend care under the supervision of a PCP for the first 6 weeks after the index or initial visit.[44,83] Over the next 12 months the surgical rates and the specialist referral rates of non-concordant group were twice as large as the concordant group; with 4% of those patients who received non-concordant care progressing to surgery versus 2% of those who received concordant care. In terms of surgical numbers, 70 patients in the non-concordant group received surgery over the next 12 months compared to only 23 patients in the concordant group. Not only is this difference statistically significant (<.001) but there is a significant cost differential to both the individual patient and the greater cohort. The risk of specialty referral at any time during the next year is 2.2 times higher in the non-concordant group. This likely contributed significantly to the difference in surgical cases between the 2 groups.

Finally, it is worth noting that there was no difference in the risk of using additional unplanned care use over the next year. Those treated with concordant or non-concordant care had a similar risk of additional ED visits. When considered with insurance type, it is likely that there are other potential drivers or biases that influence a patient's decision to choose the ED as their first contact point with the healthcare system for an acute episode of LBP. Overall, it is clear from the data above that even small improvements in the care being delivered in the emergency department could have significant influence on future medical utilization and immediate and long-term trajectories of patient care. Significant consideration should be given to non-physician providers as they have the potential to reduce both immediate long-term utilization of healthcare resources.

We identified several strengths and limitations in this study. One limitation is that our analysis contains only administrative data. Though administrative data can provide robust insights, it contains no clinical information such as severity of pain or symptomatic presentation which could clearly influence a patient's choice of practitioner and a practitioner's choice of intervention. Administrative data can provide insight into a patient's utilization and potential for additional utilization, but we can only speculate regarding patient progress and whether the result of the treatment received were of benefit or harm. An additional limitation is related the process collecting information from claims data. Many events cannot be attributed to a specific provider, only a location or a financial service class. For example, if an individual is seen in the emergency department and has a MRI 7 days later, we can't determine if it was the emergency department who ordered the MRI or the PCP who may have called the MRI into the center. We can only determine if the patient received the service and then speculate about attribution.

An additional limitation was the definitions of concordant and non-concordant care were a model based on the composite recommendations of many different clinical guidelines.[16,22,44,79,80,83] We attempted to incorporate as many recommendations as possible but limited ourselves to those specific points of emphasis in the ACP guidelines; opioid prescribing, imaging use, and surgical consultation. Another limitation is that these data were extracted from claims filed within the context of the US health care delivery system and the findings from this study may be generalizable only to ED care delivered in the United States.

The administrative nature of our data did not include data from the large under-insured and non-insured populations, which are not represented in our analysis. There is information available indicating that these populations are accessing the health care system, but their provider of choice may not be represented in this study.[74] These patients likely have LBP, but their behaviors may be vastly different from their fully or partially insured counterparts. Additionally, for those patients with insurance, benefit structure may play a key role in their choice of first provider. Many commercial plans have large co-pays that discourage patients from accessing certain providers or services. Medicaid, on the other hand, has no co-pay but low reimbursement rates with some providers leads them to not to accept patients with Medicaid. The result of the decreased co-pays and reduced access to care will also influence a patient's choice of provider. Access and availability of services directly influences the use of services. These influences can all be considered forms of selection bias. Despite the use of statistical methods (inverse weighted probability scoring) to control for potential selection bias, we cannot fully eliminate the impact of selection bias on this study. Additionally, the administrative nature of our data and the design of our study allow only for the identification of trends. Clearly, a rigorous clinical trial with strict inclusion and inclusion would yield more definitive recommendations.

Notwithstanding these limitations, there are also substantial strengths found within this study. This study is one of the first to query a database with 1.3 million members with both public and commercial insurance options. The size of the insurer and the number of active members allowed for specific inclusion criteria while still providing a robust sample size for cohort for analysis. In addition to the large number of the insured patients in this health plan, we increased our potential cohort size by using an expanded ICD 9/10 code set to define low back pain. The use of an exhaustive code list allowed us to capture a more inclusive picture of the impact of LBP, emergent and non-emergent, on our population and better represent coding practices that may vary from hospital to hospital.

Finally, there have been no previous studies to our knowledge that have attempted to analyze the impact of concordant and non-concordant care on a cohort of patients with low back pain who chose the emergency department as their first point of contact with the medical system. Previous analyses have focused on patient choice of provider and subsequent utilization[13,55,78] but have not investigated the impact of guideline concordance nor the impact of the care received. To our knowledge, this study is the first of its kind and may well serve as a model for future research.

## 3.6 Conclusion

A substantial subset of patients with LBP choose the ED as their first point of entry into the healthcare system. This study offers some of the first evidence revealing that patients may receive care in the emergency department that is inconsistent with current evidence-based guidelines and recommendations for the treatment of acute LBP. It appears that the care and recommendations made in the emergency department are associated with future utilization patterns. Those patients who receive concordant care will utilize less medication, imaging, and specialty consults in the near term and over the 12 months following their initial contact with the ED. As healthcare resources continue to dwindle, more patients may seek care for their LBP in the ED. As the burden on the ED increases, we need to consider more efficient and cost-effective strategies to manage and triage patients with LBP.

## 3.7 Tables

**Table 3.7.1 Pattern of Non-Concordant Care**

| Opioid Prescribed by ED Physician | MRI Received | Surgical Consultation | Episodes |
|---|---|---|---|
| 0 | 0 | 0 | **60** |
| 0 | 0 | 1 | **125** |
| 0 | 1 | 0 | **108** |
| 0 | 1 | 1 | **790** |
| 1 | 0 | 0 | **166** |
| 1 | 0 | 1 | **360** |
| 1 | 1 | 0 | **149** |
| 1 | 1 | 1 | **1137** |

Non-concordant care was defined as the occurrence of any one of the following events: a prescription for opioids filled in the in the ED or a prescription for opioids filled outside the ED but prescribed by the attending ED physician; imaging in the ED or a visit within the first 30 days for an MRI; or a visit within 30 days of the index visit for surgical consultation (orthopedics or neurosurgery). 1=Concordant care received on variable 0=Non-concordant care received on variable

**Table 3.7.2 Demographics of Sample Stratified by Level of Concordance**

| | Concordance | | |
|---|---|---|---|
| | Non - Concordant | Concordant | Totals |
| N | 1758 (60.7%) | 1137 (39.3%) | 2895 |
| **Insurance Type** | | | |
| Commercial | 656 (37.3%) | 348 (30.6%) | **1004 (34.7%)** |
| Medicaid | 574 (32.6%) | 399 (35.1%) | **973 (33.6%)** |
| Medicare | 528 (30.0%) | 390 (34.3%) | **918 (31.7%)** |
| **Age (mean, SD)** | 53.4 (16.9) | 53.6 (18.8) | **53.5 (17.6)** |
| **Gender (F)** | 990 (58.2%) | 711 (41.8%) | **1701 (58.8%)** |
| **CCI - Age Adjusted (Mean, 95% CI)** | 2.8 (2.6 - 2.9) | 3.1 (2.9 - 3.2) | **2.9 (2.7-3.0)** |
| **CC- CHF** | 83 (4.7%) | 71 (6.2%) | **154 (5.3%)** |
| **CC - CAD** | 216 (7.5%) | 170 (5.9%) | **386 (13.3%)** |
| **CC - COPD** | 204 (7.0%) | 151(5.2%) | **355 (12.3%)** |
| **CC - DM** | 338 (11.7%) | 231 (8.0%) | **569 (19.7%)** |
| **CC - HTN** | 774 (26.7%) | 510 (17.6%) | **1284 (44.4%)** |
| **CC - ANX** | 208 (7.18%) | 156 (5.4%) | **364 (12.8%)** |
| **CC - DEP** | 150 (5.2%) | 121 (4.2%) | **271 (9.4%)** |
| **BMI >30** | 98 (3.4%) | 45 (1.6%) | **143 (4.9%)** |
| **SPMI** | 218 (7.5%) | 199 (6.9%) | **417 (14.4%)** |
| **High Utilizers*** | 177 (6.1%) | 138 (4.77%) | **315 (10.9%)** |

*High Utilizers were identified using a proprietary insurer algorithm that identifies a member with rising resource utilization and predicts if a member's service utilization (i.e. the number of CPT-4 services) will increase or remain above a spending threshold over the coming 12 months. CCI = Charlson Co-Morbidity Index; CC = Chronic Condition; CHF = Congestive Heart Failure; CAD = Coronary Artery Disease; COPD = Chronic Obstructive Pulmonary Disease; DM = Diabetes Mellitus; HTN = Hypertension; ANX = Anxiety; DEP = Depression; BMI = Body Mass Index; SPMI = Severe Persistent Mental Illness

**Table 3.7.3 Episode Length and Costs of Care**

| | Concordance | | |
|---|---|---|---|
| | Non - Concordant | Concordant | Totals |
| N | 1758 (60.7%) | 1137 (39.3%) | 2895 |
| Episode Length (days) (Mean, 95% CI) | 60.5 (57.1 - 63.9) | 54.8 (58.7 - 68.5 | **58.2 (55.6 - 60.8)** |
| Episode Length (Median) | 37 | 33 | **35** |
| Low Back Costs (Mean, 95% CI) | $3865.41 (3508.79 - 4222.04) | $2634.61 (2185.62 - 3083.60) | **$3382.02 (3,102.06 - 3,661.99)** |
| Low Back Costs (Median) | $1151.06 | $634.98 | **$950.1** |
| Total Cost of Care (Mean, 95% CI) | $20797.26 (19236.45 - 22358.07) | $18839.18 (17239.13 - 20385.23) | **$20028.23 (18,902.67 - 21,153.80)** |
| Total Cost of Care (Median) | $9913.13 | $8615.92 | **$9,412.01** |

**Table 3.7.4 Cumulative Incidence & Adjusted Hazard Ratios for Health Care Utilization**

| | Day 1 | Day 30 | Day 60 | Day 90 | Day 365 | Hazard Ratio (95% CI) |
|---|---|---|---|---|---|---|
| **Radiograph (Low Tech)** | | | | | | |
| Non - Concordant | 6.43% | 26.17% | 31.51% | 34.81% | 41.07% | 1.16 (1.06 - 1.26) |
| Concordant | 7.39% | 20.40% | 26.39% | 29.64% | 36.06% | 1.00 |
| Total | 6.80% | 23.90% | 29.50% | 32.78% | 39.10% | N/A |
| **MRI/CT (High Tech)** | | | | | | |
| Non - Concordant | 11.09% | 39.70% | 46.59% | 49.60% | 54.03% | 1.49 (1.38 - 1.61) |
| Concordant | 3.25% | 23.48% | 32.28% | 36.06% | 42.04% | 1.00 |
| Total | 8.01% | 33.33% | 40.97% | 44.28% | 49.33% | N/A |
| **Injection** | | | | | | |
| Non - Concordant | 12.23% | 23.09% | 27.76% | 30.77% | 36.86% | 1.30 (1.18 - 1.42) |
| Concordant | 9.15% | 14.86% | 19.09% | 22.16% | 29.20% | 1.00 |
| Total | 11.02% | 19.86% | 24.35% | 27.39% | 33.85% | N/A |
| **Opioid Script Filled** | | | | | | |
| Non - Concordant | 60.81% | 70.82% | 71.73% | 71.90% | 73.44% | 5.22 (4.80 - 5.66) |
| Concordant | 3.17% | 16.89% | 19.79% | 22.17% | 27.53% | 1.00 |
| Total | 38.17% | 49.64% | 51.33% | 52.37% | 55.41% | N/A |
| **Surgery** | | | | | | |
| Non - Concordant | 0.23% | 1.88% | 2.39% | 2.79% | 4.04% | 1.82 (1.35 - 2.45) |
| Concordant | 0.09% | 0.70% | 1.06% | 1.14% | 2.37% | 1.00 |
| Total | 1.11% | 2.28% | 2.73% | 2.97% | 4.21% | N/A |
| **Specialist Referral** | | | | | | |
| Non - Concordant | 6.31% | 40.27% | 49.15% | 54.32% | 58.38% | 2.20 (2.04 - 2.38) |
| Concordant | 1.06% | 12.75% | 21.99% | 26.56% | 35.62% | 1.00 |
| Total | 5.60% | 30.16% | 38.96% | 43.42% | 50.29% | N/A |
| **Unplanned Care Use** | | | | | | |
| Non - Concordant | 11.04% | 24.12% | 26.28% | 27.99% | 30.72% | 1.09 (1.0 - 1.2) |
| Concordant | 11.70% | 23.48% | 25.77% | 27.35% | 30.96% | 1.00 |
| Total | 11.30% | 23.87% | 26.08% | 27.47% | 30.81% | N/A |

