CHANGES IN CLINICAL OUTCOMES FOLLOWING COMPLETION OF AN INTERDISCIPLINARY CHRONIC PAIN MANAGEMENT PROGRAM AND THE IMPACT OF INCREASED PAIN KNOWLEDGE: A CHART REVIEW

by

Lynita Dawn White

B.A.H., Queen's University, 2013

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Rehabilitation Sciences)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

December 2015

Abstract

Chronic non-cancer pain is widespread and has no standard treatment. Interdisciplinary pain management has demonstrated favourable outcomes for chronic pain patients, but essential program components are not known, and the evidence is limited by lack of standardization in the literature. The purpose of this study was to evaluate the impact of the 6-week, outpatient Interdisciplinary Pain Management Program at OrionHealth Vancouver on four primary outcomes. Two other aims were to determine whether increased pain knowledge predicts clinical outcomes, and to collect participant feedback on two 90-minute pain neurophysiology education sessions in the program and to identify barriers to the uptake of information from those sessions. To accomplish this, a single group pre-test/post-test anonymous chart review was conducted and five t-tests, three hierarchical multiple regressions, and one content analysis were carried out. One hundred and thirty three clients provided data for the study, and 102 completed the program. Program completers significantly improved their scores on pain knowledge, pain interference, pain severity, depression, and opioid intake between assessment and discharge from the program, although only pain knowledge, depression, and opioid intake saw substantial increases. Pain knowledge did not significantly predict any clinical outcomes (depression, pain intensity, pain severity). The most common barriers to knowledge intake were pain intensity, pain medication, language/content of the education sessions, and the amount of information presented. The majority of participants found the information provided in the education sessions valuable, and qualitatively reported positive feedback for the education sessions. This study provides further support for interdisciplinary pain management using internationally recommended outcome measures, especially on cognitive and behavioural variables. In addition, pain knowledge was

concluded not to be a candidate for predicting clinical success. However, pain neurophysiology education may be beneficial for chronic pain sufferers due to deep learning or nonspecific factors.

Preface

Contributions

This research was carried out in collaboration with my thesis supervisory committee at the Centre for Hip Health and Mobility (Dr. Alex Scott and Dr. Joanie Sims-Gould), and at OrionHealth Vancouver (Pamela Summers). In addition to my supervisory committee, I collaborated as well with staff at OrionHealth Vancouver, including Alice Yu and Michele Moon. The research topic was identified in collaboration with my thesis supervisor Dr. Alex Scott and Pamela Summers. Charts were anonymized and collated by staff at OrionHealth Vancouver, headed by Pamela Summers, before I collected them from that location.

My unique contributions to the study included methodological design, completing the ethics application, conducting the literature review, inputting and analyzing the data, and drafting this document.

Ethical Approval

The UBC Clinical Research Ethics Board granted ethical approval for this study on August 28th, 2015 (Certificate # H14-01840). Annual renewal was granted on July 17th, 2015.

Conflicts of Interest

The researchers and collaborators of this study do not report any conflicts of interest.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

OT: Occupational Therapist

PMP: Pain Management Program

PNE: Pain Neurophysiology Education

PT: Physical Therapist

RTW: Return to Work

Acknowledgements

Here I extend my deepest gratitude to all who have helped me complete this project.

First, to my supervisor Dr. Alex Scott, who was kind enough to interview a psychology student with limited experience to join the Tendon Lab. Your guidance and encouragement is incomparable and I would not be nearly as accomplished without you. Thank you for allowing me to make my own creative decisions throughout this project, for offering clear and direct guidance when I was lost and for offering kind words when I found myself in times of panic, for being a receptive ear to bounce ideas off of, for providing me with endless opportunities to work with the greats of the field, and for being an excellent professor, mentor, and support.

Thank you to my supervisory committee, Pam Summers and Dr. Joanie Sims-Gould for your direct critique (when needed) and words of genuine support and encouragement. With your combined expertise, both of you have taught me so much about the clinical and analytical side of rehabilitation, and allowed me to come to so many conclusions on my own. I thank you for your accommodation of my deadlines, your time, and your guidance. Thanks also to all of the staff at OrionHealth, who dedicated their time and a detailed and expansive knowledge to someone they didn't have to.

My lab-mates have provided incredible support and have taught me so much about, well, everything. Our experiences are so varied and I was lucky to get the chance to work with all of you and chat about your projects, your weekends, and everything in between. You all made the CHHM a place to look forward to coming to every day (or more realistically, the days I would come), and you made lunches a monthly highlight. Thank you for everything, especially your excellent restaurant choices and teaching me about your cultures via snacks. Congrats to the recent graduates, and best of luck to the next wave on their projects.

My friends and colleagues in the Rehabilitation Sciences and Master of Physical Therapy programs inspire me every day to be the best researcher and clinician I can be. You are all extremely gifted and hardworking people, who are a blast to spend time with both in and out of the classroom. I cannot wait to work with you in the future, and to continue to develop what I know will be lifelong friendships.

Thank you to the Canadian Institutes of Health Research for honouring me with the Canadian Graduate Student – Masters Award. With it I was granted the gift of time to get through the heaviest parts of this project.

A special thanks to my parents (all of you), by blood and by choice, with me and passed: Tomi Hamner, Richard White, Kostie Killas, and Tracy White. Each of you has encouraged and pushed me to achieve all of the great things so far in my personal life and academic career. Thank you Dad for instilling the spirit of a competitor, and thank you Mom for taking such great care of me through everything. Both of you, thank you for encouraging my independence and always being there when I faltered on that state. Thanks Jackson for solving all of my technological problems at inconvenient times, for inspiring me with your artistic genius, and for dealing with me for the past 23 years.

Dedication

To Shirley and Jack Hamner. This is the final family thesis from me for now – you both continue to inspire me.

and

To Kostie James Killas, my fellow Aries and role model. You are with me through all my great achievements. Thank you for everything.

Chapter 1: Introduction

1.1 Chronic Pain

Pain is a complex perceptual experience that extends beyond basic physiology. It is always subjective, no matter its source of pathology. A commonly cited definition comes from the International Association of the Study of Pain (International Association for the Study of Pain, 2002), that pain is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (International Association for the Study of Pain, 2002, p. 210). Pain intensity is specific to each individual who perceives it, and it varies depending on the interaction of many processes. Pain can be divided into two temporally distinct classifications: acute and chronic. Acute pain has high identifiable pathology and/or a short time since injury, while chronic pain falls on the opposite end, with low identifiable pathology in relationship to the extent of pain, and/or pain of a longer duration (Turk & Okifuji, 2010). Acute pain is initiated by nociceptor activation at the site of tissue damage, and generally subsides when that damage is resolved (Turk & Okifuji, 2010). Chronic non-cancer pain – the focus of this study – persists beyond tissue healing, typically 3 to 6 months or more (International Association for the Study of Pain, 2002). The minimum length of time to constitute the crossover from acute to chronic pain is arbitrary; 3 months is often used to classify chronic pain in clinical presentations and 6 months is used for research (International Association for the Study of Pain, 2002). While this is the most common definition, chronic pain has otherwise been variably defined in the literature (Boulanger, Clark, Squire, Cui, & Horbay, 2007; Turk & Okifuji, 2010).

Chronic pain presents in many different forms, and the mechanisms of chronic pain are still under review. It is currently understood as a neural response to tissue injury (Lynch, 2011) that involves the interplay of biological, cognitive, and social processes (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). Parts of the central and peripheral nervous system that are associated with nociceptive pathways undergo rapid and long-term plastic neuronal changes in response to tissue damage (Ko & Zhuo, 2004). Increased sensitization of the central and peripheral nervous system can lead to spontaneous activity or responding to non-noxious stimuli as painful (Fornasari, 2012; Lynch, 2011; Turk & Okifuji, 2010). Importantly, the sensitized nervous system interacts with psychological (emotional, cognitive) and social/environmental factors (stressors, relationships, social support, personal history), which can add to the pain's persistence and impact on the sufferer's life (Gatchel et al., 2007; Turk & Okifuji, 2010)

Many Canadians have long-standing and severe chronic pain (Schopflocher, Taenzer, & Jovey, 2011). The most recent general population survey reported the prevalence of chronic pain in Canadian adults to be 18.9%, and 21.8% in British Columbia (Schopflocher et al., 2011), which is consistent with an international estimated prevalence of 22% (Moore, Derry, Taylor, Straube, & Phillips, 2014). Chronic pain sufferers in this sample most often reported that they had been suffering from pain for 20 or more years, and the majority had been suffering for at least 5 years (66.3%, Schopflocher et al., 2011). The most common reported sites of pain were lower back (35.5%), upper back (15.4%), knee (14.9), leg (13.7%), and shoulder (11.2%), and the most common reported cause was arthritic and joint pain (36.2%), spine including neck thoracic and lower back (20.4%), and trauma including osteoporosis (15%). Over half of responders (52.9%) considered their pain to be severe (at least 7 on a scale of 0-10). A general population study conducted by Boulanger and colleagues (2007) which identified 25% of adult

Canadians as suffering from chronic pain found that chronic pain interfered with the lives of 40% of those affected.

1.2 The Cost of Chronic Pain

It is clear that a substantial number of Canadians suffer from chronic pain and its associated consequences such as depression (Miller & Cano, 2009), activity limitation (Choinière et al., 2010; Moore et al., 2014; Ramage-Morin & Gilmour, 2010), interference with employment (Moore et al., 2014; Ramage-Morin & Gilmour, 2010), sleep problems (Choinière et al., 2010), and quality of life that is comparably low to chronic conditions including cancer, cardiovascular, and neuromuscular disorders (Moore et al., 2014).