## 3.8 Figures

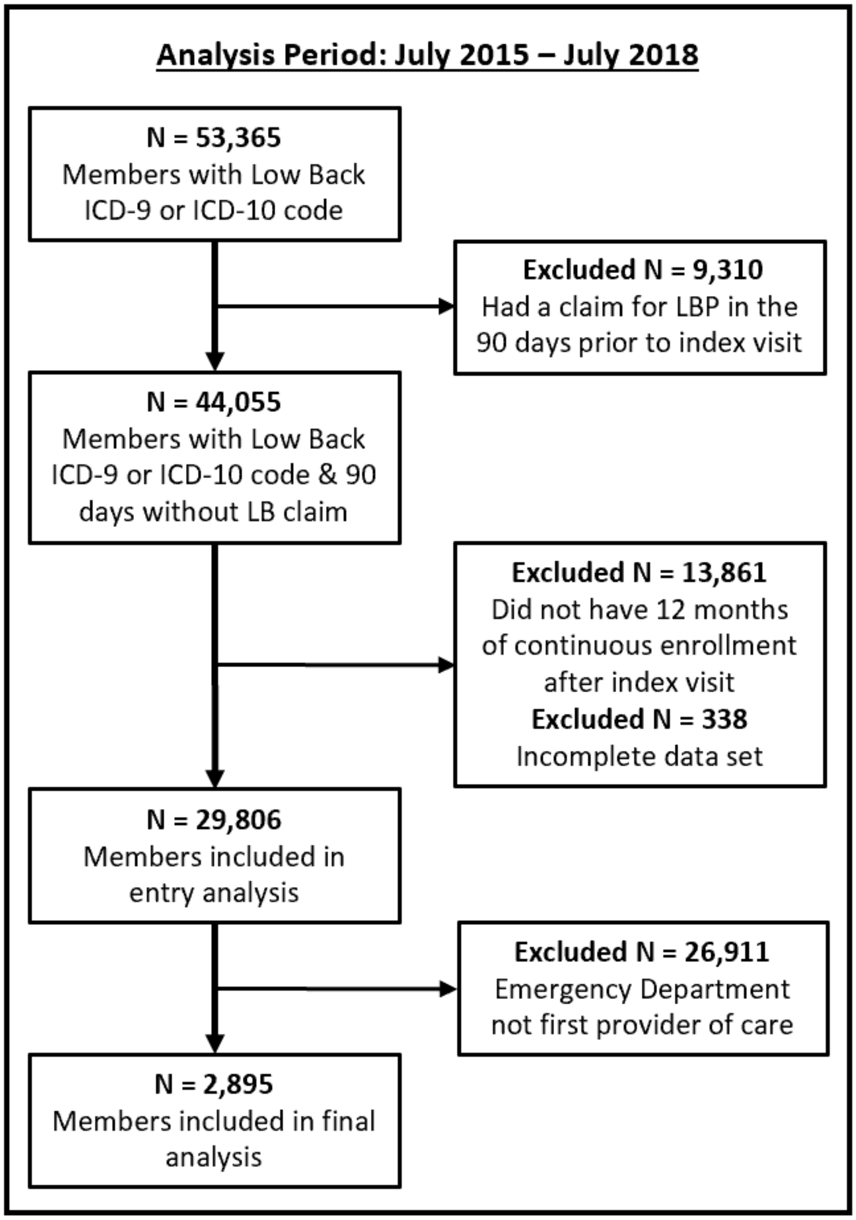


**Figure 3.8.1 Sample Selection**

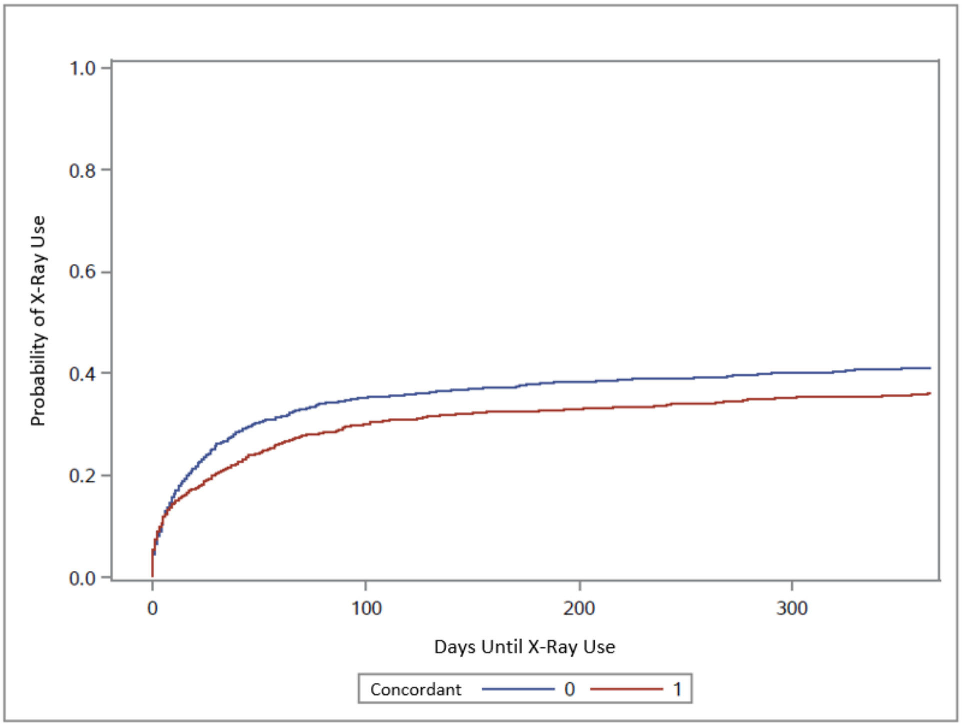


**Figure 3.8.2 Probability of Low Tech Image Use for Concordant and Non-Concordant Care**

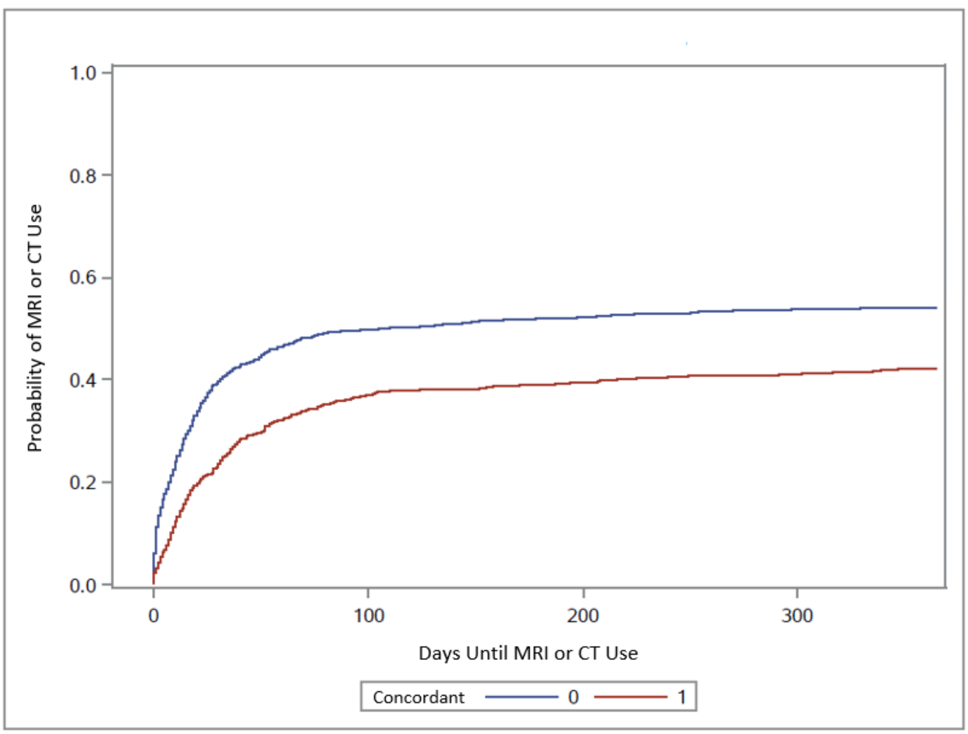


**Figure 3.8.3 Probability of High Tech Image Use for Concordant and Non-Concordant Care**

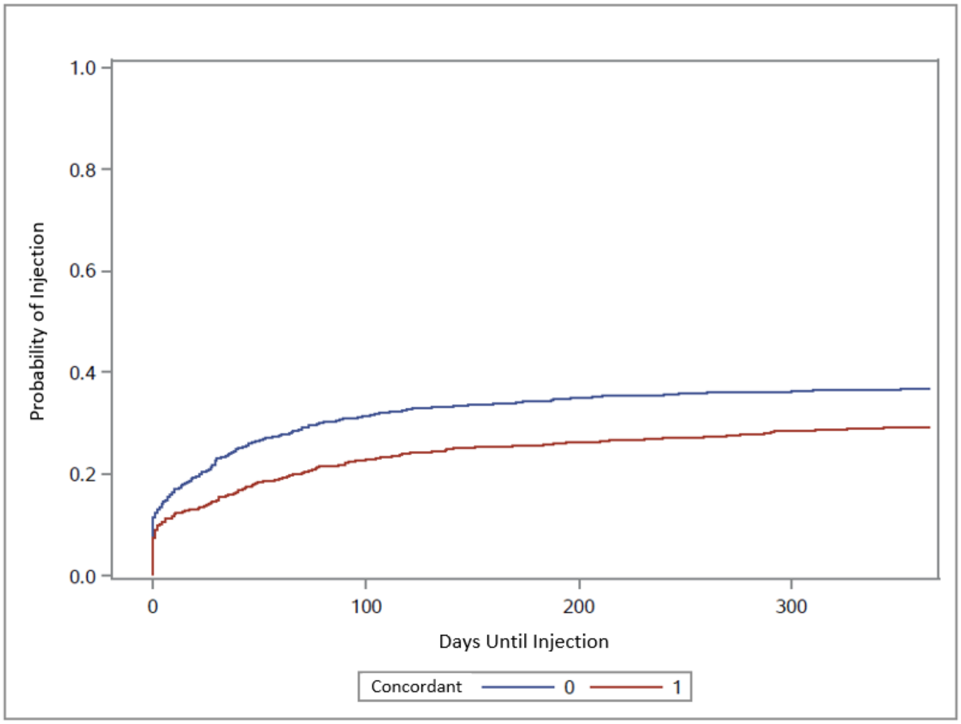


**Figure 3.8.4 Probability of Injection Use for Concordant and Non-Concordant Care**

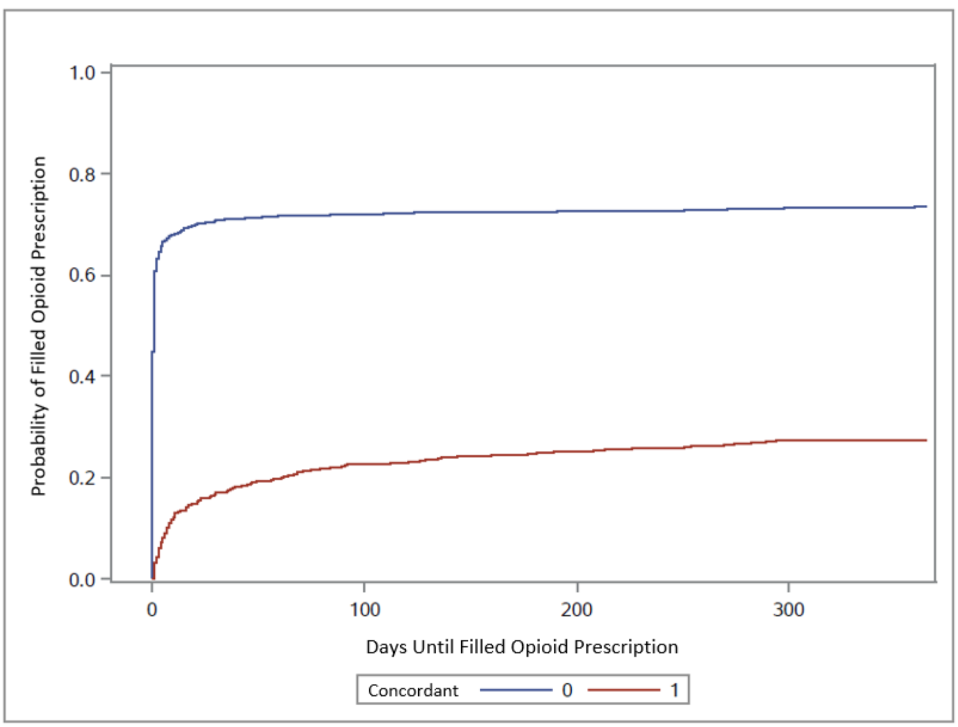


**Figure 3.8.5 Probability of Filled Opioid Prescription for Concordant and Non-Concordant Care**

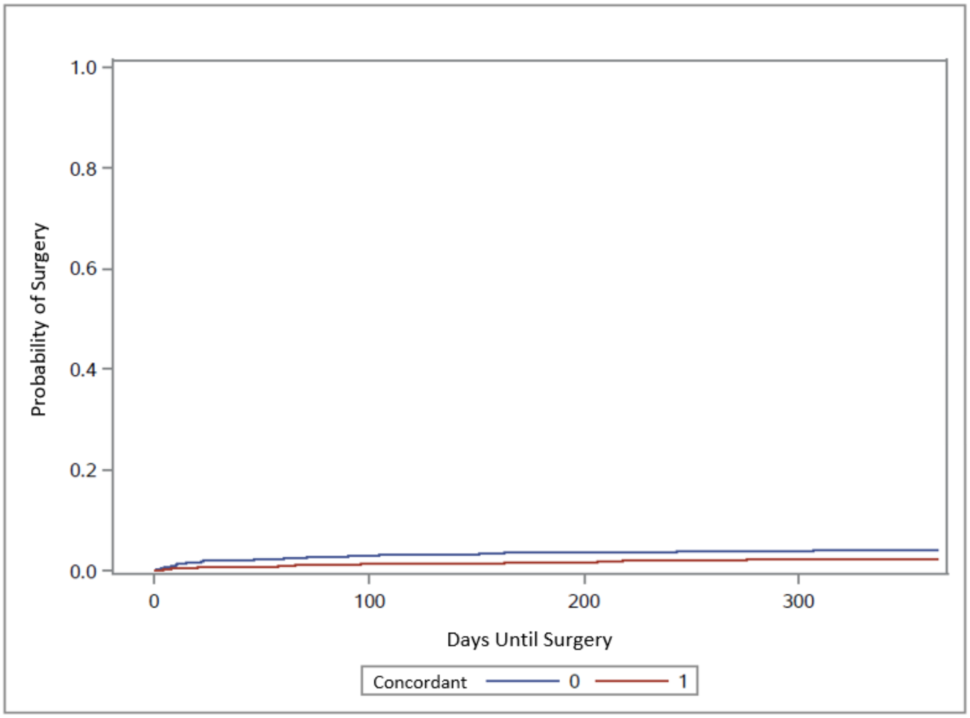


**Figure 3.8.6 Probability of Surgical Intervention for Concordant and Non-Concordant Care**

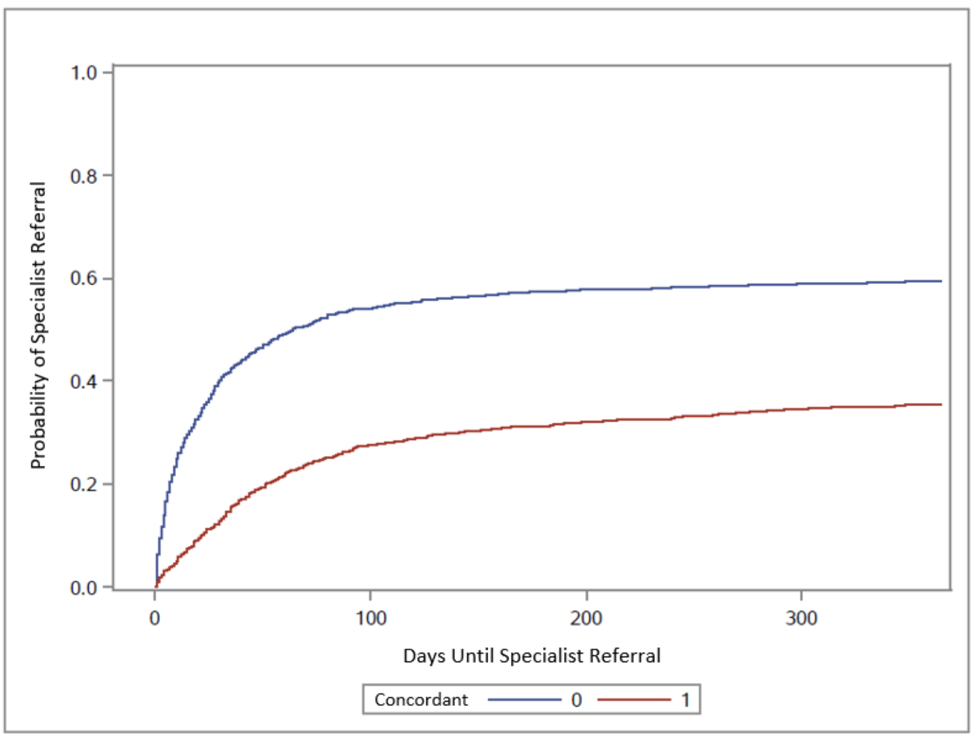


**Figure 3.8.7 Probability of Specialist Referral for Concordant and Non-Concordant Care**

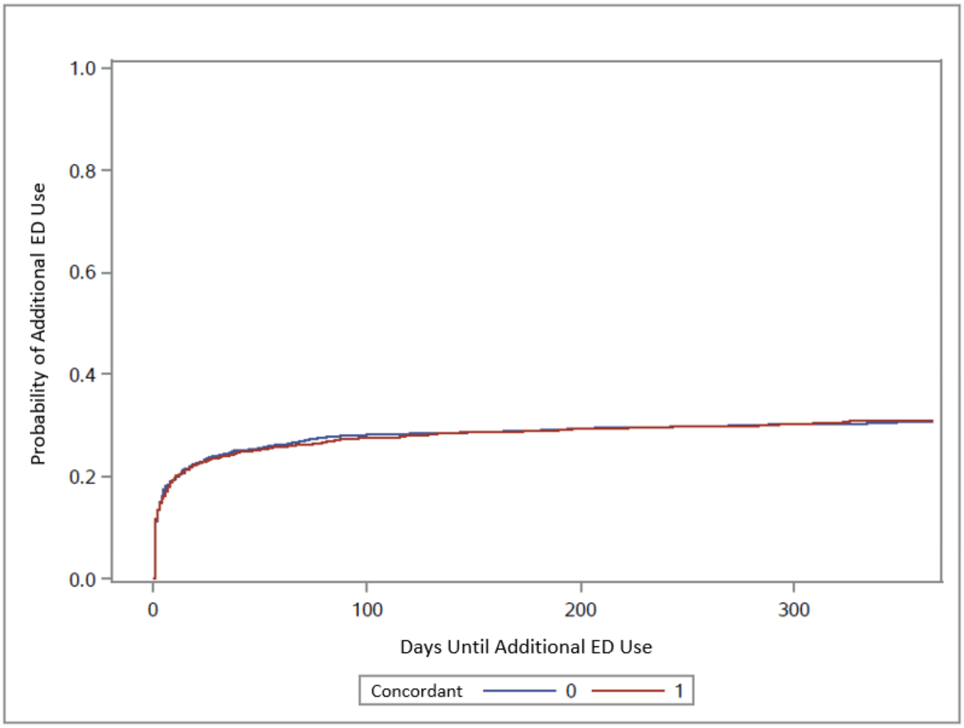


**Figure 3.8.8 Probability of Additional ED Use for Concordant and Non-Concordant Care**

## 4.0 Face-to-Face Telehealth Interventions in the Treatment of Low Back Pain: A Systematic Review

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### 4.1 Introduction

The worldwide outbreak of SARS-COV2 has fueled a renewed interest in virtual delivery of healthcare services. Telehealth is not new. Historically, telehealth has provided healthcare to patients living in remote areas who have limited access to medical professionals. As the video camera and television became commonplace in the 1950s, medicine began to leverage these new technologies.[32] The unprecedented strain that SARS-COV2 has placed upon the healthcare system, and society at large, has created a "perfect storm" from which telehealth has emerged as a potential solution that allows us to continue to social distance while maintaining our current state of healthcare delivery. Practice venues ranging from Primary Care to the Emergency Department have started to trial mechanisms to treat non-emergent patients virtually.[84]

The literature contains many examples of successful trials of "virtual" care for musculoskeletal disorders, including low back pain. [33–36] Some advocates feel the widespread implementation of telemedicine has the potential to minimize Emergency Department (ED) or Urgent Care Clinic traffic, creating more efficient workflows in those settings.[37] Others have demonstrated that the cost of a visit is reduced significantly in time and travel.[85] And all of these benefits of telehealth were being discovered before the onset of the SARS-COV2 pandemic. However, despite this interest in the potential benefits of telemedicine, there are still questions about safety and efficacy, as well as the level of satisfaction by patients and acceptance by providers.

The objective of this systematic review was to address the following questions:

- What is the effectiveness and safety of "face-to-face" tele-rehab visits in the treatment of patients with acute or chronic low back pain?
- What is the patient satisfaction patients who use tele-rehab vs. those who use in person consults for acute or chronic low back pain?
- What is the provider satisfaction patients who use tele-rehab vs. those who use in person consults for acute or chronic low back pain?

## 4.2 Methods

A protocol for this systematic review was registered a priori through PROSPERO (CRD42020212006). Protocol development and execution was completed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P).[86] Our search strategy can be found in **Appendix F.** Selection strategy, eligibility and details of our analytic process can be found below.

### 4.2.1 Search Strategy

Our search strategy attempted to identify literature, specifically randomized clinical trials, that includes a face-to-face tele-rehab evaluation or intervention for the treatment of acute low back pain. For the purposes of this study, the intervention must include a live video interaction between the patient and the provider. The platform through which the interaction occurs may vary if there is a face-to-face interaction with the provider.

Following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocol, an exhaustive search of the existing literature was performed by a research librarian (RT). Sources queried included the following databases: Ovid Medline, Embase, Ebsco CINHAL, Cochrane Database of Systematic Reviews, Cochrane Trials, Cochrane Protocols, PEDro, ClinicalTrials.gov and the Index of Chiropractic Literature. We expanded our formal inquiry to include an extensive search of the grey literature to include ongoing/registered clinical trials, protocols conference proceedings and abstracts. Finally, we performed a hand search of identified systematic reviews and meta analyses to identify additional articles that were missed in the initial database search. All databases were searched from inception to September 2020. Search strategies and keywords used for each database can be found in **Appendix F**.

### 4.2.2 Study Eligibility

Study inclusion and exclusion criteria for scientific articles were identified a priori. Studies were included if they were a clinical trial or cohort study (prospective or retrospective, published or available in the English language, included subjects over the age of 18 years seeking care for an acute or chronic episode of low back pain and, examined face-to-face telehealth for evaluation or treatment. Additionally, the article must be a clinical trial or observational cohort study. Systematic reviews and meta-analyses were identified and used to confirm our search strategy, and to identify individual studies that may have been missed. However, they were not rated for quality or included in our final analysis.

### 4.2.3 Research Team and Study Selection

Our research team consisted of 3 physical therapists (AP, MeS, CB) 2 chiropractors (ZC, MJS) 1 research assistant (SD) and a dual licensed physical therapist/chiropractor (SM) All had previous training and experience with systematic reviews. Titles and abstracts for each reference were screened independently by 2 of the above team members using Distiller SR, a web based systematic review and literature manager.[87] Disagreements during title and abstract screening were discussed between reviewers and adjudicated by the principal investigator (CB). Disagreements that could not be resolved mandated a full text review of the article in question. Full text evaluation was completed using 2 independent investigators, with disagreements being mediated by the principal investigator (CB). Articles that did not meet the inclusion criteria after full text review were removed from consideration.

### 4.2.4 Assessment of Study Quality and Data Extraction

The following information was extracted from included articles: title, author, study design, participant inclusion/exclusion criteria, participant demographic and clinical characteristics, intervention specifics, and outcomes. In addition to the risk of bias assessment, the demographic data extracted included title, author, study design, inclusion/exclusion criteria, participants, intervention specifics, and outcomes. These can be found in **Table 4.6.1**.

Study quality and risk of bias for randomized clinical trials will be assessed using the Cochrane revised tool to assess risk of bias in randomized clinical trials (RoB2).[88] This tool has been validated specifically for randomized clinical trials. Study quality and risk of bias for studies that involved face-to-face assessments but were not randomized clinical trials, will be assessed using the Methodological Index for Non-Randomized Studies (MINORS). This validated tool was developed specifically to assess the methodological quality of comparative and non-comparative, non-randomized trials.[89] The tool consists of a total of 12 items; 8 items are relevant for all studies and 4 additional items are relevant for comparative studies. Each item is given one of 3 numeric ratings: “0 not reported”, 1 “reported but inadequate” or 2 “reported and adequate”. Risk of bias will be assessed by 2 team members for each study (ZC and SM) with conflicts discussed and adjudicated by the PI (CB).[89]

## 4.3 Results

### 4.3.1 Study Identification

After our initial search, we removed 2,261 duplicates and identified 6,536 unique articles. **(Figure 4.7)** We then screened the title and abstract and excluded 6,370 records that did not meet the inclusion criteria. 166 articles underwent a full-text review. During this level of review, we excluded 5 articles because they were not in the English language; 80 articles because the participants were not seeking care for an episode of low back pain; 14 articles because the type of article was unusable; 1 article because it did not include human subjects; and 62 articles because they did not involve a face-to-face telehealth interaction. Further review of the excluded articles revealed 15 clinical trials and 2 cohort studies that did not have a face-to-face clinical intervention but would have otherwise met our inclusion criteria. The research design and telehealth interventions studied in these 17 articles appeared to cluster around 3 themes: 1) Self-help exercise websites; 2) Online exercise smartphone applications; and 3) Telephonic telehealth interventions. The study outcomes included pain, disability, and satisfaction. Summaries of these 17 studies are provided in evidence tables **4.6.2 and 4.6.3**.

We found 5 additional studies that met our inclusion criteria, but none were randomized controlled trials. The first article, Cottrell et al.[90] was a non-randomized cohort that used a non-inferiority approach. The authors attempted to establish that the use of a telerehabilitation approach (specifically videoconferencing) was non-inferior to in-person physiotherapy in treating patients with LBP or neck pain. Participants were recruited from an existing advanced-practice physiotherapy-led screening service having been referred to this service after triage from specialist neurosurgical or orthopedic outpatient services with a non-urgent musculoskeletal spinal condition. Eligible patients chose whether they received treatment in-person (control group) or via telerehabilitation (intervention group). Outcome measures consisted of pain-related disability, pain severity, and health-related quality of life recorded at four separate time points (baseline, 3-, 6-, and 9-months). Disability and pain were assessed using the Oswestry Disability Index (ODI)and Neck Disability Index (NDI). Pain was assessed with a 100 mm visual analogue scale (VAS). Quality of life was assessed with the AQoL-6D. The telehealth intervention leveraged the eHAB telerehabilitation system (eHAB; NeoRehab, Brisbane, QLD, Australia). eHAB is a computer-based video conferencing system that works via a wireless 3G Internet connection. It provides real time video conferencing, advanced media tools including chat platforms, exercise prescription, remote measurement of joint and body position and real time video feedback between patients and clinicians. The authors found there were no significant group-by-time interactions for pain-related disability, pain severity, and health-related quality of life measures. These findings appear to indicate that in terms of the previously mentioned outcomes, that treatment via telerehabilitation was not inferior to in person treatment. A significant limitation of the study is that the authors collapsed subjects with neck and back pain into a single group. Despite this limitation the authors could not establish non-inferiority for any clinical outcome measure, thus demonstrating the equanimity between video and in person treatment for low back and neck pain.[90]

The remaining 4 articles studied the reliability, validity, and feasibility of exam procedures. Each article used a standard in-person evaluation compared with a face-to-face telerehabilitation evaluation. The next four paragraphs will provide summaries of each of these 4 studies, which are also listed in **Table 4.6.1.**

The first article by Palacin-Marin et al.[91] was a pilot, repeated-measures crossover study that assessed the agreement between a face-to-face evaluation and a telerehabilitation evaluation for patients seeking care for chronic low back pain. The study was conducted in a primary care environment. Assessments were completed by 2 physical therapists with more than 10 years of experience treating chronic low back pain. The telehealth evaluations used a web-based system with a real-time connection via Skype. Joint angles and movement were assessed using Kinovea (www.kinovea.org), an open-source video analysis package. Agreement between was assessed using Cronbach's α with agreement above 0.94 for all but lateral flexion and the Sorensen test. The authors concluded that their telerehabilitation system performed an adequate assessment for individuals with chronic back pain. Future research is warranted on larger samples.[91]

Petersen et al.[92] performed a repeated-measures correlation design to assess the criterion validity and rater reliability between a face-to-face evaluation and a telerehabilitation evaluation. The study, conducted, in a Physical Therapy clinic involved two physical therapists to complete the assessments. Telehealth assessments used a HIPPA compliant version of Zoom, two personal computers and an iPad. Examination procedures followed an assessment based on the Treatment Based Classification for Low Back Pain. (TBC)[93–95] Patient satisfaction with the telehealth assessment was also assessed. Agreement for specific variables of the TBC varied between 49% - 59%. Classification agreement hovered between 25% - 38% for both assessments. Regarding satisfaction, 56% of patients agreed or strongly agreed that the face-to-face assessment was as good as the telerehabilitation assessment, while 97% agreed or strongly agreed that they would recommend the telerehabilitation assessment to someone unable to travel. The authors concluded that, based on patient satisfaction, the telerehabilitation system performed an adequate assessment. However, they recognized that the difficulties with the TBC evaluation might not be a function of the telehealth environment; rather, these disagreements are consistent with previously recognized disagreements with classification.[92]

Truter et al.[96] completed a single-blind validation study comparing a face-to-face assessment with a telerehabilitation assessment. Two physical therapists were randomly assigned to complete the in-person evaluation of the telerehabilitation evaluation. The telehealth assessments used the eHAB telerehabilitation system (eHAB v2; NeoRehab, Brisbane, QLD, Australia). eHAB is a computer-based video conferencing system that works via a wireless 3G Internet connection. Physical assessments included posture, active movement, and the SLR. Psychometric assessments included disability (ODI), pain (VAS), and a satisfaction survey. Agreement with postural assessment varied widely from 25% agreement for the presence of a lumbar lordosis to 75% agreement for anterior/posterior positioning of the pelvis. Pearson's correlation for range of motion measurements correlated well for lumbar flexion (0.89) and extension (0.83). Lateral flexion showed moderate correlation of (0.69) on the right and (0.67) on the left. The agreement on the SLR test was 90% for pain and 84% for symptom reproduction. Symptom reproduction for SLR sensitization maneuvers was 90% for SLR with dorsiflexion, 86% for hip internal rotation, and 82% for active neck flexion. Patient satisfaction was similar to the Peterson study. The authors recognized that based on satisfaction, there is value in the telerehabilitation assessment but acknowledged limitations surrounding the agreement of postural assessments. These disagreements, however, may not be a function of the telerehabilitation evaluation. It is more likely that the disagreements are representative of the existing variations in postural assessment.[96]

Varkey et al[97] completed a feasibility study evaluating patient and provider satisfaction with a work site telemedicine clinic. The study evaluated 100 consecutive patients seen for a variety of primary care ailments including low back pain. Two physicians and 2 nurse practitioners completed telemedicine visits using an independently developed videoconference system, connected to radiology, pharmacy, and patient medical records. There is no information available about the components of the low back evaluations. Patient and provider perceptions were the primary outcomes. Patient perceptions included opinions of saved travel time, saving time in appointment scheduling, preventing work absence, saving other costs, and preventing re-distribution of work to colleagues. Provider perceptions included: does a telehealth visit feel similar to a face-to-face visit; could they clearly hear the patient; and did telemedicine have a positive effect on their relationship with the patient. Overall, the authors concluded that patients and providers felt that telemedicine is feasible and, in some cases, preferred. A significant limitation to this study, however, was the small number of patients with LBP. The initial N was 100, but only 8 were seeking care for LBP.[97]

## 4.4 Discussion

### 4.4.1 Excluded Studies and Limitations

The goal of this systematic review was to identify all clinical trials and cohort studies that utilized some type of face-to-face telehealth intervention for the virtual management of low back pain. After an extensive search and evaluation of the existing literature we only found a single unblinded, non-inferiority trial comparing a face-to-face telehealth interaction with standard, in-person care.[90] The trial design is a prospective cohort with a convenience sample in which the findings indicate that face-to-face telehealth and delivers results that were "not inferior" to in-person physiotherapy for back (and neck) pain. An additional finding indicated that consumers, in terms of cost and convenience, have higher satisfactions rates with telehealth than face-to-face interactions.

The use of telehealth in the assessment and treatment of low back pain is evolving and accelerating. As physical therapists (PTs) and chiropractors are becoming the preferred clinicians to manage back pain,[14,24], access to these clinicians early and often has been shown to reduce cost and disability while improving patient reported outcomes.[71,98,99] The studies found in this review reinforce the existing literature indicating that PTs can perform comparable evaluations and interventions during in-person interactions and face-to-face telehealth environments. This adds evidence to the assertion that direct access or direct referral to PTs, via in-person or telehealth interactions, may be one of the solutions to address the growing problem of back pain.

Despite the paucity of clinical trials and observational studies utilizing face-to-face telehealth interventions in back pain, this systematic review did find some interesting studies that were excluded only because they were not delivered in a face-to-face format. Several of the studies utilized various telehealth interventions using remote monitoring, web application, short message service (SMS), and telephone monitoring. Two of the more interesting studies that were excluded used recorded videos and video reminders to improve sitting posture and postural stability muscles. The videos showed correct exercise performance and correct sitting posture. These videos were reinforced with pre-recorded daily reminders on a web client. The authors showed a clinically significant reduction in pain and disability and an increase in self-reported quality of life.[100,101]

The most interesting article that was excluded based upon our face-to-face criterion was Bailey et al.[102] The authors completed a retrospective analysis of consecutively recruited participants with complaints of LBP or knee pain. The final analysis consisted of 10,264 adults with either knee (n=3796) or LBP (n=6468) of at least 3 months in duration. Upon enrollment participants were issued a tablet computer with the digital care plan (DCP) app installed and 2 Bluetooth motion sensors with instructions for email, or in-app messaging throughout the DCP. Upon conclusion, the authors found a 69% reduction in chronic pain and a 58% reduction in depression and anxiety. The breakdown by diagnosis was not reported, however this is currently the largest observational telehealth study that we found in our literature search.. Despite the lack of long-term outcomes, these findings indicate that the use of digital care plans combined with sensor technology have the potential to reduce the burden of LBP at the population level.[102]

The studies varied widely in their risk of bias levels. **(Table 4.6.2)** The strongest studies were Peterson et al. followed by Palacin-Marin et al. Peterson scored a 24/24 indicating little to no risk of bias. Palacin-Marin et al scored 22/24, losing two points for not having a prospective power calculation of sample size. Cottrell et al., the only study that compared an intervention, scored 22/24, losing points for not having a prospective power calculation of study size. The score received by Truder et al, 17/24, indicated moderate risk of bias in the study. The endpoints were unblinded, the follow up period was not defined, and patients lost to follow up were not discussed. The weakest of the studies was Varkey et al scoring 7/16 on the MINORS scale, indicating this study had a high risk of bias. The authors did not clearly define the study endpoint, data was collected retrospectively, there was no end of study assessment and there was no prospective power calculation of sample size.

We identified several limitations associated with the included studies, other than the observational nature of the study design; The sample size was critically small for most of these studies, ranging from 8 patients to 47 patients. In addition to the size of the sample, 3 of the 4 studies did not calculate sample size prior to study initiation. As these were not clinical studies, there were no effect size calculations however, small sample size would diminish any measured effect of a telerehabilitation evaluation.Satisfaction was studied, but the focus was on the acceptability of the service to patients. Patients responded very well in terms of convenience and cost. Unfortunately, there was little research into the satisfaction on the clinical side. When, clinicians were included, they were not evaluated with the same metrics. As a critical part of the "evaluation equation," there is a need for investigations into clinician needs, and the feasibility and acceptability of this type of change.

The most significant limitation to these observational studies was the lack of a systematic approach to the clinical assessment of LBP. Each study used a unique evaluation procedure and focused on the elements the authors deemed necessary to diagnose the source of LBP. This variation is not dissimilar to clinical practice, where there is a wide variety of procedures used to evaluate the spine. As the literature evolves, identifying a core set of measures for an evaluation of LBP may be warranted. Measures for the hip, knee, shoulder and elbow, as well as suggested equipment and have previously been studied and suggested.[103]

### 4.4.2 Future Research Ideas

This review has exposed a significant gap in the face-to-face telemedicine literature for remote clinical management of LBP, and clearly suggests a need for additional research in this area. In contrast to telehealth management of LBP, there has been significant research and adoption of telehealth solutions in the fields of neurology and rheumatology.[104–110] Telehealth solutions to treat and intervene in LBP are in their infancy with no formal established research agenda. In the past research has depended on the knowledge translation model to bring findings form the "bench to the bedside." The results have been mixed with fragmented uptake of new research and difficulties with clinical application. The emergence of implementation science has provided a formal structure for applying and integrating research evidence into practice.[111]

To maximize and potentially accelerate a research agenda for telehealth solutions for LBP, an implementation science approach should be considered. This approach would create a targeted research agenda that would allow for faster adoption and dissemination into clinical practice. The Consolidated Framework for Implementation Research (CFIR) is one such approach. The CIFR, proposed by Damschroder et al. in 2009, provides five domains that need to be considered while planning or executing an implementation project.[112] These 5 domains are: 1) Intervention characteristics; 2) Outer setting; 3) Inner setting; 4) Process; and 5) Individuals involved. Using these domains and the available literature, we have outlined a plan for future telehealth research.

*Intervention Characteristics:* Telehealth, as an evaluation or intervention, is a fluid concept. Interventions classified as "telehealth" can be as simple as a short message service (SMS) or as complex as web-based algorithms to triage and predict admission from the ED to the hospital[113,114]. This speaks to the source of the intervention. A program for LBP intervention is likely to come from an internal stakeholder familiar with the current treatment paradigm. The implementation to telehealth is likely going to be perceived as complex; however, as the studies from this review have shown, equipment as simple as a tablet computer and a webcam can deliver a reliable and effective exam.[115] Additionally, telehealth by nature, can be adapted to meet the needs of both patients and clinicians. Truter et al. showed this in their low back feasibility trial while Russell and Richardson et al. achieved the same results when researching disorders of the lower limb and knee. All three studies demonstrated the effectiveness and acceptability of a remote evaluation.[35,96,116] This adaptability can continue to be studied in remote situations where access is an issue and in situations where safety may be of concern. Adaptability and stakeholders' positive perceptions of telehealth are attributes that will facilitate the adoption of telehealth. Barriers to adoption, in terms of CIFR constructs, may well be the strength of the existing evidence combined with the complexity involved with the infrastructure surrounding the telehealth delivery mechanisms. Future research must include investigation into the least complex mechanisms for effective delivery. If the implementation of telehealth has even the perception of being more difficult than the status quo, it is likely clinicians will not overcome the barriers with the associated changes.

*Outer Setting:* Policy incentives and patient satisfaction have the potential to influence the research agenda, when treating spine pain. The studies in our review did address patient satisfaction but only in terms of the evaluation itself. Additional research is needed to assess the impact of outer setting elements include patient needs and the external policy objectives. Our research found that indirect costs, especially the costs of lost work and driving to the clinic, had an impact on patient satisfaction.[92,96] Future research could focus the direct costs and subsequent savings associated with the use of telehealth. Fatoye et al. studied the clinical and cost-effectiveness of a McKenzie telerehabilitation protocol delivered via a self-guided phone-based application. Forty-seven participants were randomized to clinic-based treatments or telehealth-based treatments. The authors found that, even after providing all the participants a phone, there was a total reduction in costs of 16,000 Nigerian naira (USD $44.26).[117] On the surface this may not seem a significant source of savings. However, when put into the context of the median monthly salary of 339,000 naira (USD $888.18), the cost savings to this consumer is significant.[118] Clearly, cost may act as a outer setting facilitator to implementation. Barriers in the outer setting that may inhibit the adoption of telehealth and may directly affect costs are the governmental regulations which are constantly changing and new policy or payment initiatives that may not take into account the unique requirements of a telehealth delivery mechanism. Future research can assist in overcoming fluid payment initiatives with a comparative analysis of telehealth and "bricks and mortar" delivery mechanisms. A cost analysis could include differences in co-pay structure and alternative payment models such as bundled payments and capitated payments.