The impact of chronic pain extends beyond the individual to the Canadian economy and healthcare system. People with chronic pain see more doctors, take more medications, and stay longer in hospitals than those who don't. Their healthcare costs are at least 2.6 times higher than those who don't have chronic pain (Moore et al., 2014). Combined private and publicly funded healthcare appointments, medications, and hospitalizations total $4,800/year for undertreated longstanding sufferers (Guerriere et al., 2010). The direct healthcare costs for all Canadian chronic pain sufferers are estimated at $6 billion annually (Lynch, 2011).

Job loss and sick days cost Canada $37 billion annually (Lynch, 2011). Combining medical costs and lost productivity, the overall estimated cost of chronic pain in Canada is between $46 and $60 billion per year (Lynch, 2011; Canadian Pain Society, 2011).

1.3 Under-treatment of Chronic Pain

Although chronic pain is a recognized and widespread issue for Canadians, it is poorly managed (Lynch, 2011). Treatment for chronic pain varies – there is no standard treatment – and chronic pain patients are often subject to failed interventions (Stanos & Houle, 2006). Currently

available treatments rarely result in complete resolution of symptoms (Turk, Wilson, & Cahana, 2011), and many (e.g. pharmacological treatments, surgery, spinal cord stimulators, implantable drug delivery systems) only target the biological aspects of pain and are associated with negative side effects (Turk, 2002).

1.4 Interdisciplinary Chronic Pain Management

Interdisciplinary chronic pain management, the coordination of services from a variety of healthcare professionals toward one goal (Gatchel, McGeary, McGeary, & Lippe, 2014), has gained a significant amount of support in the literature in the past fifteen years. Interdisciplinary chronic pain management is based on the biopsychosocial model of pain (Engel, 2012), and is the only treatment modality that addresses the multidimensional nature of chronic pain and its consequences, focusing especially on the psychological, social, and environmental determinants that contribute to the persistence of chronic pain. It is the preferred form of treatment by the IASP for chronic pain patients of all etiologies (Loeser et al., n.d.), and is a conservative treatment associated with the fewest adverse events (Turk, 2002).

Interdisciplinary pain management has demonstrated favourable outcomes in many clinics for chronic pain patients in regards to depression (Bosy, Etlin, Corey, & Lee, 2010; Gagnon, Stanos, van der Ende, Rader, & Harden, 2013), anxiety (Bosy et al., 2010; Garven et al., 2011), quality of life (Becker, Sjøgren, Bech, Olsen, & Eriksen, 2000; Dysvik, Vinsnes, & Eikeland, 2004; Garven et al., 2011), pain severity (Becker et al., 2000; Buchner, Zahlten-Hinguranage, Schiltenwolf, & Neubauer, 2006; Dysvik et al., 2004; Gagnon et al., 2013; Oslund et al., 2009), physical functioning (Becker et al., 2000; Buchner et al., 2006), and health care resource use (Garven et al., 2011). Despite this, interdisciplinary chronic pain management is

often a last resort after all other treatments have failed for the chronic pain patient (Turk et al., 2011).

Interdisciplinary care is an extension of multidisciplinary pain management, which was introduced in the mid-1900s by anesthesiologist John Bonica (Gatchel et al., 2014). Multidisciplinary programs involve pain management services provided by practitioners in a variety of disciplines (e.g. a physician, psychologist, physical therapist, occupational therapist, etc.). However, these practitioners may not always work together in the same facility and often have different treatment goals (Gatchel et al., 2014). Interdisciplinary programs are differentiated by the integration of the treatment team. The healthcare professionals involved work under one roof on the same patient file; they share a common philosophy of rehabilitation, and use constant daily communication (Gatchel et al., 2014). The patient is encouraged to be an active participant in the treatment process (Schatman, 2010). The terms are sometimes used interchangeably in the literature, but multidisciplinary and interdisciplinary programs are conceptually distinct.

There is no established structure for interdisciplinary pain management programs, although staff typically includes physicians, physical therapists, occupational therapists, psychologists, and nurses. Program components also vary, but can include physical rehabilitation, exercise therapy, cognitive restructuring, behavioural treatment (e.g, relaxation), vocational rehabilitation, and drug management (Turk et al., 2011). Not all programs offered have all of these staff and services, and instead provide what is in line with the philosophy and resources of the particular clinic (Schatman, 2010). The optimal structure for an interdisciplinary pain management program is not known, but programs with varying structures have shown clinical effectiveness.

The results of individual studies of interdisciplinary pain management programs have been substantiated by a number of systematic reviews. Not only do interdisciplinary and multidisciplinary programs result in a comparable reduction in pain to mono-disciplinary noninvasive treatments (pain reduction in interdisciplinary programs ranges from 14-60% and averages 20-30%, opioid use averages 30% pain reduction (Gatchel & Okifuji, 2006), but with significantly better outcomes than other pharmacological, surgical, and other mono-disciplinary treatments such as physical therapy on outcomes such as medication decrease (Gatchel & Okifuji, 2006; Turk, 2002), healthcare resource use (Flor, Fydrich, & Turk, 1992; Gatchel & Okifuji, 2006; Turk, 2002), closure of disability claims (Gatchel & Okifuji, 2006; Turk, 2002), mood (Flor et al., 1992), physical functioning (Gatchel & Okifuji, 2006; Guzmán et al., 2001), functional activities (Turk, 2002), interference with daily living (Flor et al., 1992; Gatchel & Okifuji, 2006), and return to work (Flor et al., 1992; Gatchel & Okifuji, 2006; Turk, 2002). However, the greatest limitation of these reviews has been the inability to pool data quantitatively and interpret results with absolute confidence because of the heterogeneity of program structures, program lengths, sample demographics, and outcome measures. The interpretation of combined pain management data must be interpreted cautiously, as the true effects of individual studies may be masked by aggregated data (Turk, 2002). From the first to the most recent reviews, authors have made recommendations to address this flaw by standardizing research and using internationally accepted outcome measures to make studies more comparable (Scascighini, Toma, Dober-Spielmann, & Sprott, 2008; Turk, 2002). Further, many reviewers have concluded that although there is evidence to support the effectiveness of interdisciplinary programs, it is not clear which program components or process variables are most effective or which patients may benefit most from interdisciplinary chronic pain

management (Bruehl, 2006; Loeser, 2006; Scascighini et al., 2008; Stanos & Houle, 2006; Turk, 2002). There is an impetus for these topics to be the focus of upcoming research.

1.5 Process Variables and Essential Program Components

Very closely tied to essential program components are the essential "active ingredients" of interdisciplinary programs. A recent stream of research in the interdisciplinary pain management literature investigates process variables, which are behaviours or cognitions that are key to positive outcomes of treatment – the essential elements of a positive outcome (McCracken & Gross, 1998). Significant process variables reveal 'critical changes that determine improvement from treatment' (McCracken & Gross, 1998). Importantly, elucidating process variables helps to determine the mechanisms behind significant patient improvement from interdisciplinary programs, which can be targeted in programs and confirmed in further research. Also, in non-randomized designs in which it is difficult or impossible to vary treatment components for different subsets of patients, examining process variables is a first step to understanding important program components. For example, pain related anxiety, catastrophizing, and pain helplessness have been identified as variables whose improvements predict better clinical outcomes in interdisciplinary chronic pain management, such as pain interference, pain severity, depression, and general activity (Burns, Kubilus, Bruehl, Harden, & Lofland, 2003; McCracken & Gross, 1998). These results provide support that improving maladaptive cognitions is an essential therapeutic agent of the programs under investigation. Taking these results further, pain related anxiety, catastrophizing, and pain helplessness are deliberately targeted by Cognitive Behavioural Therapy (CBT) in interdisciplinary pain programs. The goal of CBT in the context of chronic pain is to replace maladaptive thoughts relating to the pain with adaptive ones through techniques such as relaxation training, attention

control, motivational interviewing, and activity management training (i.e. pacing; Gatchel et al., 2014). Though the results of process variable studies do not necessarily demonstrate that CBT influences program outcomes by the mechanism of these cognitive changes, the results provide indirect support to the theory that key interdisciplinary program components are ones that target psychosocial issues (Gardea & Gatchel, 2000).

Only a handful of studies have investigated process variables that predict clinical outcomes in the context of interdisciplinary programs (Burns et al., 2003), and the significant process variables only explain a fraction of the variance of outcomes. For example, McCracken and Gross (1998) found that pain related anxiety accounted for between 13% and 20% of the variance of outcomes in depression, pain severity, pain interference, affective distress, and general activity. There are clearly more agents at play to predict clinical outcomes following interdisciplinary pain management programs, and further research is needed to elucidate them.

1.6 Pain Knowledge and Pain Neurophysiology Education

Pain knowledge, specifically knowledge of the neurophysiology of pain, is a plausible process variable to predict positive outcomes in interdisciplinary treatment. Pain neurophysiology knowledge is directly targeted by a new therapeutic method – Pain Neurophysiology Education (PNE). PNE has been used as a program component in successful interdisciplinary pain management programs (Garven et al., 2011; Oslund et al., 2009), and is a candidate as an essential component of interdisciplinary pain management programs.