*Inner Setting*: The inner setting encompasses the social architecture, culture and climate that patients, providers and staff experience every day.[112] With the changes brought about by COVID-19 the tolerance for change and the acceptance of new ideas has altered the implementation climate at most organizations. Telehealth, once thought of as inferior to face-to-face interactions, has gained traction and is becoming a viable solution to many of the recent challenges. The Centers for Disease Control (CDC) recently showed a 154% increase in telehealth visits during January – March 2020 when compared to the same time last year,[119] while telemedicine provider Teladoc reported a spike in video requests to more than 15,000 per day during the same period[120]. In support of this change, the US Department of Health and Human Services (HHS) has encouraged the use of telehealth and the Centers for Medicare and Medicaid have expanded the types of telehealth services that are covered. Organizational culture and the implementation climate are 2 important inner setting CFIR constructs that, if optimized, will act as facilitators for the implementation of telehealth interventions. With increased expansion, the need for additional telehealth back pain research can only thrive in this climate. The readiness of organizations to adopt telehealth changes may still act as an inner setting barrier but this can be easily overcome as larger organizations such as HHS and CMS influence the implementation climate.

*Characteristics of Individuals*: The knowledge and beliefs of individuals as well as personal attributes can frame an individual's readiness to change. Regarding telehealth, there appears to be interest in changing behavior, from both providers and patients. Gilbert et al.[121] completed a systematic review of the qualitative methodology surrounding videoconferencing in an orthopedic setting. They found variation in the methodology, similar to the studies cited in this review. One of the common themes found across the studies was convenience. Many patients noted that remote access was more convenient because it contributed to decreased cost and saved time. What was more interesting was the patients' perceptions of the behavior of the therapists. Patients noted that "characteristics such as staring at the screen (rather than moving gaze from camera to screen), listening without interruption, and individually tailoring exercises to patients individual needs facilitated relationship building."[121] These attributes will likely need to be learned and further researched as it appears there may be different verbal and non-verbal cues that are important in telehealth interactions. Future research should focus on the qualitative aspects of the perceived barriers and facilitators that an individual might pose to telehealth implementation.

*Process*: The process domains of the CFIR involve the planning, engagement, and execution of the implementation process. These processes are more likely to involve clinician opinion leaders and implementation champions than patients. Furthermore, the process domains of the CFIR are likely to be ongoing rather than onetime events. The ability to sustain this process can act as both a barrier and a facilitator and directly influence the success or failure of an initiative. Early research into process domains has surrounded the formal training of those in the organization responsible for coordinating the implementation process. Sugavanam et al.[122] conducted a two-stage observational cohort implementation study to evaluate the effects of an online training program for clinicians. The implementation study was a follow up to the BeST trial which studied the effects of a cognitive behavioral approach for LBP.[122] Those therapists who integrated the new evidence into practice reported acceptance of the system by both clinicians and patients. They did however identify internal and external barriers that included staffing, capacity and time that prevented rapid uptake of the guidelines. The second stage of the study required implementation of the intervention and a follow-up survey of patients. The authors found that most patients (77%) reported at improvement after the cognitive behavioral intervention. Patient perception of recovery at the 12-month follow-up, a medium effect size was observed for pain in the BeST trial [0.58 (0.48–0.68)] whereas in the current study, a small effect was observed [0.34 (0.23–0.45)].[122] These findings provide insight into possible future research, including changes in staffing and the capacity of the individual and the organization for sustainable change.

## 4.5 Conclusion

The field of LBP is in dire need of a solution to increase access points for care and faster referral of patients to a non-surgical provider. Research into telehealth triage mechanisms, remote evaluation of patients using a core set of measures and choosing and implementing interventions from a remote location would serve as a foundation for future clinical trials. As researchers examine the issues of acceptability, feasibility, and validity, we can begin to compare costs between on-site and off-site services and the value that these services provide to the healthcare system at large. The huge literature gap and lack of clinical trials studying face-to-face telehealth interventions for LBP was unexpected. There are conditions for which management via telehealth has begun to thrive, and we hypothesized that LBP was no different. Unfortunately, this focused area of research is still in its infancy.

We continue to see a rise in spinal complaints year to year[6,27] and costs continue to escalate without subsequent improvements in patient-related outcomes. The key drivers of cost of care in LBP are unnecessary referral for imaging (x-ray, MRI, and CT), opioids, spinal injections, and inappropriate surgical referrals. Telehealth services that facilitate non-pharmacologic care, which is largely under-utilized, present an opportunity if implementation can overcome the challenges of remote delivery (lack of hands on evaluation and treatment). Most value-based care in chronic musculoskeletal conditions requires diligent self-care principles, which are very amenable to telehealth. Thus, some combination of in-person and telehealth would be worthy of study.

# 4.6 Tables

### Table 4.6.1 Non-Randomized Trials with Face-to-face Interaction

| Study | Sample Size | Population and Source | Study/ Intervention | Outcomes | Results | Risk of Bias |
|---|---|---|---|---|---|---|
| | | | | | | |
| Cottrell et al. 2019 | 15 Control<br>46 Telehealth | Participants were recruited from advanced-practice physiotherapy-led screening service in a single metropolitan hospital (Brisbane, Australia. All patients attending an initial visit with the service were approached to participate in this study. As per standard practice, patients were referred to the service under study having been triaged from neurosurgical or orthopedic outpatient services with a non-urgent musculoskeletal spinal condition | Non-Randomized non-inferiority clinical trial to compare usual non-surgical care for back or neck pain with telerehabilitation care for the same condition. Neck and back pain were combined for this study as was pragmatic service referral. | Primary outcome measures were the Oswestry disability index and the Neck Disability Index. Secondary measures included self-reported pain and quality of life measures. | There were no significant group-by-time interactions observed for either pain-related disability (p ¼ 0.706), pain severity (p ¼ 0.187) or health-related quality of life (p ¼ 0.425) measures. The telerehabilitation group reported significantly higher levels of treatment satisfaction (median: 97 vs. 76.5; p ¼ 0.021); | 22/22<br>LOW RISK |
| Palacin-Marin et, al (2013) | N=15 | Initially recruited 42 consecutive patients with a diagnosis of chronic LBP referred to a single rehabilitation center. 15 participants eventually enrolled. | Repeated measures crossover design for criterion validity and rater reliability | Lumbar Spine Mobility<br>Back Muscle Endurance<br>Lumbar Motor Control<br>Disability Assessment<br>Pain Assessment<br>Health Related Quality of Life<br>Kinesiophobia | Reliability between face-to-face and telerehabilitation evaluations was more than 0.80 for 7 of the 9 outcome measures. Very good inter- and intrarater intraclass correlation coefficients were obtained (0.92–0.96). | 22/24<br>LOW RISK |
| Peterson et.al (2019) | N=47 | 47 participants with <90-day history of LBP recruited from two private practice outpatient orthopedic clinics | Repeated measures correlation design comparing face-to-face evaluation with face-to-face telehealth evaluation using a modified treatment based classification algorithm<br>HIPPA compliant Zoom | Patient Satisfaction<br>Rater agreement:<br>Centralization or Peripheralization<br>Aberrant movements<br>SLR>91<br>SLR>10 asymmetry<br>SLR large but <91<br>Active straight leg raise | Rate of agreement was 68.1% (κ = 0.52; 95% confidence interval, 0.32 – 0.72). There was no difference in classification distributions between assessments ($\chi^2$ = 2.14, p = 0.54). The percentage agreement was 48.9% – 59.6% for classification variables. | 24/24<br>LOW RISK |
| Truter et.al (2014) | N=26 | 26 participants with current or recent LBP (2 years) recruited from small town in Queensland Australia. | Single blind validation study comparing face-to-face evaluation with face-to-face telehealth evaluation<br>eHAB conference system | Disability<br>Pain<br>Posture<br>Active Movement<br>SLR Test<br>Satisfaction | High levels of agreement found with detecting pain with lumbar movements, symptom reproduction and the SLR test. Moderate agreement occurred with identifying directional preference and active lumbar spine range of motion. Poor agreement with postural analysis. | 17/24<br>MODERATE RISK |
| Varkey et.al (2008) | N=100<br>Only 8 (Seeking spine care) | 100 Consecutive patients from an onsite work clinic seeking primary care for an acute episode (84) or return visit (16) | Independently developed (Mayo Clinic) videoconference system, connected to medical records. | Pt. perceptions:<br>Saved travel time<br>Saving appt. time<br>Prevent work absence<br>Saving other costs<br>Preventing work re-distribution. | Overall, the authors concluded that patients and providers felt that telemedicine is feasible and, in some cases, preferred. A significant limitation to this study, however, was the small number of patients with LBP. | 7/16<br>HIGH RISK |

**Table 4.6.2 Clinical Trials Excluded During Full Text Screening**

| Study | Sample Size | Study/ Intervention | Telehealth Medium | Outcomes | Results |
|---|---|---|---|---|---|
| **Clinical Trials** | | | | | |
| Bernardelli et al. 2020[123] | 47 Control<br>37 Telehealth | **Control:** 7 weeks of moderate intensity exercise in a gym at the worksite departments. The aim was to increase muscle strength in the lower back, neck, and shoulders and increase core (abdomen and lower back) stability<br>**Intervention:** 7 weeks of the same exercises done by the workplace group, adapted to low back pain, planned by a physiotherapist, illustrated in a booklet and in a video available on the company intranet website. | Low back booklet supported by a video on the company intranet website. | Primary outcome was the change from baseline to 7-week follow-up in the RMDQ score between the workplace- and home-based groups. Secondary outcomes, included the change in average of functional and psychological assessment. Functional assessment includes RMDQ, FABQ, and Tampa Scale. Psych assessment includes the Psychological General Well Being Index, and the Zung anxiety and depression scales. | The authors found improvement of RMDQ, TSK, and FARQ. TSK showed a slightly higher improvement in the home-based group. The ODI showed improvement in the workplace group and no effect in the home-based one. Small changes in well-being scales were observed, except a decrease of mean Zung D in the home-based group. |
| Buhurman et al. 2011[124] | 28 Control<br>26 Telehealth | **Control:** A waiting where participants were instructed to monitor their pain intensity daily for two weeks before and two weeks after the treatment period (recorded as a pain diary)<br>**Intervention: A** self-help management program based on a cognitive behavioral model of chronic pain. The therapist responded to questions, and provided feedback and encouragement on a weekly basis, in association with the completion of treatment modules and homework assignments. Approximately 10–15 min per week was spent on each participant. | E-mail based support with online print text material and forms. The site was accessible only with a password provided to the participants. All treatment contact with participants was via e-mail. | Primary outcome was the catastrophizing subscale of the Coping Strategies Questionnaire. Secondary outcomes included pain, anxiety, depression and QOL. | The authors found statistically significant reductions from pre- to post-treatment in catastrophizing & improvement in quality of life for the treatment group. On a scale measuring pain catastrophizing, 58% (15/26) of the treated participants showed reliable improvement, compared with 18% (5/28) of the control group. |
| Chhabra et al. 2018[125] | 48 Control<br>45 Telehealth | **Control:** Received a written prescription from the Physician, containing a list of prescribed medicines and dosages, and stating the recommended level of physical activity (including home exercises)<br>**Intervention:** Received the same prescription and instructions as the control and Snapcare, a web-based support app that encouraged increased physical activity. | Web-based app developed by the authors (SnapCare). Patients receive daily activity goals (including back and aerobic exercises), tailored to individual health status, ADLs, and daily activity progress. The app attempts to motivate, promote, and guide participants to increase their level of physical activity and exercise adherence | Primary outcomes were pain and disability. | Both groups had a significant improvement in pain and disability ($p<0.05$). The App group showed a statistically significantly greater decline in disability ($p<0.001$) |

**Table 4.6.2 continued**

| Study | Sample Size | Study/ Intervention | Telehealth Medium | Outcomes | Results |
|---|---|---|---|---|---|
| Chiauzzi et al 2010[126] | 104 Control<br>95 Telehealth | **Control: P**articipants were e-mailed a back pain guide after baseline screening.<br>**Intervention:** Participants were instructed to log onto the painACTION-Back Pain study Website, in their own environment, for two weekly sessions across 4 weeks. Participants were asked to spend at least 20 minutes in each session. Protocols served as guides to online content to be reviewed, with instructions for the intervention phase (first 4 weeks) as well as the booster phase (five monthly visits during the follow-up period). | painACTION-Back Pain is a website based on CBT and self-management principles. It includes components that help people cope with chronic low back pain: collaborative decision making with health professionals; CBT to improve self-efficacy, manage thoughts and mood, set clinical goals, work on problem-solving life situations, and prevent pain relapses; motivational enhancement through tailored feedback; wellness activities to enhance good sleep, nutrition, stress management, and exercise practices. | Outcomes included:<br>The Brief Pain Inventory (BPI), the Oswestry Disability Questionnaire (ODQ), the Depression Anxiety Stress Scales (DASS), the Chronic Pain Coping Inventory-42 (CPCI-42, Pain Catastrophizing Scale (PCS), Pain Self-Efficacy Questionnaire (PSEQ), Fear-Avoidance Beliefs Questionnaire (FABQ). | Intervention participants reported significantly: lower stress; increased coping self-statement; greater use of social support. Comparisons between groups suggested clinically significant differences in current pain intensity, depression, anxiety, stress, and global ratings of improvement. Among participants recruited online, those using the Website reported significantly: lower "worst" pain; lower "average" pain; and 3) increased coping self-statements, compared with controls |
| Cottrell et al. 2019[90] | 15 Control<br>46 Telehealth | **Control:** Non-surgical management for their back or neck pain within person visits to their local physiotherapy provider.<br>**Intervention:** Participants who chose to undertake their nonsurgical management via telerehabilitation were referred to the Telehealth Clinic. The Telehealth Clinic utilized the eHAB telerehabilitation web-based platform, where patients were able to independently connect with their clinicians on their own Internet enabled computer device from within their home. | The eHAB telerehabilitation web-based platform is a clinically validated telehealth system from NEOREHAB. It provides real time video conferencing, advanced media tools including chat platforms and exercise prescription, remote measurement of joint and body position and real time feedback to patients. | Outcomes included the Oswestry Disability Index, the Neck Disability Index, Pain severity using a 100 mm visual analogue scale (VAS), the Assessment of Quality of Life – 6 Dimensions (AQoL-6D). the Pain Self-Efficacy Questionnaire, (PSEQ), the Depression, Anxiety and Stress Scale (DASS-21) | There were no significant group-by-time interactions observed for either pain-related disability (p ¼ 0.706), pain severity (p ¼ 0.187) or health-related quality of life (p ¼ 0.425) measures. The telerehabilitation group reported significantly higher levels of treatment satisfaction (median: 97 vs. 76.5; p ¼ 0.021); |
| Pozo-Cruz et al. 2012[101] | 50 Control<br>50 Telehealth | **Control:** Standard preventive medicine care.<br>**Intervention:** A short e-mail was sent every day with a reminder message containing a link to the online "session of the day". The sessions were structured in real-time, first playing a video of postural reminders (2 min), then a video of the exercise(s) for the day (7 min), followed by postural reminders once again (2 min). The videos were available Monday to Friday, weekly, for 9 months. Participants were asked not to perform any formal physical activity routine during the training period. | Web based email with links to online resources. Each participant was assigned a username and password to access the system, and the treatment program was explained to them. | Primary outcome measures included STarT Back Screening Tool (SBST), Roland Morris score, and European Quality of Life Questionnaire – 5 dimensions – 3 levels. | At 9 months, SBST was analyzed and compared with the baseline and controls. Significant positive effects were found on mean scores recorded in the online occupational exercise intervention group for risk of chronicity (p<0.019). A correlation between functional disability, health-related quality of life and risk of chronicity of low back pain was observed. |

**Table 4.6.2 continued**

| | Sample Size | Study/ Intervention | Telehealth Medium | Outcomes | Results |
|---|---|---|---|---|---|
| Priebe et al. 2020[127] | 312 Control 933 Telehealth | **Control**: standard of care for the treatment of LBP coordinated by the general practitioner after signing the informed consent. It was considered that the control GPs use the German national guidelines as their "standard of care" **Intervention**: The Rise-uP treatment protocol was inspired by the German National Guideline for the treatment of NLBP. Treatment was initiated using the STarT Back screening tool. Risk scoring initiated a teleconsultation with pain specialists was initiated. The patient was supplied with the Kaia App via the Kaia server. | Kaia Health is a multiplatform app for iOS, Android, and native Web solutions. Kaia is available via the App Store (iOS), the Google Play Store, or as a native website. App sign up involves extensive medical screening and a general fitness screen to tailor a specific exercise regimen for each patient. The exercise content features a pool of each different exercises (physiotherapy, mindfulness, and education). Exercises in each of the categories are customized more clearly to the user's feedback. PT exercises are subdivided into 19 different difficulty levels. The exercises are based on the concept of lumbar motor control exercise. | The primary outcome was pain intensity measured on a 11-point numeric ratings scale for the current pain as well as for maximum and average pain over the previous 4 weeks. Secondary outcomes included functional ability, psycho pathological and wellbeing parameters as well as pain graduation. The Depression-Anxiety-Stress-Scale (DASS) was applied for measuring psycho pathological symptoms. The Hannover Functional Ability Questionnaire (HFAQ) was used to determine functional ability. The Veterans RAND 12 Item Health Survey (VR-12) measured mental and physical wellbeing. The Graded Chronic Pain Status GCPS was used for grading pain severity. | The intervention group showed significantly stronger pain reduction compared to the control group after 3 months (IG: M=−33.3% vs CG: M=−14.3%). The Rise-uP group was also superior in secondary outcomes. |
| Krein et al. 2013[128] | 118 Control 111 Telehealth | **Control:** Enhanced usual care participants received the uploading pedometer and monthly email reminders to upload their pedometer data. However, they did not receive any goals or feedback and their access to the study website was limited. **Intervention:** Consisted of three primary components: the uploading pedometer, a website that provided automated goal setting and feedback, targeted messages, and educational materials, and an e-community Participants wore their pedometer from the time they got up in the morning until they went to bed. Intervention participants received weekly email reminders to upload their pedometer data, which established individualized walking goals. | Website developed by the authors to upload pedometer data, establish weekly goals, and find graphical and written feedback about their progress toward goals. Informational messages are emailed to participants that included quick tips, which changed every other day, and weekly updates about topics in the news. Back class materials, which included handouts about topics such as body mechanics, use of cold packs, lumbar rolls, and good posture, as well as a video demonstrating specific strengthening and stretching exercises were also available on the website. Finally, the website-based e-community or forum allowed participants to post suggestions, ask questions, and share stories. | Primary outcome measure was Roland Morris Disability Quotient (RDQ). | At 6 months, average RDQ scores were 7.2 for intervention participants compared to 9.2 for usual care, an adjusted difference of 1.6 (95% CI 0.3-2.8, P=.02) for the complete case analysis and 1.2 (95% CI -0.09 to 2.5, P=.07) for the all case analysis. A post hoc analysis of patients with baseline RDQ scores ≥4 revealed even larger adjusted differences between groups at 6 months but at 12 months the differences were no longer statistically significant. |
| Mayer et al. 2020[129] | 83 Control 86 Supervised 96 Telehealth | **Control:** received a 1-on-1 60-minute exercise education **Supervised Exercise:** group physical fitness exercises twice a week throughout the 12-month study period. Exercises were expected to take 10 to 15 minutes and were performed under direct 1-on-1 supervision **Telehealth:** study exercises under the same conditions as supervised exercise group Participants in this group received subsequent exercise instruction and guidance using a telehealth system. | WebExercises (Novato CA) system with: video and audio instruction of exercises; ability to contact study staff with exercise questions; ability to interact by telephone, email, text; automated email and text reminders to perform study exercises according to prescribed schedule; ability to record exercise performance; performance reports; remote monitoring of exercise adherence and progression. | Primary outcome was the quantity of lost work time. | Statistically significant differences were noted between the groups. For each hour of lost work time due to LBP in the supervised exercise group, the control group experienced 1.15 hours (95% CI: 1.04, 1.27; P ¼ 0.008). For each hour of lost work time due to LBP in the telehealth exercise group, the control group experienced 5.51 hours (95% CI: 4.53, 6.70; P < 0.0001), and the supervised group experienced 4.8 hours (95% CI: 3.9, 5.9; P < 0.0001). |

**Table 4.6.2 continued**

| Study | Sample Size | Study/ Intervention | Telehealth Medium | Outcomes | Results |
|---|---|---|---|---|---|
| Mbada et al. 2019[130] | 26 Control<br>21 Telehealth | **Control:** The CBMT group received the McKenzie extension protocol. The protocol involves a course of specific lumbosacral repeated movements in extension that cause the symptoms to centralize, decrease, or abolish<br>**Telehealth:** The TBMT group received an app-based version of the McKenzie extension protocol. The TBMT app is a combination of the McKenzie extension protocols and back care education developed and enabled to run on a smartphone | Phone based app developed by the authors. The TBMT is a mobile phone video app designed for patients with chronic LBP based on McKenzie therapy principles. The app provides personalized and guided self-therapy using the same protocols in the McKenzie protocol (i.e., Extension Lying Prone, Extension in Prone, and Extension in Standing). | Main treatment outcome was pain on the VAS. | Between groups comparison of effects showed no significant differences (p>0.05) in change in mean pain scores at the end of the 4th week of the study and no significant differences (p>0.05) in mean pain scores groups at the end of the 8th week of the study. |
| Petrozzi et al. 2020[131] | 49 Control<br>54 Telehealth | **Control:** 12 Sessions of exercise manual therapy and advice. Manual therapy included spinal manipulation or mobilization and/or soft tissue massage. Exercise included specific exercise or general conditioning Advice and education consisted of reassurance and advice about symptom management and encouragement to remain active.<br>**Intervention:** Participants received the same physical treatments as the Control Group with the addition of access to the MoodGYM program. Participants were instructed to work through one module per week whilst concurrently undertaking their physical treatments. | MoodGYM is a self-guided, web-based app. The program is presented as a combination of written information, real-life examples, and quizzes, delivered within the principles of a CBT framework. | Primary outcomes: The Pain Self Efficacy Questionnaire (PSEQ), the Roland Morris Disability Questionnaire (RMD). Secondary outcomes included the Pain Catastrophizing Scale (PCS), the Patient Specific Functional Scale (PSFS), Depression Anxiety and Stress Scale (DASS21), the Pain Numerical Rating Scale (PNRS), Work Ability Index (WAI). | No statistically significant difference between the two groups in either disability (p = .70) or self-efficacy (p = .52) at any follow-up time points. Between group effect sizes were insignificant. A statistically significant within-group reduction in disability was observed for both groups at post-treatment (p < .001) which was maintained at 6 and 12 months. |
| Riva et al. 2014[132] | 24 Control<br>27 Telehealth | **Control:** Static version of the ONSELF website including only the library, first aid and the FAQ sections.<br>**Intervention:** Active version of the website including all features, static and active. | Internet based intervention called ONESELF. For this study, a modified version of the original website was created, restricting access to content on CBP only. Features including a patient Library, a First Aid section, and a Frequently Asked Questions (FAQ) section. Interactive features included a Virtual Gym, Testimonials and Commentaries, a weekly Action Plan, and a Quiz Game. | Primary outcome was the change in empowerment measured by the psychological empowerment scale. | Overall, the intervention had a moderate effect. Compared to the control group, the availability of ONESELF increased patient empowerment (midterm assessment: mean difference=+1.2, P=.03, d=0.63; final assessment: mean difference=+0.8, P=.09, d=0.44) and reduced medication misuse (midterm assessment: mean difference=−1.5, P=.04, d=0.28; final assessment: mean difference=−1.6, P=.03, d=−0.55) in the intervention group. |
| Sander et al. 2020[133] | 146 Usual Care 149 Intervention | **Usual Care:** Treatment varies for subclinical depression and usual care might consist of visits to a primary care physician but may not entail treatment by a mental health care specialist.<br>**Intervention:** Guided self-help program with 6 obligatory modules and 3 optional modules based on CBT. .E-coaches guided the participants by giving written feedback. | The intervention (eSano BackCare-DP) is a web based guided self-help program with 6 obligatory modules and 3 optional modules based on cognitive behavioral therapy principles.<br>Reminder short message service (SMS) supported patients in complying with the plan. | The primary outcome was the occurrence of a major depressive event (MDE). | The intervention reduced the risk of major depressive event onset by 52% (hazard ratio, 0.48; 95% CI, 0.28-0.81; P < .001). Twenty-one participants (14.1%) in the intervention group and 41 participants (28.1%) in the control group experienced an MDE over the 12-month period. The number needed to treat to prevent 1 new case of MDE was 2.84 (95% CI, 1.79-9.44). |

**Table 4.6.2 continued**

| Study | Sample Size | Study/ Intervention | Telehealth Medium | Outcomes | Results |
|---|---|---|---|---|---|
| Schaller et al. 2017[134] | 73 Control<br>71 Telehealth | **Control:** A low intensity intervention comprising two general presentations on health-enhancing physical activity (30 min each) during inpatient rehabilitation which could be downloaded from a homepage during aftercare.<br>**Intervention:** A multicomponent approach comprising three different components: face-to-face contact (small group intervention, 3 times during IP rehabilitation), tailored telephone aftercare (8 and 12 weeks after rehabilitation) and an internet-based aftercare (web 2.0 platform; available up to six months after rehabilitation). | The web 2.0 internet platform obtained further information on health-enhancing physical activity and offered social support by providing a forum to communicate with other participants and the Coach. | The primary outcome was domain specific physical activity. | At six- and twelve-month follow-up there were no statistically significant between group differences in total (T1: p = 0.79; T2: p = 0.30) as well as domain-specific physical activity (workplace (T1: p = 0.16; T2: p = 0.65), leisure time (T1: p = 0.54; T2: p = 0.89), transportation (T1: p = 0.29; T2: p = 0.77) between Movement Coaching and the control group. In both groups, workplace physical activity showed the highest proportion of total physical activity. From baseline to twelve-month follow-up the results showed a decline in total physical activity (Movement Coaching: p = 0.04; control group: p = 0.50). |
| Schaller et al. 2016[135] | 100 Control<br>92 Telehealth | **Control:** A low intensity intervention comprising two general presentations on health-enhancing physical activity (30 min each) during inpatient rehabilitation which could be downloaded from a homepage during aftercare.<br>**Intervention:** A multi-component approach comprising three different components: face-to-face contact (small group intervention, 3 times during IP rehabilitation), tailored telephone aftercare (8 and 12 weeks after rehabilitation) and an internet-based aftercare (web 2.0 platform; available up to six months after rehabilitation). | The web 2.0 internet platform obtained further information on health-enhancing physical activity and offered social support by providing a forum to communicate with other participants and the Coach. | The primary outcome was domain specific physical activity. | At six months follow-up, 92 participants in Movement Coaching (46 %) and 100 participants in the control group (47 %) completed the postal follow-up questionnaire. No significant differences between the two groups could be shown in total physical activity (P = 0.30). In addition to this, workplace (P = 0.53), transport (P = 0.68) and leisure time physical activity (P = 0.21) and pain (P = 0.43) did not differ significantly between the two groups. In both groups, physical activity decreased during the six-month follow-up. |
| Shebib et al. 2019[136] | 64 Control<br>113 Telehealth | **Control:** The control group received three digital education articles only. All participants maintained access to treatment-as-usual.<br>**Intervention: A** remote digital care program (DCP) available through a mobile app. Subjects participated in a 12-week multimodal DCP incorporating education, sensor-guided exercise therapy (ET), and behavioral health support with 1-on-1 remote health coaching. | Participants received a tablet computer with the Hinge Health app installed, along with 2 Bluetooth wearable motion sensors with straps and instructions to be placed above and below the painful region during the in-app exercise therapy (ET). In the lower back program, a sensor was placed on the posterior lower back and anterior chest. Sensors were used to objectively monitor compliance and performance of exercises. | Primary pain outcome was the Korff Pain scale; secondary outcomes included VAS pain, Primary disability outcomes included Korff Disability, and the Oswestry Disability Index. Secondary outcome included VAS Impact on Daily Life), as well as secondary outcomes of understanding of LBP and reduction in back surgery interest. | At 12 weeks, an intention-to-treat analysis showed each primary outcome—Oswestry Disability Index (p <0.001), Korff Pain (p < 0.001) and Korff Disability (p < 0.001) as well as each secondary outcome improved more for participants in the DCP group compared to control group. For participants who completed the DCP (per protocol), average improvement in pain outcomes ranged 52-64% (Korff: 48.8–23.4, VAS: 43.6–16.5, VAS impact on daily life: 37.3–13.4; p < 0.01 for all) and average improvement in disability outcomes ranged 31–55% (Korff: 33.1–15, ODI: 19.7–13.5; p < 0.01 for both). Surgical interest significantly reduced in the DCP group |

## Table 4.6.3 Cohort Studies Excluded During Full Text Screening

| Study | Sample Size | Study/ Intervention | Telehealth Medium | Outcomes | Results |
|---|---|---|---|---|---|
| **Cohort Studies** | | | | | |
| Bailey et al. 2020[102] | 10,264 Total Knee = 3796 LBP = 6468 | Retrospective observational cohort study using a remote digital care program (DCP) available through a mobile app. Subjects participated in a 12-week multimodal DCP incorporating education, sensor-guided exercise therapy (ET), and behavioral health support with 1-on-1 remote health coaching. ET sessions comprised light-intensity stretching and strengthening exercises commonly used in clinical practice. Exercise sessions used animations and instructional videos for demonstration. During exercise, the app shows real-time graphics showing the position of the user's relevant body parts based on the wearable sensors and indicated if the exercise was within the desired range of movement. Participants were assigned a personal coach and communication was performed via text message, email, or in-app messaging. | Participants received a tablet computer with the Hinge Health app installed, along with 2 Bluetooth wearable motion sensors with straps and instructions to be placed above and below the painful region during the in-app exercise therapy (ET). In the lower back program, a sensor was placed on the posterior lower back and anterior chest. Sensors were used to objectively monitor compliance and performance of exercises. | | Participants experienced a 68.45% average improvement in VAS pain between baseline intake and 12 weeks. In all, 73.04% (7497/10,264) participants completed the DCP into the final month. In total, 78.60% (5893/7497) of program completers (7144/10,264, 69.60% of all participants) achieved minimally important change in pain. Secondary outcomes included a 57.9% and 58.3% decrease in depression and anxiety scores, respectively, and 61.5% improvement in work productivity. |
| Clement et al. 2018[137] | 1251 | Retrospective observational cohort study using a sample of convenience recruited from Facebook, google ads and the company home page. | Kaia Health is a multiplatform app for iOS, Android, and native Web solutions. Kaia is available via the App Store (iOS), the Google Play Store, or as a native website. App sign up involves extensive medical screening and a general fitness screen to tailor a specific exercise regimen for each patient. The exercise content features a pool of each different exercises (physiotherapy, mindfulness, and education). Exercises in each of the categories are customized more clearly to the user's feedback. PT exercises are subdivided into 19 different difficulty levels. The exercises are based on the concept of lumbar motor control exercise. | Primary outcomes were differences in app use time and number of specific exercise use. | Users signing up during availability of the 1.x version completed significantly more exercises of each type in the app (physical exercises: 0.x mean 1.99, SD 1.61 units/week vs 1.x mean 3.15, SD1.72 units/week; P<.001; mindfulness exercises: 0.x mean 1.36, SD 1.43 units/week vs 1.x mean 2.42, SD 1.82 units/week; P<.001; educational content: 0.x mean 1.51, SD 1.42 units/week vs 1.x mean 2.71, SD 1.89 units/week; P<.001). This translated into a stronger decrease in user-reported pain levels in versions 1.x (F1,1233=7.084, P=.008). |

**Table 4.6.4 MINORS Risk of Bias Assessment**

| | Clearly stated aim | Inclusion of consecutive patients | Prospective data collection | Endpoint is appropriate to study aim | Unbiased assessment of study endpoint | Follow up period appropriate for study aim | < 5% loss to follow up | Prospective calculation of study size | Adequate control group | Contemporary groups | Baseline equivalence of groups | Adequate statistical analysis | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| Cottrell et al. 2019 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 22 |
| Palacin-Marin et al. 2013 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 22 |
| Peterson et al. 2019 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| Truter et al. 2013 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 17 |
| Varkey et al. 2008 | 2 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | - | - | - | - | 7 |

## 4.7 Figures

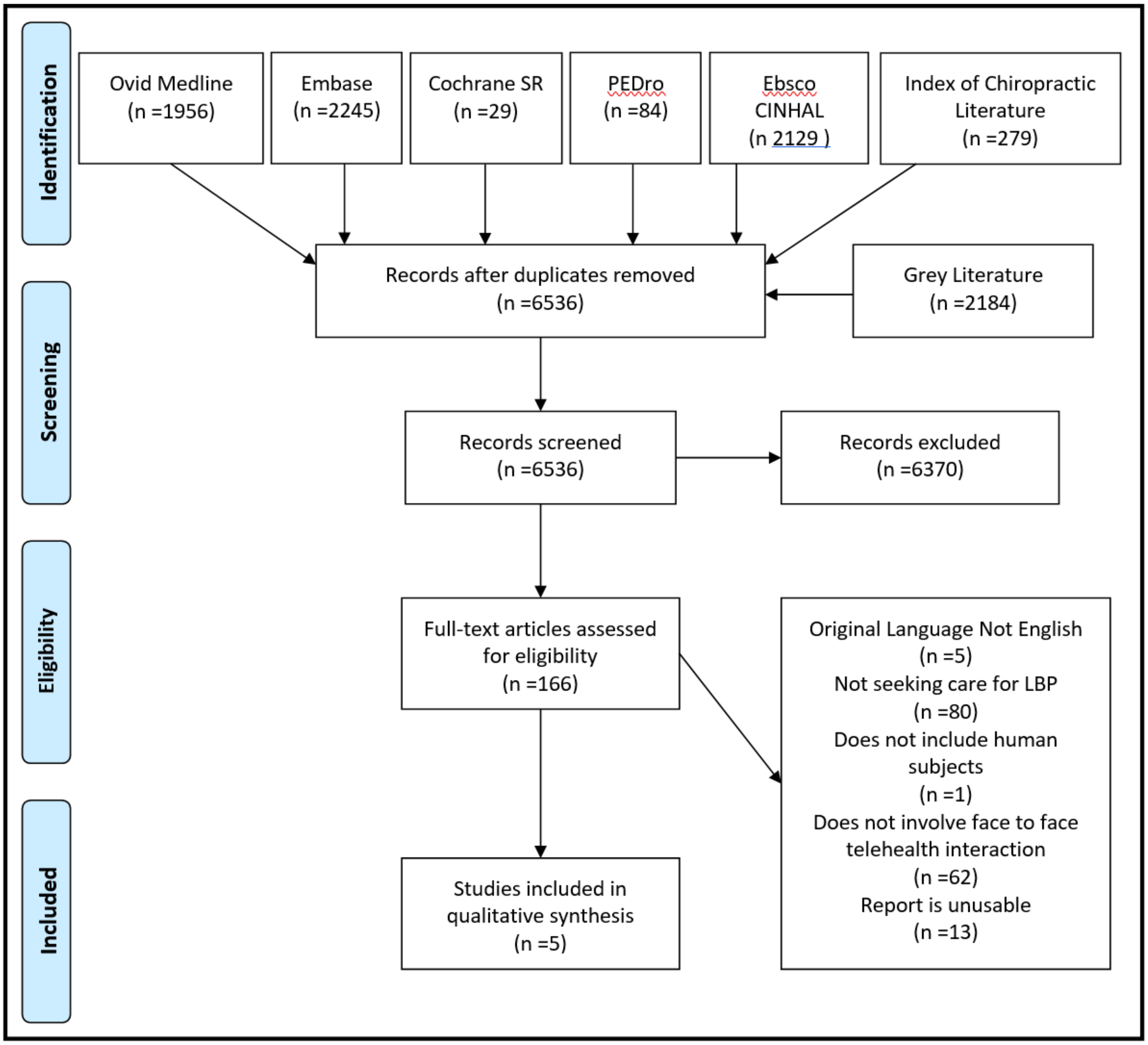


**Figure 4.7.1 PRISMA Diagram**

## 5.0 Conclusions

There is clearly an interaction between the utilization of healthcare resources and the choice of first contact provider seen for an acute episode of back pain. The research from this dissertation highlights the consequences that this choice has on the immediate treatment received and the potential influence on subsequent interventions. The first and second papers addressed the gaps in the literature surrounding the immediate and subsequent utilization patterns of patients seeking care for LBP. The third and final paper was a systematic review of the existing literature surrounding the use of face-to-face telehealth interventions for LBP, which has been identified as a novel solution for getting patients to the appropriate provider in a timely manner.