PNE was first introduced in 2002 to complement physical therapy for chronic pain (Clarke, Ryan, & Martin, 2011). Very few studies have been conducted on the topic of PNE, with two recent reviews reporting the results of two and eight studies on the topic (Clarke et al., 2011, and Louw, Diener, Butler, & Puentedura, 2011, respectively). Even so, there is promising evidence

that PNE leads to improvements in return to work, physical performance, disability, and pain (Clarke et al., 2011; Louw et al., 2011; Moseley, 2002), alone and in the context of a pain management program. Importantly, PNE leads to improvements in maladaptive pain beliefs such as catastrophizing and perceived disability (Louw et al., 2011; Moseley, 2004).

The rationale of PNE is to increase patient understanding of chronic pain and to reconceptualize pain by explaining the neurobiology and neurophysiology of pain in detail, using metaphors and pictures when possible (Butler & Moseley, 2013; Clarke et al., 2011; Moseley, 2012). Louw and colleagues describe PNE clearly and succinctly:

> Instead of a traditional model of connecting tissue injury or nociception and pain, [PNE] aims to describe how the nervous system, through peripheral nerve sensitization, central sensitization, synaptic activity, and brain processing, interprets information from the tissues and that neural activation, as either upregulation or downregulation, has the ability to modulate the pain experience. Patients are thus educated that the nervous system's processing of their injury, in conjunction with various psychosocial aspects, determines their pain experience and that pain is not always a true representation of the status of the tissues. By reconceptualizing their pain as the nervous system's interpretation of the threat of the injury, rather than an accurate measure of the degree of injury in their tissues, patients may be more inclined to move, exercise, and push into some discomfort. (2011, pp. 2041–2042)

In PNE, by explaining pain to patients, pain beliefs (in particular, evaluations of nociceptive input as threatening) are altered, leading to increased ability for movement due to increased pain threshold (Moseley, 2012), or decreased somatic vigilance (Moseley, 2004). If patients are able to move more, they will be able to increase their participation and adherence to treatment

elements that include a physical aspect, and their prognosis should improve. Also, negative pain beliefs such as catastrophizing are associated with pain intensity and disability (Tracey & Mantyh, 2007). There is some evidence that PNE is related to improved attitudes towards pain as well as improved physical performance (Clarke et al., 2011; Meeus, Nijs, Van Oosterwijck, Van Alsenoy, & Truijen, 2010; Moseley, 2004; Van Oosterwijck et al., 2011).

Although cognitive variables are impacted by exposure to PNE, it is important to emphasize that the goal of each PNE session is to increase patients' understanding of the complex biological processes that underpin their pain (Catley, O'Connell, & Moseley, 2013); to provide evidence for a new conceptualization of their pain, and then to test, confirm, and embed that new conceptualization so it can guide behaviour (Moseley, 2012). Louw argues that it is the content of PNE courses that are the key element guiding positive outcomes. Measures exist to test patients' pain neurophysiology knowledge (Catley et al., 2013), and chronic pain patients are able to substantially increase their knowledge after a PNE session (Meeus et al., 2010; Moseley, 2003). It has not been established whether pain knowledge change predicts good clinical outcomes. Therefore, pain neurophysiology knowledge is a potential process variable to investigate in the context of interdisciplinary pain management.

1.7 Current State of the Literature

It is clear that interdisciplinary pain management programs have demonstrated effectiveness in treating chronic pain sufferers. However, gaps remain in the literature. First, there is massive homogeneity in the evaluation and reporting of trials. The first review of the literature (Flor et al., 1992) to the most recent all comment on the diversity in outcome measures, criteria for success, patient characteristics, and program structure in individual studies of interdisciplinary programs. Because of this, it is nearly impossible to combine the results of these

studies to make the strongest case for interdisciplinary pain management and to make comparisons between studies to determine for whom these programs work or what parts of the programs are most essential. It is recommended and imperative to begin standardizing the conducting and reporting of clinical trials relating to pain treatment in general, and interdisciplinary chronic pain management programs in particular.

Next, it has been demonstrated that not all chronic pain patients benefit equally from all types of treatment. In his 2002 review, Turk demonstrated that each currently available treatment only benefits a subset of patients, and that it is likely that different groups of patients benefit from different treatments. In another review, Turk (2004) argued that treatment matching is a strong possibility once researchers determine what works for whom. Steps toward treatment matching can be achieved with a clear description of each sample in a pain trial, and the use of established outcome measures for comparisons across trials.

Finally, it is important to establish the most effective process variables and treatment components of interdisciplinary chronic pain management programs. Despite the well-reported cost effectiveness of interdisciplinary pain management programs, third party payers have had issues with the high up-front cost of these programs (Schatman, 2010). By determining which behaviours and cognitions are most essential for clinical improvement, resources can be directed accordingly. Pain neurophysiology knowledge may be an important process variable, and Pain Neurophysiology Education (which directly targets pain knowledge) holds promise as an important aspect of interdisciplinary programs.

1.8 Current Study

OrionHealth Vancouver is a rehabilitation centre that offers an interdisciplinary pain management program. The core interdisciplinary component of OrionHealth Vancouver's Pain

Clinic's Pain Management Program typically takes place over 6 weeks, with options for extension. Amongst the various treatment strategies utilized in the program, patients receive daily education classes throughout, including two 90-minute sessions on pain neurophysiology. For this study, all primary program components, the program rationale, and program staff will be outlined and described. In addition, a description of the study sample, including those who reduce their pain by at least 30% and 50% (minimal difference related to overall improvement, and substantial improvement in pain, respectively; Dworkin et al., 2005, 2008), will be provided.

One of the fundamental goals of this study is to adhere to the initiative to regulate research in this field. Along with a report of participant characteristics and a detailed program description, I will be using internationally recommended outcome measures (Dworkin et al., 2005). There are several specific outcomes recommended for the evaluation of chronic pain interventions that allow for an accurate reflection of program effectiveness and for meaningful comparisons between treatments (Dworkin et al., 2005). Although all measures aren't required, it is recommended to consider them when conducting pain research. Of the six core outcome domains recommended, three are included in this study.

Pain knowledge, the process variable candidate targeted in the neurophysiology of pain education sessions, will be specifically investigated in this study. In addition, I will report participant feedback on the pain education class.

1.9 Purpose of Current Study

The primary purpose of this study is to determine whether patients improve on internationally recommended clinical outcomes following completion of an interdisciplinary pain management program. The next goal is to explore who benefits most from this interdisciplinary pain management program. I aim to investigate pain neurophysiology knowledge, a process

variable that may predict good clinical outcomes. Finally, I aim to understand the subjective experience of participants in the pain neurophysiology education sessions and to understand if and why participants have difficulties achieving gains in the process variable under investigation in these sessions.

1.10 Objectives and Hypotheses

1.10.1 Objective 1.

To evaluate changes in primary (clinical) and secondary outcome measures following completion of the interdisciplinary pain management program.

1.10.2 Hypothesis 1.

There will be a statistically and clinically significant difference between patients' pre- and post-program scores on pain severity, pain interference, depression, pain knowledge, and opioid intake.

1.10.3 Objective 2.

To determine whether changes in pain neurophysiology knowledge are related to clinical outcomes.

1.10.4 Hypothesis 2.

Increased pain knowledge will significantly predict improvements in depression, pain severity, and pain interference for participants who complete the program.

1.10.5 Objective 3.

To identify participants' barriers to the uptake of information from the neurophysiology of pain education sessions, and to summarize participants' comments about the neurophysiology of pain education sessions.

Chapter 2: Body of Thesis

2.1 Study Design

To evaluate the impact of an interdisciplinary pain management program on a variety of outcomes and to examine the impact of the acquisition of pain knowledge on those outcomes, a single group, within subject, pre-test/post-test anonymous chart review was conducted. The review was mostly quantitative with a small content analysis piece. The pain management program is designed and implemented by OrionHealth, and the measures used in this study are collected alongside other information as a part of usual care. The study design, choice of outcomes, data syntheses and analysis, and the creation and implementation of the Barriers to Knowledge Uptake questionnaire are all exclusive to this study.

Data in client charts, which were collected by the assessing or treating clinicians at OrionHealth, were used in analyses. There was no contact by UBC researchers with the clinical population and UBC researchers were blinded to any identifying information in client charts.

2.2 Interdisciplinary Intervention

2.2.1 Program background.

OrionHealth is a group of six rehabilitation and assessment centres in Western Canada, with four clinics in British Columbia and two in Alberta. OrionHealth's first interdisciplinary persistent pain rehabilitation clinic opened in Canmore in 1989, and the Vancouver Pain Clinic (the focus of this thesis) opened in the early 1990s. Among many services and programs, the Vancouver Pain Clinic offers an interdisciplinary pain management program, which will be described in detail below.

2.2.2 Program goals and rationale.

Consistent with the majority of interdisciplinary pain management programs in the literature, the pain management program at OrionHealth uses a biopsychosocial approach, and the client plays an active role in their rehabilitation – they are encouraged to self-manage their pain and are involved in setting treatment goals and measuring progression, among other aspects of the program. Also in line with the current implementation strategies of interdisciplinary pain management, the program focuses on physical and functional restoration (Gatchel & Okifuji, 2006), with the goal of providing clients with skills and strategies to manage their pain so they can more fully independently participate in vocational, recreational, and social activities. There is also a focus on medication management, sleep hygiene, education, and psychological wellness. The program emphasizes return to work as a determinant of health and primary goal for clients.

2.2.3 Clients.

Inclusion and exclusion criteria for the program are described in the methods section of this paper. Most clients are referred to the program by an insurance source: WorkSafeBC, private long-term disability insurers, RCMP, Veteran's affairs, and ICBC. Very few clients privately pay for program participation.