Specifically, the first paper which investigated access patterns, provider care practices, and resource utilization for patients seeking care for LBP, found a clear relationship between the first choice of provider and healthcare utilization in the 12 months immediately following that interaction. In terms of total utilization the average total cost of care (TCOC) for all medical costs was lowest in those who first sought care with Chiropractic or Physical Therapy and the highest average TCOC for all medical costs was seen in those patients who chose the Emergency Department or a Surgeon. Similarly, when costs were limited to only those claims associated with LBP codes, the lowest average LBP related spending occurred in Chiropractic and Physical Therapy while the highest LBP related spending was seen in Surgery and Emergency Department. While we recognize that Chiropractic and Physical Therapy are unique in that neither has prescribing rights and only chiropractors can provide or refer for imaging, the data continue to suggest that these two professions, when accessed early in the course of care, continue to provide a cost-effective, non-surgical management strategy for LBP. Based on previous findings and the findings from this study, increased consideration should be given to these providers as front line care for the treatment of low back pain. Their provision of interventions that align with current clinical practice guidelines and are considered “high value” by insurers, should cement them as the “first” choice for treatment. Additionally, when a patient arrives at an alternate portal of entry, systems should seamlessly direct these patients to these high value/low cost providers.

The second paper was an investigation into the care being delivered specifically in the Emergency Department (ED). When a model of guideline-based care was applied to a subset of patients who chose the ED as their first choice of provider, we found 1758/2895 (61%) of patients seeking care had at least one of the variables that met the definition of “non-concordant” care, 401/2895 (14%) had 2 or more non-concordant variables and 60/2895 (2%) of patients met the definition of non-concordant care on all three variables. In terms of cost, the ED group generated more costs than the previous groups analyzed in the first paper. The total cost of care for all medical services - and specifically those related to LBP related services provided over the next 12 months - was lowest in those patients who received concordant care. Though our model has limitations, it suggests that care in the ED inconsistently aligns with current clinical practice guidelines. This variation in care likely contributes to the propagation of service utilization in the ED and during the 12 months following initial contact. Taken in the context of the results for the first paper, when patients with non-emergent LBP arrive at the ED, consideration should be given to immediate referral to physical therapy or chiropractic. Additional consideration should be given to embedding these providers into the ED practice flow, whether on site, or available at an adjoining location. Based on out data from both studies, we anticipate that the early referral to these providers would result in decreased immediate and long term costs.

The third paper was a systematic review investigating face-to-face telehealth interventions for LBP. The results revealed wide gaps in the existing literature. The current literature surrounding telehealth interventions involves 3 themes: self-help exercise websites; online exercise smartphone applications; and telephonic telehealth interventions. Currently there are no randomized clinical trials investigating the success or effectiveness of face-to-face telehealth interventions compared with usual care or other forms of telehealth. Therefore, research comparing in-person and telehealth management of LBP would be worthy of future study.

## 5.1 Clinical Implications

The findings from this dissertation appear to confirm our hypothesis, that patients are seeking care from a wide variety of providers for an acute episode of LBP and, the choice of provider appears to have a relationship with costs and outcomes. We also found that the care provided is fraught with variation. The result of this variation is that many patients continue to receive unnecessary low value and high cost tests and interventions with no appreciable gain in patient outcomes. Before completing this study, the influence and impact of the first choice of provider on utilization and patient trajectory have been unclear. Our data indicate that this trajectory is significantly influenced by the first choice of provider, affecting the length of the episode, the initial and subsequent costs associated with that episode, and the risks associated with low value tests and interventions. In the ED specifically, we found that those patients who received guideline-based care had shorter episode length (55 days vs. 60 days) and fewer low back related and total medical expenditures over the year following their ED visit. Given that both Chiropractic and Physical Therapy provide non-pharmacologic and non-surgical interventions that promote behavior change, significant consideration should be given to these groups as first-line care providers. They appear to reduce both immediate and long-term utilization of healthcare resources.

## 5.2 Future Research

This dissertation has provided evidence and insight into the short and long-term costs associated with the treatment of LBP; the immediate interventions used by providers; concordance with current clinical practice guidelines; and the current landscape surrounding telehealth interventions for LBP. A common theme connecting the three papers is the need to consider more efficient and cost-effective strategies to manage patients with LBP. The first paper confirmed the influence of the first choice of provider on healthcare utilization. One of the significant limitations, however, was the lack of clinical outcomes. We can speculate about reducing cost and episode length using the absence of utilization, but this gives us very little information about actual health status. Future research in this area should use similar methodologies with the addition of patient reported outcome measures such as the PROMIS-CAT. With this information, we can initiate cost-effectiveness and utility research.

The second paper offered evidence surrounding the care delivered to patients who used the ED as their first choice of provider. To our knowledge, this study is the first of its kind. Our findings indicate there is room for improvement surrounding treatment in the ED. Future research should be directed toward the implementation of guideline-based treatment and triage mechanisms. There has been some interest and success with these mechanisms[84,138] but the results have not been widely disseminated or studied outside of isolated environments. Specific implementation strategies should be multi-faceted, aimed at behavior change in the ED, and involve extensive use of non-surgical and non-opioid interventions.

The third paper exposed a significant gap in the face-to-face telemedicine literature. Telehealth solutions to treat and intervene in LBP are in their infancy. Research into telehealth triage mechanisms, remote evaluation of patients using a core set of measures and choosing and implementing interventions from a remote location would serve as a foundation for future clinical trials.

We proposed using the Consolidated Framework for Implementation Research (CFIR) as the foundation of an approach for future research into the implementation of telehealth services for the management of LBP. This approach would allow multiple research teams to focus on specific aspects of implementation while working on the problem. Because of the scarcity of research in this area and the current need, research studies about telehealth interventions for LBP should be a high priority for funding agencies.

**Appendix A – ICD-9/ICD-10 Codes used for Patient Identification Title**

ICD - 10 CODES

M41.25Other idiopathic scoliosis, thoracolumbar region
M41.26Other idiopathic scoliosis, lumbar region
M41.27Other idiopathic scoliosis, lumbosacral region
M41.35Thoracogenic scoliosis, thoracolumbar region
M41.45Neuromuscular scoliosis, thoracolumbar region
M41.46Neuromuscular scoliosis, lumbar region
M41.47Neuromuscular scoliosis, lumbosacral region
M41.55Other secondary scoliosis, thoracolumbar region
M41.56Other secondary scoliosis, lumbar region
M41.57Other secondary scoliosis, lumbosacral region
M41.85Other forms of scoliosis, thoracolumbar region
M41.86Other forms of scoliosis, lumbar region
M41.87Other forms of scoliosis, lumbosacral region
M42.05Juvenile osteochondrosis of spine, thoracolumbar region
M42.06Juvenile osteochondrosis of spine, lumbar region
M42.07Juvenile osteochondrosis of spine, lumbosacral region
M42.09Juvenile osteochondrosis of spine, multiple sites in spine
M42.15Adult osteochondrosis of spine, thoracolumbar region
M42.16Adult osteochondrosis of spine, lumbar region
M42.17Adult osteochondrosis of spine, lumbosacral region
M42.19Adult osteochondrosis of spine, multiple sites in spine
M43.05Spondylolysis, thoracolumbar region
M43.06Spondylolysis, lumbar region
M43.07Spondylolysis, lumbosacral region
M43.09Spondylolysis, multiple sites in spine
M43.15Spondylolisthesis, thoracolumbar region
M43.16Spondylolisthesis, lumbar region
M43.17Spondylolisthesis, lumbosacral region
M43.19Spondylolisthesis, multiple sites in spine
M43.25Fusion of spine, thoracolumbar region
M43.26Fusion of spine, lumbar region
M43.27Fusion of spine, lumbosacral region
M43.5X5Other recurrent vertebral dislocation, thoracolumbar region
M43.5X6Other recurrent vertebral dislocation, lumbar region
M43.5X7Other recurrent vertebral dislocation, lumbosacral region
M43.8X5Other specified deforming dorsopathies, thoracolumbar region
M43.8X6Other specified deforming dorsopathies, lumbar region
M43.8X7Other specified deforming dorsopathies, lumbosacral region
M46.05Spinal enthesopathy, thoracolumbar region
M46.06Spinal enthesopathy, lumbar region
M46.07Spinal enthesopathy, lumbosacral region

M46.09Spinal enthesopathy, multiple sites in spine
M46.25Osteomyelitis of vertebra, thoracolumbar region
M46.26Osteomyelitis of vertebra, lumbar region
M46.27Osteomyelitis of vertebra, lumbosacral region
M46.35Infection of intvrt disc (pyogenic), thoracolumbar region
M46.36Infection of intervertebral disc (pyogenic), lumbar region
M46.37Infection of intvrt disc (pyogenic), lumbosacral region
M46.39Infection of intvrt disc (pyogenic), multiple sites in spine
M46.45Discitis, unspecified, thoracolumbar region
M46.46Discitis, unspecified, lumbar region
M46.47Discitis, unspecified, lumbosacral region
M46.49Discitis, unspecified, multiple sites in spine
M46.55Other infective spondylopathies, thoracolumbar region
M46.56Other infective spondylopathies, lumbar region
M46.57Other infective spondylopathies, lumbosacral region
M46.59Other infective spondylopathies, multiple sites in spine
M46.85Oth inflammatory spondylopathies, thoracolumbar region
M46.86Other specified inflammatory spondylopathies, lumbar region
M46.87Oth inflammatory spondylopathies, lumbosacral region
M46.89Oth inflammatory spondylopathies, multiple sites in spine
M46.95Unspecified inflammatory spondylopathy, thoracolumbar region
M46.96Unspecified inflammatory spondylopathy, lumbar region
M46.97Unspecified inflammatory spondylopathy, lumbosacral region
M46.99Unsp inflammatory spondylopathy, multiple sites in spine
M47.15Other spondylosis with myelopathy, thoracolumbar region
M47.16Other spondylosis with myelopathy, lumbar region
M47.17Other spondylosis with myelopathy, lumbosacral region
M47.25Other spondylosis with radiculopathy, thoracolumbar region
M47.26Other spondylosis with radiculopathy, lumbar region
M47.27Other spondylosis with radiculopathy, lumbosacral region
M47.815Spondyls w/o myelopathy or radiculopathy, thoracolum region
M47.816Spondylosis w/o myelopathy or radiculopathy, lumbar region
M47.817Spondyls w/o myelopathy or radiculopathy, lumbosacr region
M47.895Other spondylosis, thoracolumbar region
M47.896Other spondylosis, lumbar region
M47.897Other spondylosis, lumbosacral region
M48.05Spinal stenosis, thoracolumbar region
M48.06Spinal stenosis, lumbar region
M48.07Spinal stenosis, lumbosacral region
M48.15Ankylosing hyperostosis [Forestier], thoracolumbar region
M48.16Ankylosing hyperostosis [Forestier], lumbar region
M48.17Ankylosing hyperostosis [Forestier], lumbosacral region
M48.19Ankylosing hyperostosis [Forestier], multiple sites in spine
M48.25Kissing spine, thoracolumbar region
M48.26Kissing spine, lumbar region
M48.27Kissing spine, lumbosacral region
M48.35Traumatic spondylopathy, thoracolumbar region
M48.36Traumatic spondylopathy, lumbar region

M48.37Traumatic spondylopathy, lumbosacral region
M48.8X5Other specified spondylopathies, thoracolumbar region
M48.8X6Other specified spondylopathies, lumbar region
M48.8X7Other specified spondylopathies, lumbosacral region
M51Thoracic, thoracolum, and lumbosacral intvrt disc disorders
M51.0Thoracic, thrclm and lumbosacr intvrt disc disord w myelpath
M51.05Intvrt disc disorders w myelopathy, thoracolumbar region
M51.06Intervertebral disc disorders with myelopathy, lumbar region
M51.07Intvrt disc disorders w myelopathy, lumbosacral region
M51.1Thor, thrclm & lumbosacr intvrt disc disord w radiculopathy
M51.15Intvrt disc disorders w radiculopathy, thoracolumbar region
M51.16Intervertebral disc disorders w radiculopathy, lumbar region
M51.17Intvrt disc disorders w radiculopathy, lumbosacral region
M51.2Oth thoracic, thrclm and lumbosacr intvrt disc displacmnt
M51.25Other intervertebral disc displacement, thoracolumbar region
M51.26Other intervertebral disc displacement, lumbar region
M51.27Other intervertebral disc displacement, lumbosacral region
M51.3Oth thoracic, thrclm and lumbosacr intvrt disc degeneration
M51.35Other intervertebral disc degeneration, thoracolumbar region
M51.36Other intervertebral disc degeneration, lumbar region
M51.37Other intervertebral disc degeneration, lumbosacral region
M51.45Schmorl's nodes, thoracolumbar region
M51.46Schmorl's nodes, lumbar region
M51.47Schmorl's nodes, lumbosacral region
M51.8Oth thoracic, thoracolum and lumbosacr intvrt disc disorders
M51.85Other intervertebral disc disorders, thoracolumbar region
M51.86Other intervertebral disc disorders, lumbar region
M51.87Other intervertebral disc disorders, lumbosacral region
M51.9Unsp thoracic, thoracolum and lumbosacr intvrt disc disorder
M53Other and unspecified dorsopathies, not elsewhere classified
M53.2X5Spinal instabilities, thoracolumbar region
M53.2X6Spinal instabilities, lumbar region
M53.2X7Spinal instabilities, lumbosacral region
M53.3Sacrococcygeal disorders, not elsewhere classified
M53.85Other specified dorsopathies, thoracolumbar region
M53.86Other specified dorsopathies, lumbar region
M53.87Other specified dorsopathies, lumbosacral region
M54.05Panniculitis affecting regions of neck/bk, thoracolum region
M54.06Panniculitis affecting regions of neck/bk, lumbar region
M54.07Panniculitis affecting regions of neck/bk, lumbosacr region
M54.09Panniculitis aff regions, neck/bk, multiple sites in spine
M54.15Radiculopathy, thoracolumbar region
M54.16Radiculopathy, lumbar region
M54.17Radiculopathy, lumbosacral region
M54.31Sciatica, right side
M54.32Sciatica, left side
M54.41Lumbago with sciatica, right side
M54.42Lumbago with sciatica, left side

ICD - 9 CODES

721Spondylosis and allied disorders
721.3Lumbosacral spondylosis without myelopathy
721.4Thoracic or lumbar spondylosis with myelopathy
721.42Spondylosis with myelopathy, lumbar region
721.5Kissing spine
721.6Ankylosing vertebral hyperostosis
721.7Traumatic spondylopathy
721.8Other allied disorders of spine
721.9Spondylosis of unspecified site
721.90Spondylosis of unspecified site without mention of myelopathy
721.91Spondylosis of unspecified site with myelopathy
722Intervertebral disc disorders
722.1Displacement of thoracic or lumbar disc without myelopathy
722.10Displacement of lumbar disc without myelopathy
722.2Displacement of disc, site unspecified, without myelopathy
722.3Schmorl's nodes
722.30Schmorl's nodes, unspecified region
722.32Schmorl's nodes, lumbar region
722.39Schmorl's nodes, other spinal region
722.5Degeneration of thoracic or lumbar intervertebral disc
722.51Degeneration of thoracic or thoracolumbar intervertebral disc
722.52Degeneration of lumbar or lumbosacral intervertebral disc
722.6Degeneration of intervertebral disc, site unspecified
722.7Intervertebral disc disorder with myelopathy
722.70Intervertebral disc disorder with myelopathy, unspecified region
722.73Intervertebral lumbar disc disorder with myelopathy, lumbar region
722.8Postlaminectomy syndrome
722.80Postlaminectomy syndrome, unspecified region
722.83Postlaminectomy syndrome, lumbar region
722.9Other and unspecified disc disorder
722.90Other and unspecified disc disorder of unspecified region
722.93Other and unspecified disc disorder of lumbar region
724Other and unspecified disorders of back
724.0Spinal stenosis, other than cervical
724.00Spinal stenosis, unspecified region other than cervical
724.02Spinal stenosis of lumbar region, without neurogenic claudication
724.03Spinal stenosis of lumbar region, with neurogenic claudication
724.09Spinal stenosis, other region other than cervical
724.2Lumbago
724.3Sciatica
724.4Thoracic or lumbosacral neuritis or radiculitis, unspecified
724.5Unspecified backache
724.6Disorders of sacrum
724.8Other symptoms referable to back

724.9Other unspecified back disorder
729.2Unspecified neuralgia, neuritis, and radiculitis
738.4Acquired spondylolisthesis
738.5Other acquired deformity of back or spine
738.6Acquired deformity of pelvis
739Nonallopathic lesions, not elsewhere classified
739.3Nonallopathic lesion of lumbar region, not elsewhere classified
739.4Nonallopathic lesion of sacral region, not elsewhere classified
739.5Nonallopathic lesion of pelvic region, not elsewhere classified
756.11Congenital spondylolysis, lumbosacral region
756.12Congenital spondylolisthesis
846Sprains and strains of sacroiliac region
846.0Sprain and strain of lumbosacral (joint) (ligament)
846.1Sprain and strain of sacroiliac (ligament)
846.2Sprain and strain of sacrospinatus (ligament)
846.3Sprain and strain of sacrotuberous (ligament)
846.8Other specified sites of sacroiliac region sprain and strain
846.9Unspecified site of sacroiliac region sprain and strain
847Sprains and strains of other and unspecified parts of back
847.2Lumbar sprain and strain
847.3Sprain and strain of sacrum
847.9Sprain and strain of unspecified site of back