2.2.4 Program staff.

The collective roles of the staff in this program fit with the current model of interdisciplinary pain management. All staff work together under one roof on the same client file, practice ongoing communication, and coordinate their services toward the same goals. All staff members take part in team meetings and case conferencing, except the pharmacist who receives direction from the physician and also liaises with the rehabilitation clinicians regarding medication changes and side effects and how this may impact performance in the gym or in the

workplace. The entire interdisciplinary team and their general roles in the program are described below.

2.2.4.1 Clinical case coordinator.

The clinical case coordinator coordinates the client's overall program, and communicates with the client's insurance referral contact. They coordinate and attend interdisciplinary team meetings, and facilitate communication throughout the program between the client, team referrer, and other relevant stakeholders. After program discharge, the clinical coordinator facilitates follow up contact with the client.

2.2.4.2 Psychologist.

The primary role of the psychologist is to address the relationship between clients' emotions, mood, cognition, and pain. In one-on-one counseling sessions, they introduce stress management strategies, address the changes in identity that go along with a chronic pain diagnosis, and support the rehabilitation process. There is no single therapeutic approach used; however, there is an emphasis on cognitive behavioural approaches and acceptance and commitment therapy.

The psychologist carries out client assessments, provides individual counseling as needed (once every three weeks to 2 times per week), facilitates practice of various pain management strategies, and teaches education classes.

2.2.4.3 Occupational therapist.

The primary role of the Occupational Therapist (OT) is to support the client's ability to return to work, participate in activities of daily living, and meet recreational goals. This is primarily accomplished by creating an individualized functional program for each client with graded progressions and by facilitating the integration of active pain management strategies

introduced in the clinic to home and work tasks. Further, the OT liases with the client's employer about return to work plans, pain management, and realistic expectations for symptom resolution. The OT also determines necessary modifications to the client's home and work environment and to techniques used to carry out activities in these environments. The OT suggests tools, equipment, alternative techniques, and provides education on proper posture and body mechanics.

The OT carries out client assessments, provides one-on-one clinical sessions at a frequency that meets the needs of the client and teaches education classes.

2.2.4.4 Physical therapist.

The Physical Therapist (PT)'s role is to assist the client in improving their physical function and independence. This is carried out with an individualized exercise prescription with graded progressions. The PT reassesses the client's progress at times that are specific to the client's' needs and goals over the program, and makes changes to the client's exercises if necessary. The exercises are designed to increase endurance, strength, flexibility, and confidence. The PT may provide hands-on therapeutic interventions to facilitate activation when necessary (e.g. taping, manual therapy, acupunture), but their therapeutic emphasis is on client self-management.

The PT carries out client assessments, provides individual clinical sessions (typically 2-3 times per week per client), and teaches education classes.

2.2.4.5 Kinesiologist.

The kinesiologist supervises the clients during group gym hours, and works with the OT and PT to implement and monitor the functional program and exercise prescriptions. They are present in the gym whenever it is open to clients, supervising clients' programs at all times and

progressing the programs when appropriate and necessary. The kinesiologist provides technique corrections and reinforces the application of active pain management skills in the gym.

The kinesiologist teaches education sessions and leads some group gym sessions (e.g. morning walk and stretch, yoga).

2.2.4.6 Physician.

The clinic's pain program physician determines the medical stability of each client, confirms diagnoses, and provides medical guidance and medication rationalization and management. The physician makes recommendations about changes to primarily pain medications with the goal of optimizing their effects and/or tapering those found to be inappropriate. This is done gradually and safely and the physician works closely with the pharmacist, who carries out and monitors those changes. The physician ensures the ongoing safety and appropriateness of the program for the client; they educate the client about their condition, and communicate with the client's attending physician (family doctor, specialist physician, etc.). The physician plays a key role working with the interdisciplinary team to address potential safety issues, which may be medication related, for return to work.

The physician carries out client assessments, provides individual follow up sessions, and participates in weekly case conference meetings with the interdisciplinary team.

2.2.4.7 Pharmacist.

The pharmacist works under the direction of the physician, and assists in carrying out and monitoring the changes in medication. The pharmacist determines the most appropriate and effective medication routine based on the physician's recommendations, implements these changes, and answers any client questions about medication. Although no medication changes are mandatory, many clients reduce or change their opioid intake. The opioid reduction regimen

involves a typical dose decrease of 10% every 4 days, which can vary based on individual factors. Some clients will change from short-acting to long-acting opioids. Medications such as sleep aids and non-opioid alternatives are added when necessary and appropriate. Medication changes are carried out with consideration of each client's physical and functional progression. The pharmacist aims to decrease medication use as much as possible while allowing the client to concurrently increase their physical activity as much as possible. This balance is achieved though coordination with the with the other members of the treatment team.

The pharmacist meets with clients for one on one counseling if they are on opioids or if they are undergoing medication changes during the program, typically once per week.

2.2.4.8 Other stakeholders.

Although they are not a part of the core interdisciplinary rehabilitation team, the client's referral source, attending physician, employer and vocational rehabilitation consultant may be included in communication about the client's progress and collaboration regarding the return to work plan.

2.2.5 Program components.

2.2.5.1 One on one clinical appointments.

Throughout the program, clients meet with interdisciplinary team members for scheduled individual counseling or therapy sessions. All clients have the opportunity for regular meetings with the psychologist, the occupational therapist, the physical therapist, the physician, and the pharmacist.

2.2.5.2 Gym time.

For much of their time at the clinic, clients have structured gym time. Three hours of gym time is typically scheduled over the course of a day unless there are one-on-one scheduled clinical

appointments. During gym time, clients follow their exercise prescriptions from the physical therapist and functional program from the occupational therapist, under the supervision of the kinesiologist, occupational therapist, or physical therapist. Gym activities are specific to the individual client but typically include components such as stretching, work simulation, core stabilization, cardiovascular fitness, muscle strenghtneing, and incorporation of pain management strategies with activity.

2.2.5.3 Education classes.

Clients attend one-hour education classes on rotating topics four times per week. The psychologist, the occupational therapist, the physical therapist, and the kinesiologist lead these classes. Class topics include: stress management, relaxation and mindfulness, stages of change, developing confidence, pacing, ergonomics, stages of healing, neuroplasticity, posture, stretching, nutrition, balance and stability, cardiovascular fitness, and graduated return to work. Topics change on a regular basis as part of the clinic's ongoing improvement efforts.

Twice during the program, clients attend a pain neurophysiology education class. These classes are ninety minutes long, and are a focus of this study. Pain Neurophysiology Part 1 typically takes place during the first week of clients' programs and Pain 2 takes place during the second week. The content of the program is comparable to Moseley's teaching resources (Butler & Moseley, 2013). The first class teaches very basic neuroanatomy (i.e. sensory nerves, spinal cord, brain) and neurophysiology (i.e. action potentials, neurotransmission). The experience of pain is explained as a normal response to the brain interpreting a sensation or situation as threatening or dangerous. Because of this, pain is complex and not necessarily indicative of tissue damage, and that "danger signals" from the tissues can be "dialed up" or "dialed down" by the brain. Later in the classes, neuroplasticity is introduced, and clients learn that when pain

persists, the nervous system can become more sensitive and therefore feel pain from less sensory input than previously elicited pain. The contribution of negative thoughts, beliefs, and past experience to the interpretation of threat and experience of pain are discussed. Tools for decreasing the sensitivity of the nervous system are briefly introduced and reinforced throughout the program.

2.2.5.4 Pain management training.

Pain Management Training (PMT) is a 30-minute session that takes place four days per week. The classes focus on breathing and relaxation techniques to reduce muscle tension and anxiety related to pain and its exacerbation. There are four types of PMT sessions, scheduled on a rotating basis. The four sessions are: active progressive muscle relaxation, passive progressive muscle relaxation, safe place imagery, and deep breathing + guided imagery. In addition, clients have two 30-minute mindfulness sessions per week.

2.2.6 Program structure.

OrionHealth's PMP can be broken down into four major components: assessment and triage, treatment modules, return to work monitoring, and follow up. Length of services and further subdivisions of these services are described below

2.2.6.1 Assessment and triage.

Client assessment and triage takes place over two days. The physical therapist, occupational therapist, physician, and psychologist assess each prospective client individually. All clinicians take part in gathering aspects of the client's history independently, and each clinician gathers additional information specific to their discipline. The goal of the assessment is to determine as a team whether the client is appropriate for the PMP and to get an idea of major areas to be addressed in treatment.

Once all assessment components are completed, the assessment team attends a meeting to triage each prospective client and determine their suitability for the program. If the initial decision is not unanimous, the assessing clinicians will come to an eventual consensus after discussion.

2.2.6.2 Treatment modules.

Once admitted, clients begin the pain management program. There can be a delay between assessment and program commencement depending on a variety of factors (i.e. referrer approval, pending medical clearance, client specific issues). A typical program is made up of two blocks of three-week pain management modules, for a total of 6 weeks. If a client is from out of town, and if clinically indicated, a "home practice" week can be incorporated between module 1 and module 2 to allow the client to test what they have learned so far from the program within their community.

At the beginning of module 1, clients attend a goal setting meeting with the interdisciplinary team and the case coordinator. There is typically a second meeting halfway through the program. Additional team meetings occur on an as-need basis for the remainder of the program. Module 1 and module 2 have the same daily schedule.

Clients attend the clinic Monday to Friday from 9:00AM to 3:00PM, with a one-hour lunch break from 12:00PM – 1:00PM, for a total of 150 clinic hours over the course of two modules. A typical day involves a group walk/stretch session from 9:00-9:30AM, gym time from 9:30-10:00AM, an education class from 10:00-11:00AM, a lunch break from 12:00-1:00PM, gym time from 1:00-2:30PM, and Pain Management Training from 2:30-3:00PM. Gym time involves supervised practice of PT and OT prescriptions and time for one on one clinician appointments.

Options for Extension. The treatment team may request additional treatment time for clients who may benefit from more time in the program, usually in relation to return to work readiness. The amount of additional time varies but is usually anywhere from 4-8 weeks.

2.2.6.3 Return to work monitoring.

For clients who are appropriate to attempt a return to work after completion of module 2 in the clinic, the OT will work with the client, employer, case manager and other stakeholders to design a customized graduated return to work (GRTW) plan. The OT will then monitor the GRTW, modify the plan as needed, help the client address challenges along the way and communicate with stakeholders to discuss progress and maximize potential for success.

2.2.6.4 Follow up.

A sub-sample of clients is contacted by phone 3 months after discharge from the program to follow up on their progress and work status. As appropriate and clinically indicated, arrangement for follow up session(s) at the clinic or over the phone may occur for up to a year post-discharge for ongoing monitoring and support.

2.3 Participants

Charts from all clients who completed and had been discharged from OrionHealth Vancouver's Interdisciplinary pain management program during the study period (June 2014 – June 2015) were anonymously and retrospectively reviewed for this study.

2.3.1 Inclusion criteria.

All client charts used in this study were drawn from the clinical population which met the program-specific enrollment criteria for the pain management program as set by OrionHealth Vancouver, who enrolled in and completed that program, and who completed any of the questionnaires analyzed in this study (Neurophysiology of Pain Questionnaire - Revised, the

Barriers to Knowledge Uptake questionnaire, the Beck Depression Inventory, and the Brief Pain Inventory). During the period of chart review (June 30 2014 – June 1 2015), the program enrollment criteria were as follows: completion of an appropriate assessment which indicates clinical benefit from the pain management program; requirement of the level of service provided in the pain management program; consent to participate in the pain management program; medical stability as assessed by a physician (participation in the program is not medically contraindicated); psychological stability; demonstrated difficulty coping with pain or difficulty with complex return to work barriers that could not be adequately addressed by the resources in an Occupational Rehabilitation (OR) program; meeting program specific admission criteria specified by the referral source (e.g. psychosocial issues better addressed in an alternative program, diagnosis of Complex Regional Pain Syndrome). There is no requirement for duration of pain or length of time since injury.

2.3.2 Exclusion criteria.

The charts of clients who did not meet the inclusion criteria were not used in this study. Clients who were excluded from enrolling in the program by OrionHealth were by default not included in this study. Criteria which made prospective clients ineligible to enroll in the pain management program include the following: requirement for additional medical or psychological intervention or investigation, recommendation for other treatment approaches, engagement in behavior that will interfere with the program such as attendance or participation issues as well as aberrant or criminal behavior (e.g. medication diversion or use of illicit substances); attendance at the program that will place other participants or staff at risk; treatment with injected opioids.

2.4 Variables and Measures

The primary outcome measures of this study are consistent with the recommendations made by the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT; Dworkin et al., 2005). Three of six core outcomes (emotional functioning, pain, physical functioning), and four recommended measures (two for pain) are used. All outcome measures are presented in Table 1.

Table 1. ***Primary and secondary outcome measures used in this study.***

Outcome	Name of Measure	ID
Depression	The Beck Depression Inventory (BDI)	Beck, Ward, Mendelson, Mock & Erbaugh, 1961
Pain Intensity	Brief Pain Inventory (BPI)	Cleeland, 2009
Pain Severity	Brief Pain Inventory (BPI)	Cleeland, 2009
Pain Knowledge	The Neurophysiology of Pain Questionnaire – Revised (NPQ-R)	Catley et al, 2013
Opioid Intake	Morphine Equivalent Dose (MEQ)	WorksafeBC, 2015
Barriers to knowledge intake/use, general Pain Neurophysiology Education Feedback	Barriers to Knowledge Uptake Questionnaire (BKU)	Study coordinators (White, Summers, Sims-Gould, Scott, 2014)

2.4.1 Primary outcomes.

2.4.1.1 The Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961).

This 21-item questionnaire measures depression. Clients report their depressive symptoms in the past week on a 4-point scale, and the questionnaire yields a score with a maximum 63 that indicates the severity of client depression. Beck and colleagues validated the questionnaire by comparing inventory scores to independent clinical ratings, and its reliability

(internal consistency and stability) confirmed (Beck et al., 1961). The BDI is recommended by IMMPACT as a measure to evaluate the core outcome domain of emotional functioning (Dworkin et al., 2005).

2.4.1.2 Brief Pain Inventory (BPI; Cleeland, 2009).

This questionnaire measures clinical pain severity and pain interference. Pain severity can be assessed with four items on a numerical rating scale (NRS), to which clients rate the intensity of their pain in the last 24 hours on a scale of 0-10, with 0 meaning "no pain" and 10 meaning "pain as bad as you can imagine" (Cleeland, 2009). The four items ask about pain at its least, worst, average, and now. IMMPACT recommends using a single item to measure the core outcome pain severity (Dworkin et al., 2005). In this study, the IMMPACT recommended item, "please rate your pain by indicating the number that best describes your pain on average in the last 24h" is used to measure pain severity.

Pain interference is assessed with 7 items, to which clients indicate how much pain has interfered with a variety of activities on a scale of 0-10. The activities include general activity, walking, work, mood, enjoyment of life, relations with others, and sleep. Pain interference is scored as the mean of these seven items (Cleeland, 2009; Dworkin et al., 2005). IMMPACT recommends using the pain interference subscale to measure the core outcome of physical functioning (Dworkin et al., 2005).

The BPI has been validated in a number of studies, including studies with chronic pain populations, and both subscales demonstrate high test-retest and alternate form reliability (Cleeland, 2009).

2.4.1.3 Neurophysiology of Pain Questionnaire – Revised (NPQ-R; Catley et al., 2013).

This questionnaire measures pain knowledge, how well an individual understands "how and why pain is perceived, and the biological mechanisms that underpin pain" (Catley et al., 2013, p. 1). The NPQ-R questionnaire consists of 13 statements about the neurophysiology of pain, to which participants respond by checking a box labeled "Yes", "No", or "Unsure". In scoring, a correct answer is assigned one point, and an incorrect answer or an "Unsure" response is assigned zero points. The questionnaire yields a single pain knowledge score, indicating how many questions were answered correctly. The original Neurophysiology of Pain Questionnaire demonstrated good psychometric properties including acceptable internal consistency and good test-retest reliability (Catley et al., 2013). Seven of 20 poorly functioning items were removed to improve the psychometric properties of the questionnaire, and the revised version with 13 items is used in this study.

2.4.2 Secondary outcomes.

2.4.2.1 Opioid intake.

IMMPACT recommends that use of rescue analgesics be assessed to supplement self-report measures of pain, however a specific measure is not recommended. For this study, an Oral Morphine Equivalent Dose (MEQ) is used to measure rescue analgesic use. The calculation of MEQs is consistent with conversions used by the clinic's primary referrer (WorkSafeBC, 2015). All opioid analgesics are recorded by the pharmacist, and converted into an MEQ score, which is quantified in mg/day.

2.4.2.2 Barriers to knowledge uptake.

This custom questionnaire measures barriers to pain knowledge uptake as perceived by clients, and is a secondary outcome of this study. The questionnaire asks one question about

client barriers to the uptake of knowledge from the neurophysiology of pain education sessions, and one question about client barriers to use of knowledge from these sessions. A list of possible barriers is provided in checklist format for clients to select from.

There is space for clients to write barriers that were not indicated in the checklist. There is also space at the end of the questionnaire for clients to provide general feedback about the education sessions. This custom questionnaire is used for evaluation and didactic purposes in the OrionHealth Vancouver pain management program group education sessions. The questionnaire was updated twice during the study period to be more concise. All three versions of the BKU are in Appendix A.

2.4.2.3 Demographic and other client information:

Additional information collected included program completion status, program start date, program end date, highest level of education, gender, age, primary language spoken at home, interpreter use, and pain location.

2.5 Procedures/Data Management

As a part of the standard protocol of the OrionHealth Vancouver Pain Management Program, clients complete a number of questionnaires including the BPI, BDI, and NPQ-R at their intake assessment and at discharge. Clients complete the BKU following the second of two neurophysiology of pain education classes, in the second week of the program.

Beginning in September 2014, and for every subsequent month, the following procedures were carried out:

Before data pick up, completed NPQ-R, BPI, and BKU hard copy questionnaires were photocopied and stripped of identifying information by OrionHealth staff, and assigned an

identifying number randomly generated by the OrionHealth database which is not related to any identifying information such as date of birth or health number.

An OrionHealth staff member generated a password-protected excel spreadsheet report from the database. The excel spreadsheet contained demographic information, MEQ scores at assessment and discharge, and composite BDI scores at assessment and discharge. Clients are identified in the spreadsheet with the number generated by the OrionHealth database.

During the second week of every month, the primary author went to OrionHealth to pick up the anonymized hard copy questionnaires and the electronic copy spreadsheets using an encrypted USB. This data pick up process continued approximately once per month after the first pick up date.

All of the data was securely transported to the Centre for Hip Health and Mobility (CHHM) for storage and analysis. Data will be stored at the CHHM for 7 years, and disposed of (hard copies shredded and electronic files deleted) at that time.