**Appendix B – ICD-9/10 Codes for exclusion**

592.0Kidney Stones
N20.0Calculus of Kidney
594.0 Bladder Stones
N21.0 Calculus of Bladder
574.2 Gall Bladder Stones
K80.20 Calculus of Gallbladder
599.0 Urinary Tract infection
N39.0Urinary Tract infection
S32.xFracture of the Lumbar Spine, Sacrum, Pelvis
805 Fracture of vertebral column without mention of spinal cord injury
808 Fracture of pelvis
809 Ill-defined fractures of bones of trunk
733.13Pathologic fracture of vertebra
M48.50XA Collapsed vertebra, not elsewhere classified, site unspecified, initial encounter for fracture
M80.08XA Age-related osteoporosis with current pathological fracture, vertebra(e), initial encounter for fracture
M84.48XA Pathological fracture, other site, initial encounter for fracture
M84.68XA Pathological fracture in other disease, other site, initial encounter for fracture
733.98Stress fracture of the pelvis
M84.350AStress fracture, pelvis, initial encounter for fracture
730.2Unspecified osteomyelitis, site unspecified
M.86.9Osteomyelitis
720.0 Ankylosing spondylitis
M45.9Ankylosing spondylitis of unspecified sites in spine
S34.3XXA Injury of cauda equina, initial encounter
952.4 Cauda equina spinal cord injury without evidence of spinal bone injury
140 – 209Malignant Neoplasms
C00 – C96Malignant Neoplasms
O00 – O9APregnancy, childbirth, and the puerperium

## Appendix C – "Other" First Contact Providers

Acupuncture
Ambulatory surgery
Anesthesiology
Cardiology
Critical care medicine
Durable medical equipment & ox
Emergency medicine aca
Gastroenterology
Hematology/oncology
Home health
Hospital
Infectious diseases
Lab
Oncology
Ophthalmology
Palliative medicine
Pathology
Pediatric critical care medici
Pediatrics
Psychiatry
Psychology
Radiology
Radiology-mri
Rural clinic reimbursement
Skilled nursing facility-adult
Specialty products/services-bo
Surgery (critical care)
Transportation services
Unknown
Urology

## Appendix D – SPMI ICD-9/10 codes

ICD-9-CM Group codes: 295, 296
ICD-9-CM codes: 298.9, 301.83
ICD-10-CM Group codes: F20, F25
ICD-10-CM codes: F29, F30.10, F30.11, F30.12, F30.13, F30.2, F30.3, F30.4, F30.8, F30.9, F31.0, F31.10, F31.11, F31.12, F31.13, F31.2, F31.30, F31.31, F31.32, F31.4, F31.5, F31.60, F31.61, F31.62, F31.63, F31.64, F31.70, F31.71, F31.72, F31.73, F31.74, F31.75, F31.76, F31.77, F31.78, F31.81, F31.89, F31.9, F32.0, F32.1, F32.2, F32.3, F32.4, F32.5, F32.89, F32.9, F33.0, F33.1, F33.2, F33.3, F33.40, F33.41, F33.42, F33.8, F33.9, F34.81, F34.89, F34.9, F39, F60.3

## Appendix E – Outcomes Codes

Surgery – DRG codes '304', '321', '454', '455', '456', '457', '458', '459', '460', '472', '473', '490', '491', '496', '497', '498', '499', '500', '551', '552'

Injections – CPT-4 codes C9209', 'G0260', 'J0131', '216T', '217T', '218T', '230T', '231T', 'J1020', 'J1030', 'J1040', 'J1100', 'J1170', 'J1885', 'J2001', 'J2175', 'J2270' 'J2274', 'J2400', 'J2920', 'J2930', 'X0620', '01991', '01992', '20526', '20550', '20551', '20552', '20553', '27096', '62273', '62282', '62311', '62319', '62322', '62323', '62326', '62327', '64445', '64447', '64449', '64475', '64476', '64483', '64484', '64493', '64494', '64495

## Appendix F – Systematic Review Search Strategies

**All searches run September 17, 2020**

**Ovid Medline**

| # | Searches | Results |
|---|---|---|
| 1 | exp Back Pain/ or exp Back Injuries/ or exp sciatic neuropathy/ or exp Spinal Diseases/ or spinal fusion/ or (arachnoiditis or backache* or coccydynia or discitis or dorsalgia or lumbago or postlaminectomy or sciatica or spinal stenosis or spondylarth* or spondylisthesis or spondylo* or ((disc* or disk*) adj (degeneration* or herniation* or prolapse*))).ti,ab,kw. | 203492 |
| 2 | exp Back/ or (back or coccyx or facet joint* or intervertebral disc or lumbar or lumbo sacral* or lumbosacral* or spine or spinal or zygapophyseal joint*).ti,ab,kw. | 586571 |
| 3 | exp Pain/ or (injur* or pain or pains or painful).ti,ab,kw. | 1570976 |
| 4 | 1 or (2 and 3) | 324285 |
| 5 | exp Telemedicine/ or telecommunications/ or exp Computer Communication Networks/ or decision making, computer-assisted/ or user computer interface/ or exp Videoconferencing/ or (digital care or digital treatment* or e coach or e health or information communication technolog* or information technolog* or internet quer* or m health or mhealth or mobile health or patient internet portal* or remote visit* or short message service or tele care* or tele coach* or tele conference* or tele consult* or tele diagnosis or tele health* or tele home* or tele management or tele med* or tele mentor* or tele monitor* or tele nurs* or tele rehab* or tele screen* or tele support or tele therap* or telecare* or telecoach* or teleconference* or teleconsult* or telediagnosis or telehealth* or telehome* or telemanagement or telematic* or telemed* or telementor* or telemonitor* or telenurs* or telerehab* or telerehabilitation or telescreen* or telesupport or teletherap* or video conferenc* or video rehab* or virtual reality or "Doctor on Demand" or "Livehealth Online" or Amwell or Blue jeans or Chiron health or Doxy or "Go to meeting" or "Go to webinar" or Google hangout* or Google meeting* or Healthtap or Icliniq or Mdlive or Memd or Microsoft teams or Plushcare or Skype or Teladoc or Virtuwell or Vsee or Vtconnec or Zoom).ti,ab,kw. | 187881 |
| 6 | ((app or computer based or internet or mobile or mobile or on line or online or phone or remote or tele* or video or virtual or web*) adj5 (assess* or care or coach* or | 103594 |

| | | |
|---|---|---|
| | communication or consult* or forum* or intervention* or monitor* or rehab* or specialist or therap* or train* or treatment* or visit*)).ti,ab,kw. | |
| 7 | 5 or 6 | 255639 |
| 8 | 4 and 7 | 1956 |

**EMBASE via Embase.com**

| # | Searches | Results |
|---|---|---|
| 1 | 'backache'/exp OR 'spine injury'/exp OR 'sciatic neuropathy'/exp OR 'spine disease'/exp OR 'spine fusion'/de | 348,272 |
| 2 | arachnoiditis:ti,ab,kw OR backache*:ti,ab,kw OR coccydynia:ti,ab,kw OR discitis:ti,ab,kw OR dorsalgia:ti,ab,kw OR lumbago:ti,ab,kw OR postlaminectomy:ti,ab,kw OR sciatica:ti,ab,kw OR 'spinal stenosis':ti,ab,kw OR spondylarth*:ti,ab,kw OR spondylisthesis:ti,ab,kw OR spondylo*:ti,ab,kw | 57744 |
| 3 | ((disc* or disk*) NEAR/1 (degeneration* or herniation* or prolapse*)):ti,ab,kw | 19457 |
| 4 | #1 OR #2 OR #3 | 361051 |
| 5 | 'back'/exp OR 'lumbar region'/exp OR 'lumbosacral region'/exp OR 'back'/exp | 226782 |
| 6 | back:ti,ab,kw OR coccyx:ti,ab,kw OR 'facet joint*':ti,ab,kw OR 'intervertebral disc':ti,ab,kw OR lumbar:ti,ab,kw OR 'lumbo sacral*':ti,ab,kw OR lumbosacral*:ti,ab,kw OR spine:ti,ab,kw OR spinal:ti,ab,kw OR 'zygapophyseal joint*':ti,ab,kw | 788915 |
| 7 | #5 OR #6 | 851031 |
| 8 | 'pain'/exp | 1357148 |
| 9 | injur*:ti,ab,kw OR pain:ti,ab,kw OR pains:ti,ab,kw OR painful:ti,ab,kw | 2013891 |
| 10 | #8 OR #9 | 2655033 |
| 11 | #4 OR (#7 AND #10) | 530684 |
| 12 | 'telemedicine'/exp OR 'telecommunication'/de OR 'telehealth'/exp OR 'teleconference'/exp OR 'computer network'/exp OR 'computer interface'/exp OR 'videoconferencing'/exp | 117474 |

| | | |
|---|---|---|
| 13 | 'digital care':ti,ab,kw OR 'digital treatment*':ti,ab,kw OR 'e coach':ti,ab,kw OR 'e health':ti,ab,kw OR 'information communication technolog*':ti,ab,kw OR 'information technolog*':ti,ab,kw OR 'internet quer*':ti,ab,kw OR 'm health':ti,ab,kw OR mhealth:ti,ab,kw OR 'mobile health':ti,ab,kw OR 'patient internet portal*':ti,ab,kw OR 'remote visit*':ti,ab,kw OR 'short message service':ti,ab,kw OR 'tele care*':ti,ab,kw OR 'tele coach*':ti,ab,kw OR 'tele conference*':ti,ab,kw OR 'tele consult*':ti,ab,kw OR 'tele diagnosis':ti,ab,kw OR 'tele health*':ti,ab,kw OR 'tele home*':ti,ab,kw OR 'tele management':ti,ab,kw OR 'tele med*':ti,ab,kw OR 'tele mentor*':ti,ab,kw OR 'tele monitor*':ti,ab,kw OR 'tele nurs*':ti,ab,kw OR 'tele rehab*':ti,ab,kw OR 'tele screen*':ti,ab,kw OR 'tele support':ti,ab,kw OR 'tele therap*':ti,ab,kw OR telecare*:ti,ab,kw OR telecoach*:ti,ab,kw OR teleconference*:ti,ab,kw OR teleconsult*:ti,ab,kw OR telediagnosis:ti,ab,kw OR telehealth*:ti,ab,kw OR telehome*:ti,ab,kw OR telemanagement:ti,ab,kw OR telematic*:ti,ab,kw OR telemed*:ti,ab,kw OR telementor*:ti,ab,kw OR telemonitor*:ti,ab,kw OR telenurs*:ti,ab,kw OR telerehab*:ti,ab,kw OR telerehabilitation:ti,ab,kw OR telescreen*:ti,ab,kw OR telesupport:ti,ab,kw OR teletherap*:ti,ab,kw OR 'video conferenc*':ti,ab,kw OR 'video rehab*':ti,ab,kw OR 'virtual reality':ti,ab,kw OR 'doctor on demand':ti,ab,kw OR 'livehealth online':ti,ab,kw OR amwell:ti,ab,kw OR 'blue jeans':ti,ab,kw OR 'chiron health':ti,ab,kw OR doxy:ti,ab,kw OR 'go to meeting':ti,ab,kw OR 'go to webinar':ti,ab,kw OR 'google hangout*':ti,ab,kw OR 'google meeting*':ti,ab,kw OR healthtap:ti,ab,kw OR icliniq:ti,ab,kw OR mdlive:ti,ab,kw OR memd:ti,ab,kw OR 'microsoft teams':ti,ab,kw OR plushcare:ti,ab,kw OR skype:ti,ab,kw OR teladoc:ti,ab,kw OR virtuwell:ti,ab,kw OR vsee:ti,ab,kw OR vtconnec:ti,ab,kw OR zoom:ti,ab,kw | 77278 |
| 14 | ((app OR 'computer based' OR internet OR mobile OR mobile OR 'on line' OR online OR phone OR remote OR tele* OR video OR virtual OR web*) NEAR/5 (assess* OR care OR coach* OR communication OR consult* OR forum* OR intervention* OR monitor* OR rehab* OR specialist OR therap* OR train* OR treatment* OR visit*)):ti,ab,kw | 151904 |
| 15 | #12 OR #13 OR #14 | 278352 |
| 16 | #11 AND #15 | 3429 |
| | Duplicates removed = 1300 | 2129 |
| | NOT Conference Abstracts | **945** |
| | Conference Abstracts | 1184 |

**EBSCO CINAHL**

| # | Searches | Results |
|---|---|---|

| | | |
|---|---|---|
| 1 | (MH "Back Pain+") or (MH "Back Injuries+") or (MH "Sciatica") or (MH "Spinal Diseases+") or (MH "Spinal Fusion") | 73,866 |
| 2 | TI (arachnoiditis or backache* or coccydynia or discitis or dorsalgia or lumbago or postlaminectomy or sciatica or "spinal stenosis" or spondylarth* or spondylisthesis or spondylo*) OR AB (arachnoiditis or backache* or coccydynia or discitis or dorsalgia or lumbago or postlaminectomy or sciatica or "spinal stenosis" or spondylarth* or spondylisthesis or spondylo*) OR SU (arachnoiditis or backache* or coccydynia or discitis or dorsalgia or lumbago or postlaminectomy or sciatica or "spinal stenosis" or spondylarth* or spondylisthesis or spondylo*) | 13,647 |
| 3 | TI ((disc* or disk*) N1 (degeneration* or herniation* or prolapse*)) OR AB ((disc* or disk*) N1 (degeneration* or herniation* or prolapse*)) OR SU ((disc* or disk*) N1 (degeneration* or herniation* or prolapse*)) | 4,517 |
| 4 | S1 OR S2 OR S3 | 77,705 |
| 5 | (MH "Back") | 3,660 |
| 6 | TI (back or coccyx or "facet joint*" or "intervertebral disc" or lumbar or "lumbo sacral*" or lumbosacral* or spine or spinal or "zygapophyseal joint*") OR AB (back or coccyx or "facet joint*" or "intervertebral disc" or lumbar or "lumbo sacral*" or lumbosacral* or spine or spinal or "zygapophyseal joint*") OR SU (back or coccyx or "facet joint*" or "intervertebral disc" or lumbar or "lumbo sacral*" or lumbosacral* or spine or spinal or "zygapophyseal joint*") | 187,669 |
| 7 | S5 OR S6 | 187,669 |
| 8 | (MH "Pain+") | 204,983 |
| 9 | TI (injur* or pain or pains or painful) OR AB (injur* or pain or pains or painful) OR SU (injur* or pain or pains or painful) | 597,804 |
| 10 | S8 OR S9 | 617,327 |
| 11 | S4 or (S7 AND S10) | 126,560 |
| 12 | (MH "Telemedicine+") OR (MH "Telenursing") OR (MH "Telepsychiatry") OR (MH "Telehealth") OR (MH "Videoconferencing+") OR (MH "Telecommunications") OR (MH "Teleconferencing") OR (MH "Computer Communication Networks+") OR (MH "Decision Making, Computer Assisted") OR (MH "User-Computer Interface") | 189,923 |
| 13 | TI ("digital care" or "digital treatment*" or "e coach" or "e health" or "information communication technolog*" or "information technolog*" or "internet quer*" or "m health" or mhealth or "mobile health" or "patient internet portal*" or "remote visit*" or "short message service" or "tele care*" or "tele coach*" or "tele conference*" or | 58,640 |

| | | |
|---|---|---|
| | "tele consult*" or "tele diagnosis" or "tele health*" or "tele home*" or "tele management" or "tele med*" or "tele mentor*" or "tele monitor*" or "tele nurs*" or "tele rehab*" or "tele screen*" or "tele support" or "tele therap*" or telecare* or telecoach* or teleconference* or teleconsult* or telediagnosis or telehealth* or telehome* or telemanagement or telematic* or telemed* or telementor* or telemonitor* or telenurs* or telerehab* or telerehabilitation or telescreen* or telesupport or teletherap* or "video conferenc*" or "video rehab*" or "virtual reality" or "Doctor on Demand" or "Livehealth Online" or Amwell or "Blue jeans" or "Chiron health" or Doxy or "Go to meeting" or "Go to webinar" or "Google hangout*" or "Google meeting*" or Healthtap or Icliniq or Mdlive or Memd or "Microsoft teams" or Plushcare or Skype or Teladoc or Virtuwell or Vsee or Vtconnec or Zoom) OR AB ("digital care" or "digital treatment*" or "e coach" or "e health" or "information communication technolog*" or "information technolog*" or "internet quer*" or "m health" or mhealth or "mobile health" or "patient internet portal*" or "remote visit*" or "short message service" or "tele care*" or "tele coach*" or "tele conference*" or "tele consult*" or "tele diagnosis" or "tele health*" or "tele home*" or "tele management" or "tele med*" or "tele mentor*" or "tele monitor*" or "tele nurs*" or "tele rehab*" or "tele screen*" or "tele support" or "tele therap*" or telecare* or telecoach* or teleconference* or teleconsult* or telediagnosis or telehealth* or telehome* or telemanagement or telematic* or telemed* or telementor* or telemonitor* or telenurs* or telerehab* or telerehabilitation or telescreen* or telesupport or teletherap* or "video conferenc*" or "video rehab*" or "virtual reality" or "Doctor on Demand" or "Livehealth Online" or Amwell or "Blue jeans" or "Chiron health" or Doxy or "Go to meeting" or "Go to webinar" or "Google hangout*" or "Google meeting*" or Healthtap or Icliniq or Mdlive or Memd or "Microsoft teams" or Plushcare or Skype or Teladoc or Virtuwell or Vsee or Vtconnec or Zoom) OR SU ("digital care" or "digital treatment*" or "e coach" or "e health" or "information communication technolog*" or "information technolog*" or "internet quer*" or "m health" or mhealth or "mobile health" or "patient internet portal*" or "remote visit*" or "short message service" or "tele care*" or "tele coach*" or "tele conference*" or "tele consult*" or "tele diagnosis" or "tele health*" or "tele home*" or "tele management" or "tele med*" or "tele mentor*" or "tele monitor*" or "tele nurs*" or "tele rehab*" or "tele screen*" or "tele support" or "tele therap*" or telecare* or telecoach* or teleconference* or teleconsult* or telediagnosis or telehealth* or telehome* or telemanagement or telematic* or telemed* or telementor* or telemonitor* or telenurs* or telerehab* or telerehabilitation or telescreen* or telesupport or teletherap* or "video conferenc*" or "video rehab*" or "virtual reality" or "Doctor on Demand" or "Livehealth Online" or Amwell or "Blue jeans" or "Chiron health" or Doxy or "Go to meeting" or "Go to webinar" or "Google hangout*" or "Google meeting*" or Healthtap or Icliniq or Mdlive or Memd or "Microsoft teams" or Plushcare or Skype or Teladoc or Virtuwell or Vsee or Vtconnec or Zoom) | |
| 14 | TI ((app or computer or internet or mobile or mobile or online or phone or remote or tele* or video or virtual or web*) N5 (assess* or care or coach* or communication or consult* or forum* or intervention* or monitor* or rehab* or specialist or therap* or | 71689 |

| | | |
|---|---|---|
| | train* or treatment* or visit*)) OR AB ((app or computer or internet or mobile or mobile or online or phone or remote or tele* or video or virtual or web*) N5 (assess* or care or coach* or communication or consult* or forum* or intervention* or monitor* or rehab* or specialist or therap* or train* or treatment* or visit*)) OR SU ((app or computer or internet or mobile or mobile or online or phone or remote or tele* or video or virtual or web*) N5 (assess* or care or coach* or communication or consult* or forum* or intervention* or monitor* or rehab* or specialist or therap* or train* or treatment* or visit*)) | |
| 15 | S12 OR S13 OR S14 | 260568 |
| 16 | S11 AND S15 | 2129 |