2.6 Study Size

To determine the minimum sample size for the proposed analyses, in order to yield effect sizes from a similar study that used pain related anxiety as a final predictor in a hierarchical regression model (Bosy et al., 2010), with a power of .80, an alpha of .05, and 7 predictors in total, I used G*Power software (Erdfelder, Faul, & Buchner, 1996). Based on this calculation, the minimum sample size for this study was 51 participants. However, in anticipation of incomplete charts, and based on common sample sizes in similar research (Bosy et al., 2010; Garven et al., 2011; Oslund et al., 2009) the aim of this study was to collect data for 100 program completers.

2.7 Statistical Methods

2.7.1 Analyses.

2.7.1.1 Analysis 1.

To determine whether primary outcome measures and the secondary outcome measure of opioid intake improve after completion of the pain management program, knowledge scores, depression scores, pain severity scores, pain interference scores, and oral morphine equivalent dose scores from assessment and discharge were compared using a series of five paired samples t-tests.

2.7.1.2 Analysis 2.

To determine whether changes in pain knowledge predict improvements in clinical outcomes, three hierarchical multiple regressions were conducted. Pretreatment outcome variables were entered at step one, demographic variables at step two, and changes in pain knowledge at step 3. The post-treatment outcome variables were the criterion variable.

2.7.1.3 Analysis 3.

Quantitative BKU items were described with frequencies and percentages for all participants who completed the questionnaire. The free-form written responses provided by clients on the Barriers to Knowledge Uptake questionnaire were coded and summarized with using a content analysis to determine common themes (Strauss & Corbin, 2008).

Quantitative data was analyzed using IBM SPSS Statistics Version 19.

2.7.2 Data considerations.

Demographic analyses were run for the entire sample, including program non-completers. The t-tests and regressions for analyses 1 and 2 were run using data from program completers only, and the BKU analysis (analysis 3) included data drawn from the entire sample of

completers and non-completers. A subset of participants was excluded from analyses on a test-by-test basis. When participants did not have sufficient relevant data required to conduct a given statistical test, they were excluded from the analysis of that test only.

Data for depression was considered sufficient if the participant answered 100% of BDI questions. For clinical and statistical purposes, the staff at OrionHealth consider the BDI invalid if one or more questions is not answered, and only composite scores were provided for this study. Pain severity was measured with one item, so data was considered sufficient if that item was answered. Consistent with the BPI user guide, data for pain interference was considered sufficient if more than 50% of questions (at least 4 of 7) are answered (Cleeland, 2009). Pain knowledge data was considered sufficient if at least 10 of 13 NPQ items were answered.

No imputations were conducted for missing data. If a participant was missing between 1 and 3 items on the NPQ, those items were scored as incorrect. If a participant was missing between 1 and 3 items on the BPI interference subscale, the BPI interference average score was computed only using items that were answered. The data was tested for normality for each t-test and regression. The results of these tests are outlined in the results section.

A sensitivity analysis was conducted for all t-tests and regressions in analysis 1 and analysis 2, including only clients who had least 3 months elapse since their injury at the time of admission. OrionHealth generally and this study in particular do not have any criteria that require clients/participants to have experienced pain for a specified period of time, however the common definition of chronic pain is pain that lasts at least 3-6 months or more (International Association for the Study of Pain, 2002). For that reason, all relevant analyses were conducted for the subgroup of clients who fit the IASP definition of chronic pain – clients with pain less than 3 months at admission (n = 6) were excluded. All results of the sensitivity analysis but one were in

line with the analyses run with the entire group of completers and are not reported. The result that differed from the full group analyses is reported in the results section: analysis 1 pain severity change.

2.8 Results

2.8.1 Participant demographics.

Characteristics of the study sample are located in Tables 2 and 3. Means and standard deviations for continuous variables and frequencies and percentages for categorical variables are reported for the total sample (all clients who provided chart information for analysis), as well as by completion status, and by pain severity improvement. Program completers who improve on the BPI pain severity subscale by increments of 30% and 50% are recommended for reporting by IMMPACT (Dworkin et al., 2005).

The amount of time elapsed between injury and program assessment (time since injury) ranged from 1 month to 435 months for program completers, however most program completers had a relatively short time since injury. Few completers had been injured for an extended period – 89% had been injured for fewer than 3 years, and many (28%) had been injured between 3 and 6 months. Six percent of completers had been injured fewer than 3 months since assessment. Median length of time since injury was 10 months for the entire sample, 8 months for program completers, 20 months for non-completers, 8.5 months for participants who improved pain severity by at least 30%, and 9 months for those who improved pain severity by at least 50%.

Table 2. ***Continuous demographic characteristics of all participants and by completion status and by improvement status for those who completed the program.***

		By completion status		By pain severity improvement status	
	Total sample (n=133)	Completed (n=102)	Did not complete (n=31)	≥30% (n=16)	≥50% (n=11)
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Age	45.87(11.62)	45.91(11.65)	45.74(11.70)	45.44(12.52)	44.82(13.78)
MEQ pre	16.54(31.36)	15.41(30.44)	20.45(34.65)	20.45(37.41)	21.55(38.06)
Time since injury (months)	27.81(61.93)	22.31(52.82)	45.90(83.89)	17.88(26.59)	16.27(23.95)

Table 3. ***Categorical demographic characteristics of all participants and by completion status and by improvement status for those who completed the program.***

		By program completion status		By pain severity improvement status	
	Total sample (n=133) n(%)	Completed (n=102) n(%)	Did not complete (n=31) n(%)	≥30% (n=16) n(%)	≥50% (n=11) n(%)
Gender					
Male	79(59.4)	57(55.9)	22(71.0)	10(62.5)	7(63.6)
Female	54(40.6)	45(44.1)	9(29.0)	6(37.5)	4(36.4)
Language					
English	100(75.2)	75(73.5)	25(80.6)	11(68.8)	7(63.6)
Other	24(18.0)	20(19.6)	4(12.9)	2(12.5)	1(9.1)
Missing	2(1.5)	1(1)	1(3.2)	0(0)	0(0)
>1 incl. English	7(5.3)	6(5.9)	1(3.2)	3(18.8)	3(27.3)
>1 excl. English	0(0)	0(0)	0(0)	0(0)	0(0)
Interpreter n(%)					
Yes	11(8.3)	9(8.8)	2(6.5)	1(6.3)	1 (9.1)
No	122(91.7)	93(91.2)	29(93.5)	15(93.8)	10 (90.9)
Education					
Some primary (1-7)	2(1.5)	2(1.9)	0(0)	0(0)	0(0)
Some secondary (8-11)	15(11.3)	11(10.8)	2(6.5)	0(0)	0(0)
Completed secondary	39(29.3)	29(28.4)	10(32.3)	7(43.8)	4(36.4)
Some post secondary	5(3.8)	3(2.9)	2(6.5)	1(56.3)	1(9.1)
Completed post secondary	38(28.6)	31(30.4)	7(22.6)	3(18.8)	1(9.1)
Other	2(1.5)	2(1.9)	0(0)	0(0)	0(0)
Missing	32(24.1)	24(23.5)	8(25.8)	5(31.3)	5(45.5)
Referrer					
WorkSafeBC	121(91)	96(94.1)	25(80.6)	15(93.8)	10(90.9)
Other	12(9)	6(5.9)	6(19.4)	1(6.3)	1(9.1)
Pain site[a]					
Cervical	8	7	1	1	0
Upper shoulder, upper limbs	45	76	8	6	5
Thoracic region	11	7	3	0	0
Lower back, lumbar spine, sacrum, coccyx	58	46	12	7	4
Lower limbs	44	30	14	3	2
>3 major sites	18	13	5	2	2

[a] Participants could list >1 pain site.

Highest level of education was not reported for 24% of participants (Table 3). A summary is presented in Table 3, but education is not used as a predictor in subsequent analyses

because of the substantial amount of missing data. Non-English languages included: Hindi, Punjabi, Cantonese, Farsi, Vietnmise, Serbo-Croatian, Korean, Spanish, Tagalog, Arabic, and Assyrian.

Length of stay, the mean length of time between assessment and discharge for program completers, was 71.75 (SD = 28.11) days. It should be noted that there is often a delay of a few days to a few weeks for some clients between assessment and the beginning of module 1 (program start), and that many clients take a "home practice" week between the first and second modules of the program. Some clients undergo program interruptions outside of these common program breaks. Program interruption dates/times were not provided in client charts.

Analysis 1 and 2 used data from program completers only, and analysis 3 used available data from any participant, regardless of completion status.

2.8.2 Main analyses.

2.8.2.1 Analysis 1.

The results of the paired samples t-tests investigating changes in pain knowledge and clinical outcomes are presented in Table 4 and Figures 1-5. The t-tests were run to determine whether the primary outcome measures (pain knowledge, depression, pain severity, and pain interference) and opioid intake improved after completion of the Interdisciplinary Pain Management Program at OrionHealth Vancouver.