**Wiley Cochrane Database of Systematic Reviews**

| ID | Search | Hits |
|---|---|---|
| #1 | MeSH descriptor: [Back Pain] explode all trees | 4880 |
| #2 | MeSH descriptor: [Back Injuries] explode all trees | 865 |
| #3 | MeSH descriptor: [Sciatic Neuropathy] explode all trees | 319 |
| #4 | MeSH descriptor: [Spinal Diseases] explode all trees | 4090 |
| #5 | MeSH descriptor: [Spinal Fusion] this term only | 933 |
| #6 | (arachnoiditis OR backache* OR coccydynia OR discitis OR dorsalgia OR lumbago OR postlaminectomy OR sciatica OR "spinal stenosis" OR spondylarth* OR spondylisthesis OR spondylo*):ti,ab,kw | 8268 |
| #7 | ((disc* or disk*) NEAR/1 (degeneration* or herniation* or prolapse*)):ti,ab,kw | 2118 |
| #8 | #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 | 17001 |
| #9 | MeSH descriptor: [Back] explode all trees | 686 |
| #10 | ("low back" OR coccyx OR "facet joint*" OR "intervertebral disc" OR lumbar OR "lumbo sacral*" OR lumbosacral* OR spine OR spinal OR "zygapophyseal joint*"):ti,ab,kw | 48350 |
| #11 | #9 OR #10 | 48495 |
| #12 | MeSH descriptor: [Pain] explode all trees | 48748 |
| #13 | (injur* or pain or pains or painful):ti,ab,kw | 225318 |
| #14 | #12 OR #13 | 231230 |
| #15 | #11 AND #14 | 28284 |
| #16 | #8 OR #15 | 36433 |
| #17 | MeSH descriptor: [Telemedicine] explode all trees | 2488 |
| #18 | MeSH descriptor: [Telecommunications] this term only | 86 |
| #19 | MeSH descriptor: [Computer Communication Networks] explode all trees | 3989 |
| #20 | MeSH descriptor: [Decision Making, Computer-Assisted] this term only | 131 |
| #21 | MeSH descriptor: [User-Computer Interface] this term only | 1230 |
| #22 | MeSH descriptor: [Videoconferencing] explode all trees | 203 |
| #23 | ("digital care" OR "digital treatment*" OR "e coach" OR "e health" OR "information communication technolog*" OR "information technolog*" OR "internet quer*" OR "m health" OR mhealth OR "mobile health" OR "patient internet portal*" OR "remote visit*" OR "short message service" OR "tele care*" OR "tele coach*" OR | 13497 |

| | | |
|---|---|---|
| | "tele conference*" OR "tele consult*" OR "tele diagnosis" OR "tele health*" OR "tele home*" OR "tele management" OR "tele med*" OR "tele mentor*" OR "tele monitor*" OR "tele nurs*" OR "tele rehab*" OR "tele screen*" OR "tele support" OR "tele therap*" OR telecare* OR telecoach* OR teleconference* OR teleconsult* OR telediagnosis OR telehealth* OR telehome* OR telemanagement OR telematic* OR telemed* OR telementor* OR telemonitor* OR telenurs* OR telerehab* OR telerehabilitation OR telescreen* OR telesupport OR teletherap* OR "video conferenc*" OR "video rehab*" OR "virtual reality" OR "Doctor on Demand" OR "Livehealth Online" OR Amwell OR "Blue jeans" OR "Chiron health" OR Doxy OR "Go to meeting" OR "Go to webinar" OR "Google hangout*" OR "Google meeting*" OR Healthtap OR Icliniq OR Mdlive OR Memd OR "Microsoft teams" OR Plushcare OR Skype OR Teladoc OR Virtuwell OR Vsee OR Vtconnec OR Zoom):ti,ab,kw | |
| #24 | (((app or "computer based" or internet or mobile or mobile or "on line" or online or phone or remote or tele* or video or virtual or web*) NEAR/5 (assess* or care or coach* or communication or consult* or forum* or intervention* or monitor* or rehab* or specialist or therap* or train* or treatment* or visit*))):ti,ab,kw | 57679 |
| #25 | #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 | 64418 |
| #26 | #16 AND #25 | 1067 |
| | Systematic Reviews | 29 |
| | Trials | 1037 |
| | Protocols | 1 |

*updated back in keyword search to “low back” because back appears often in full text.

**PEDro**

| | | |
|---|---|---|
| 1 | Abstract and Title: Remote<br>Problem: pain<br>Body Part: lumbar spine, sacro-iliac joint or pelvis | 6 |
| 2 | Abstract and Title: Tele*<br>Problem: pain<br>Body Part: lumbar spine, sacro-iliac joint or pelvis | 38 |
| 3 | Abstract and Title: Video*<br>Problem: pain<br>Body Part: lumbar spine, sacro-iliac joint or pelvis | 23 |
| 4 | Abstract and Title: Online*<br>Problem: pain<br>Body Part: lumbar spine, sacro-iliac joint or pelvis | 22 |
| 5 | 1 OR 2 OR 3 OR 4 | 84 |

**Index of Chiropractic Literature**

| **Query** | **Items found** |
|---|---|

| | |
|---|---|
| Subject:\"Back\" OR All Fields:back OR All Fields:lumbar OR All Fields:lumbosacral* OR All Fields:spine OR All Fields:spinal OR All Fields:\"lumbo sacral*\", Peer Review only | 4448 |
| Subject:\"Acute Pain\" OR All Fields:pain OR All Fields:pains OR All Fields:painful OR All Fields:injur*, Peer Review only | 4362 |
| Subject:\"Back\" OR All Fields:back OR All Fields:lumbar OR All Fields:lumbosacral* OR All Fields:spine OR All Fields:spinal OR All Fields:\"lumbo sacral*\", Peer Review only AND Subject:\"Acute Pain\" OR All Fields:pain OR All Fields:pains OR All Fields:painful OR All Fields:injur*, Peer Review only | 2692 |
| Subject:\"Back Pain\" OR Subject:\"Back Injuries\" OR Subject:\"Spinal Diseases\" OR Subject:Spinal Fusion\" OR All Fields:arachnoiditis OR backache* OR coccydynia OR discitis OR dorsalgia OR lumbago OR postlaminectomy OR sciatica OR \"spinal stenosis\" OR spondylarth* OR spondylisthesis OR spondylo*, Peer Review only | 953 |
| Subject:\"Back\" OR All Fields:back OR All Fields:lumbar OR All Fields:lumbosacral* OR All Fields:spine OR All Fields:spinal OR All Fields:\"lumbo sacral*\", Peer Review only AND Subject:\"Acute Pain\" OR All Fields:pain OR All Fields:pains OR All Fields:painful OR All Fields:injur*, Peer Review only OR Subject:\"Back Pain\" OR Subject:\"Back Injuries\" OR Subject:\"Spinal Diseases\" OR Subject:Spinal Fusion\" OR All Fields:arachnoiditis OR backache* OR coccydynia OR discitis OR dorsalgia OR lumbago OR postlaminectomy OR sciatica OR \"spinal stenosis\" OR spondylarth* OR spondylisthesis OR spondylo*, Peer Review only | 2754 |
| Subject:\"telemedicine\" OR Subject:\"Computer Communication Networks\" OR Subject:\"Computers\" OR All Fields:\"digital care\" OR \"digital treatment*\" OR \"e coach\" OR \"e health\" OR \"information communication technolog*\" OR \"information technolog*\" OR \"internet quer*\" OR \"m health\" OR mhealth OR \"mobile health\" OR \"patient internet portal*\" OR \"remote visit*\" OR \"short message service\" OR \"tele care*\" OR \"tele coach*\" OR \"tele conference*\" OR \"tele consult*\" OR \"tele diagnosis\" OR \"tele health*\" OR \"tele home*\" OR \"tele management\" OR \"tele med*\" OR \"tele mentor*\" OR \"tele monitor*\" OR \"tele nurs*\" OR \"tele rehab*\" OR \"tele screen*\" OR \"tele support\" OR \"tele therap*\" OR telecare* OR telecoach* OR teleconference* OR teleconsult* OR telediagnosis OR telehealth* OR telehome* OR telemanagement OR telematic* OR telemed* OR telementor* OR telemonitor* OR telenurs* OR telerehab* OR telerehabilitation OR telescreen* OR telesupport OR teletherap* OR \"video conferenc*\" OR \"video rehab*\" OR \"virtual reality\" OR \"Doctor on Demand\" OR \"Livehealth Online\" OR Amwell OR \"Blue jeans\" OR \"Chiron health\" OR Doxy OR \"Go to meeting\" OR \"Go to webinar\" OR \"Google hangout*\" OR \"Google meeting*\" OR Healthtap OR Icliniq OR Mdlive OR Memd OR \"Microsoft teams\" OR Plushcare OR Skype OR Teladoc OR Virtuwell OR Vsee OR Vtconnec OR Zoom, Peer Review only | 28 |

| | |
|---|---|
| All Fields:tele* OR All Fields:web* OR All Fields:computer* OR All Fields:online* OR All Fields:remote OR All Fields:internet OR All Fields:mobile OR All Fields:virtual OR All Fields:video, Peer Review only | 1011 |
| Subject:\"telemedicine\" OR Subject:\"Computer Communication Networks\" OR Subject:\"Computers\" OR All Fields:\"digital care\" OR \"digital treatment*\" OR \"e coach\" OR \"e health\" OR \"information communication technolog*\" OR \"information technolog*\" OR \"internet quer*\" OR \"m health\" OR mhealth OR \"mobile health\" OR \"patient internet portal*\" OR \"remote visit*\" OR \"short message service\" OR \"tele care*\" OR \"tele coach*\" OR \"tele conference*\" OR \"tele consult*\" OR \"tele diagnosis\" OR \"tele health*\" OR \"tele home*\" OR \"tele management\" OR \"tele med*\" OR \"tele mentor*\" OR \"tele monitor*\" OR \"tele nurs*\" OR \"tele rehab*\" OR \"tele screen*\" OR \"tele support\" OR \"tele therap*\" OR telecare* OR telecoach* OR teleconference* OR teleconsult* OR telediagnosis OR telehealth* OR telehome* OR telemanagement OR telematic* OR telemed* OR telementor* OR telemonitor* OR telenurs* OR telerehab* OR telerehabilitation OR telescreen* OR telesupport OR teletherap* OR \"video conferenc*\" OR \"video rehab*\" OR \"virtual reality\" OR \"Doctor on Demand\" OR \"Livehealth Online\" OR Amwell OR \"Blue jeans\" OR \"Chiron health\" OR Doxy OR \"Go to meeting\" OR \"Go to webinar\" OR \"Google hangout*\" OR \"Google meeting*\" OR Healthtap OR Icliniq OR Mdlive OR Memd OR \"Microsoft teams\" OR Plushcare OR Skype OR Teladoc OR Virtuwell OR Vsee OR Vtconnec OR Zoom, Peer Review only OR All Fields:tele* OR All Fields:web* OR All Fields:computer* OR All Fields:online* OR All Fields:remote OR All Fields:internet OR All Fields:mobile OR All Fields:virtual OR All Fields:video, Peer Review only | 1011 |
| Subject:\"Back\" OR All Fields:back OR All Fields:lumbar OR All Fields:lumbosacral* OR All Fields:spine OR All Fields:spinal OR All Fields:\"lumbo sacral*\", Peer Review only AND Subject:\"Acute Pain\" OR All Fields:pain OR All Fields:pains OR All Fields:painful OR All Fields:injur*, Peer Review only OR Subject:\"Back Pain\" OR Subject:\"Back Injuries\" OR Subject:\"Spinal Diseases\" OR Subject:Spinal Fusion\" OR All Fields:arachnoiditis OR backache* OR coccydynia OR discitis OR dorsalgia OR lumbago OR postlaminectomy OR sciatica OR \"spinal stenosis\" OR spondylarth* OR spondylisthesis OR spondylo*, Peer Review only AND Subject:\"telemedicine\" OR Subject:\"Computer Communication Networks\" OR Subject:\"Computers\" OR All Fields:\"digital care\" OR \"digital treatment*\" OR \"e coach\" OR \"e health\" OR \"information communication technolog*\" OR \"information technolog*\" OR \"internet quer*\" OR \"m health\" OR mhealth OR \"mobile health\" OR \"patient internet portal*\" OR \"remote visit*\" OR \"short message service\" OR \"tele care*\" OR \"tele coach*\" OR \"tele conference*\" OR \"tele consult*\" OR \"tele diagnosis\" OR \"tele health*\" OR \"tele home*\" OR \"tele management\" OR \"tele med*\" OR \"tele mentor*\" OR \"tele monitor*\" OR \"tele nurs*\" OR \"tele rehab*\" OR \"tele screen*\" OR \"tele support\" OR \"tele therap*\" OR telecare* OR telecoach* OR teleconference* OR teleconsult* OR telediagnosis OR telehealth* OR telehome* OR telemanagement OR telematic* OR telemed* OR telementor* OR telemonitor* OR telenurs* OR telerehab* OR telerehabilitation OR telescreen* OR telesupport OR teletherap* OR \"video conferenc*\" OR \"video rehab*\" | 279 |

| | |
|---|---|
| OR \"virtual reality\" OR \"Doctor on Demand\" OR \"Livehealth Online\" OR Amwell OR \"Blue jeans\" OR \"Chiron health\" OR Doxy OR \"Go to meeting\" OR \"Go to webinar\" OR \"Google hangout*\" OR \"Google meeting*\" OR Healthtap OR Icliniq OR Mdlive OR Memd OR \"Microsoft teams\" OR Plushcare OR Skype OR Teladoc OR Virtuwell OR Vsee OR Vtconnec OR Zoom, Peer Review only OR All Fields:tele* OR All Fields:web* OR All Fields:computer* OR All Fields:online* OR All Fields:remote OR All Fields:internet OR All Fields:mobile OR All Fields:virtual OR All Fields:video, Peer Review only | |

**ClinicalTrials.gov**

160 Studies found for: telemedicine OR telerehabilitation OR telehealth OR remote OR video OR mobile health OR online OR virtual OR web OR tele OR internet \| Low Back Pain

## Appendix G – MINORS Assessment Scale

| Methodological items for non-randomized studies | Score† |
|---|---|
| 1. **A clearly stated aim:** the question addressed should be precise and relevant in the light of available literature<br>2. **Inclusion of consecutive patients**: all patients potentially fit for inclusion (satisfying the criteria for inclusion) have been included in the study during the study period (no exclusion or details about the reasons for exclusion)<br>3. **Prospective collection of data**: data were collected according to a protocol established before the beginning of the study<br>4. **Endpoints appropriate to the aim of the study**: unambiguous explanation of the criteria used to evaluate the main outcome which should be in accordance with the question addressed by the study. Also, the endpoints should be assessed on an intention-to-treat basis.<br>5. **Unbiased assessment of the study endpoint**: blind evaluation of objective endpoints and double-blind evaluation of subjective endpoints. Otherwise the reasons for not blinding should be stated<br>6. **Follow-up period appropriate to the aim of the study**: the follow-up should be sufficiently long to allow the assessment of the main endpoint and possible adverse events<br>7. **Loss to follow up less than 5%**: all patients should be included in the follow up. Otherwise, the proportion lost to follow up should not exceed the proportion experiencing the major endpoint<br>8. **Prospective calculation of the study size**: information of the size of detectable difference of interest with a calculation of 95% confidence interval, according to the expected incidence of the outcome event, and information about the level for statistical significance and estimates of power when comparing the outcomes | |
| *Additional criteria in the case of comparative study*<br>9. **An adequate control group**: having a gold standard diagnostic test or therapeutic intervention recognized as the optimal intervention according to the available published data<br>10. **Contemporary groups**: control and studied group should be managed during the same time period (no historical comparison)<br>11. **Baseline equivalence of groups**: the groups should be similar regarding the criteria other than the studied endpoints. Absence of confounding factors that could bias the interpretation of the results<br>12. **Adequate statistical analyses**: whether the statistics were in accordance with the type of study with calculation of confidence intervals or relative risk | |

†The items are scored 0 (not reported), 1 (reported but inadequate) or 2 (reported and adequate). The global ideal score being 16 for non-comparative studies and 24 for comparative studies.

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