Table 4. ***Descriptive statistics and t-test results for primary outcome variables and opioid intake.***

	Assessment		Discharge				
	M	SD	M	SD	t	df	p
Pain knowledge	4.59	2.12	6.27	2.48	6.337***	91	<.001
Depression	21.31	10.78	16.07	9.68	-4.868***	80	<.001
Pain Severity	5.84	1.73	5.41	1.98	-2.038*	96	.044
Pain Interference	6.76	1.86	5.87	2.45	-4.175***	96	<.001
Morphine Equivalent Intake[a]	13.27	26.49	9.61	27.10	-2.781**	98	.006

* p < .05
**p < .01
***p <.001
[a]Results of the t-test including all participants who provided data, including n=52 with 0 recorded MEQ at intake and at discharge

2.8.2.1.1 Pain knowledge change.

Assumptions for a paired-samples t-test were tested and met. A box-plot was created to examine outliers, and two outliers were detected that were more than 1.5 box-lengths from the edge of the box. Inspection of their values did not reveal them to be extreme and they were retained for analysis. The difference scores for knowledge at assessment and discharge were normally distributed, as assessed by visual inspection of a Normal Q-Q Plot. As displayed in Table 4 and Figure 1, participant's scores on the NPQ-R significantly increased between program assessment and discharge for program completers. The mean increase was 1.68 (95% CI 1.16 to 2.21), a 37% increase. Results show that participants increased their pain neurophysiology knowledge after completing the Pain Management Program. The effect size of this test was d = .66, indicating a medium to large effect. Ninety-two participants were included in the test.

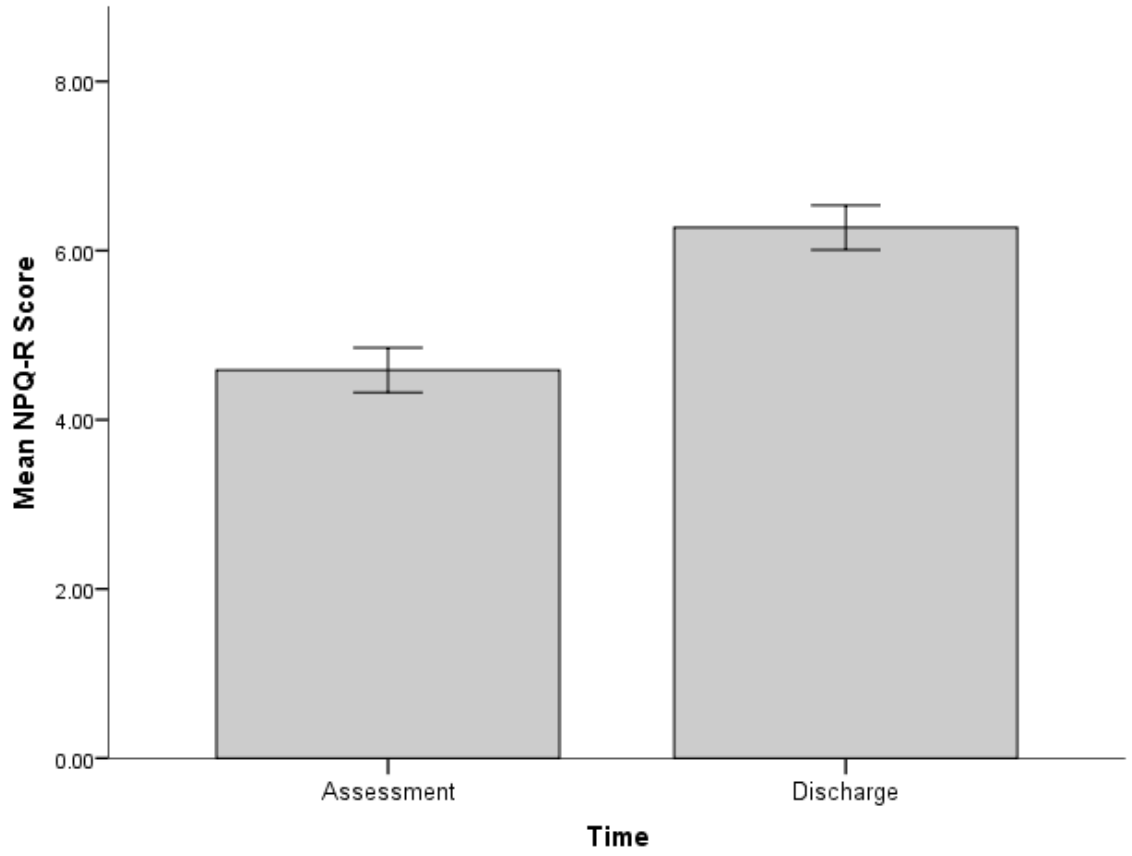

Figure 1. Differences in pain knowledge for program completers at assessment and discharge. Error bars represent confidence intervals that have been adjusted to remove between subject variance (Cousineau, 2005). $p < .001$.

2.8.2.1.2 Depression change.

Assumptions were tested and met for the BDI paired samples t-test. Three outliers were found in the boxplot, and their values examined and determined to be reflective of client status and not extreme. These scores were kept in analysis. Visual inspection of a Normal Q-Q plot indicated that the difference scores approximated a normal distribution. As indicated in Table 4 and Figure 2, participants scored significantly lower on the BDI at discharge than at assessment, mean decrease -5.24 (95% CI -7.37 to -3.10), a 25% decrease. Results indicate that participants

experienced decreased depression after completion of the Pain Management Program. The effect size of this test was d = .54, indicating a medium effect. Eighty-two participants were included in this test.

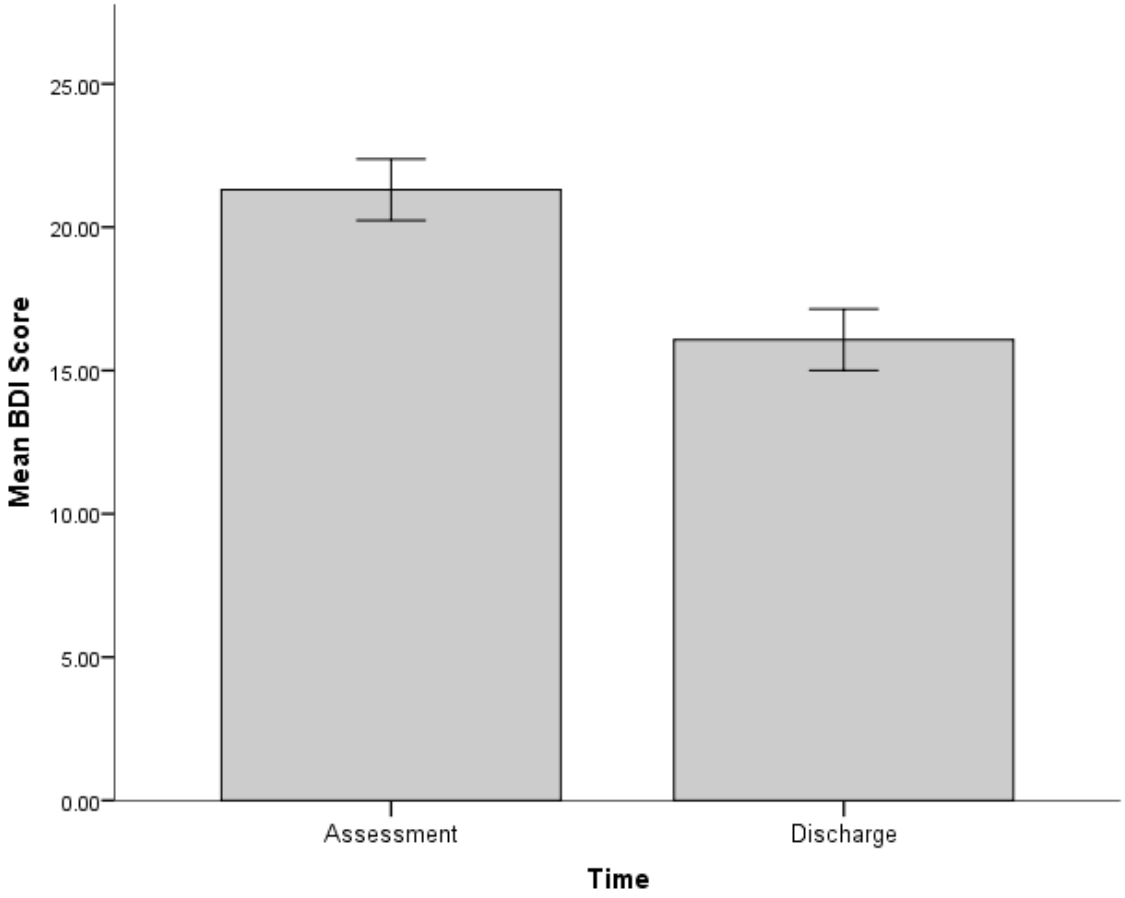

Figure 2. Differences in depression for program completers at assessment and discharge. Error bars represent confidence intervals that have been adjusted to remove between subject variance (Cousineau, 2005). $p > .001$.

2.8.2.1.3 Pain severity change.

Assumptions were tested for the paired samples t-test for BPI item 5, used to assess pain severity. Four non-extreme outliers were found through inspection of a boxplot, and they were retained. The difference scores in the Normal Q-Q Plot approximated normality. Results of the t-

test are displayed in Table 4 and Figure 3. Participants significantly decreased their average pain severity; mean decrease of BDI scores was -.43 (95% CI -.85 to -.01), a 7% decrease. These results indicate that after participating in the pain management program, participants' pain severity slightly but significantly decreased. The effect size was d = 0.21, indicating a small effect. Ninety-seven participants were included in analysis.

In the sensitivity analysis excluding clients with fewer than 3 months of pain, pain severity at discharge did not significantly differ from pain interference at assessment, t(85) = -1.801, M = -4.18, SD = 2.16. This result indicates that program completers who experienced pain for at least 3 months at assessment did not significantly improve their pain severity after completion of the pain management program.

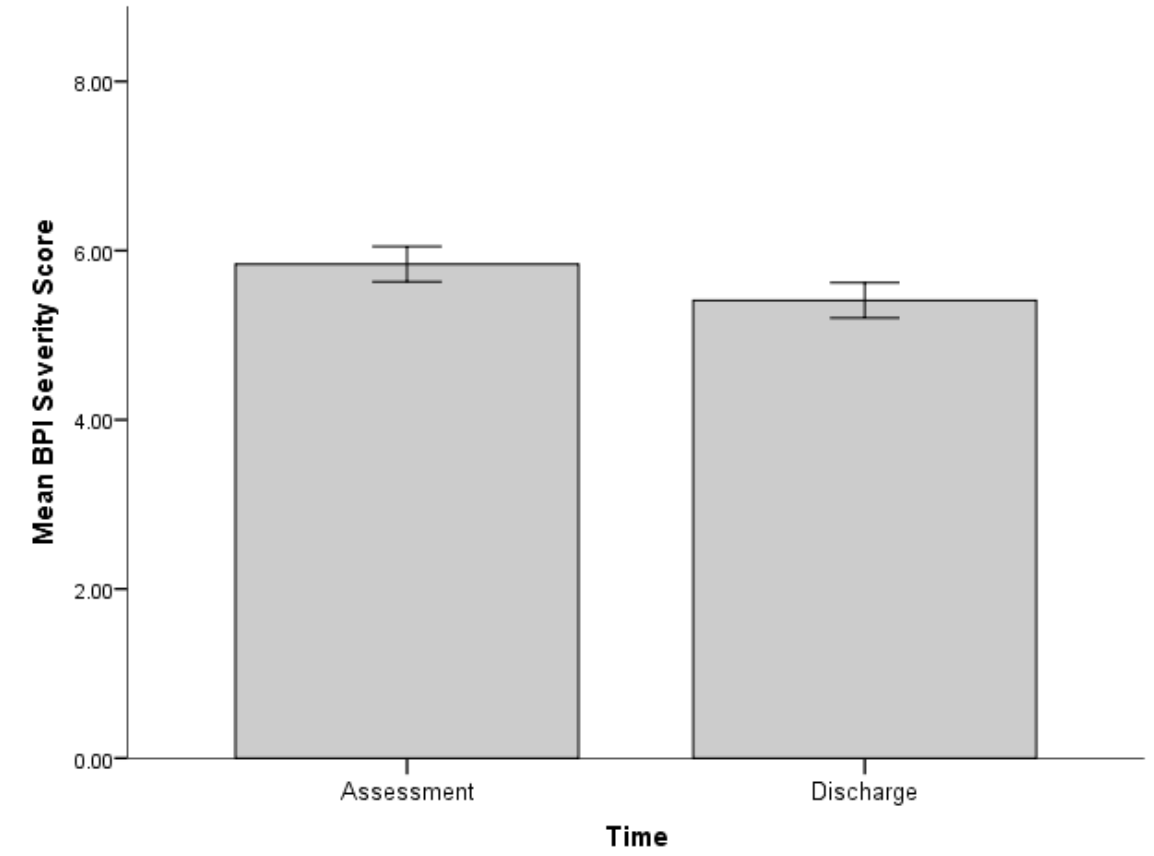

Figure 3. Differences in pain severity for program completers at assessment and discharge. Error bars represent confidence intervals that have been adjusted to remove between subject variance (Cousineau, 2005). $p = .044$.

2.8.2.1.4 Pain interference change.

Assumptions for the t-test measuring the pain interference subscale of the BPI were tested and met, with no extreme outliers (eight outliers were identified and none were extreme, all were retained for analysis), and a distribution that approximated normal as determined by visual inspection of a Normal Q-Q Plot. As indicated in Table 4 and Figure 4, participants' pain interference levels decreased between assessment and discharge, with a mean change of -.88 (95% CI -1.30 to -.46), a 13% decrease. This indicates a slight but significant decrease in pain

interference for program completers by the end of the pain management program. Effect size was d = .42, indicating a small to medium effect, and ninety-seven participants were included in analysis.

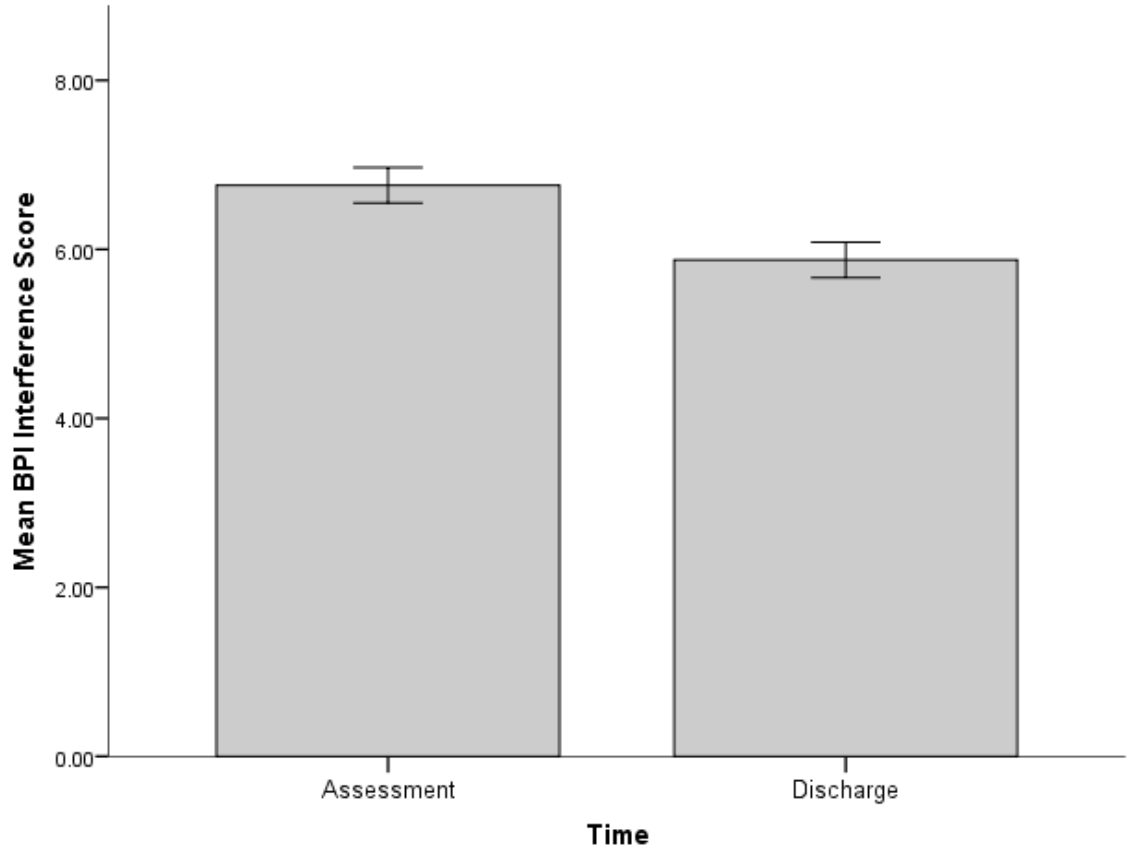

Figure 4. Differences in pain interference for program completers at assessment and discharge. Error bars represent confidence intervals that have been adjusted to remove between subject variance (Cousineau, 2005). $p < .001$.

2.8.2.1.5 Opioid intake change.

Assumptions were tested for the paired samples t-test for opioid intake as measured by MEQ scores. Eleven extreme outliers were present upon examining the boxplot, and the data was significantly negatively skewed from inspection of a histogram and Normal Q-Q Plot. While all

outliers fell within or just over 3 standard deviations from the mean (highest = 3.07, second lowest = -2.53), it was suspected that the most extreme negative outlier (z score -5.89) was skewing the data, so it was removed and normality plots re-checked. After this point was removed, the histogram and Normal Q-Q plot approximated a normal distribution, with a leptokurtic curve. The remaining extreme outliers (now highest z-score 3.72 and lowest z-score -3.16) were retained, as it was decided upon further investigation that their actual values were not extreme. It was decided that these outliers appeared extreme on the boxplot and in their z-scores because many participants (n = 52) entered and left the program with zero opioid intake (MEQ change = 0). A t-test was carried out with this data. As displayed in Table 4 and Figure 5, participants who completed the pain management program significantly decreased their opioid intake between program assessment and discharge (mean change -3.66, 95% CI -6.26 to -1.05), a 28% decrease. Ninety-nine participants were included in analysis, including 52 who did not change their opioid intake from zero, and effect size was d = .28, indicating small to medium effect. These results indicate that program completers decreased their opioid intake by 3.66mg/day

A sensitivity analysis was conducted excluding data from participants who had a MEQ score of 0 at assessment and discharge. The same extreme outlier was excluded from analysis for the same reasons outlined above. With the extreme outlier removed, seven outliers remained but their data was retained because upon further inspection their values were not extreme and not expected to significantly impact the distribution mean. In the t-test with only opioid “users”, participants significantly decreased their MEQ scores between assessment (M = 27.90 SD = 32.80) and discharge (M = 20.25 SD = 36.66), t(46)=-2.895, p = .006. Mean MEQ decrease was 7.70 (95% CI -13.05 to -2.35), also 28%, d= .42, indicating a small to medium effect size. These

results indicate that program completers who used opioids at any point during the pain management program on average decreased their opioid intake by nearly 8 mg/day.

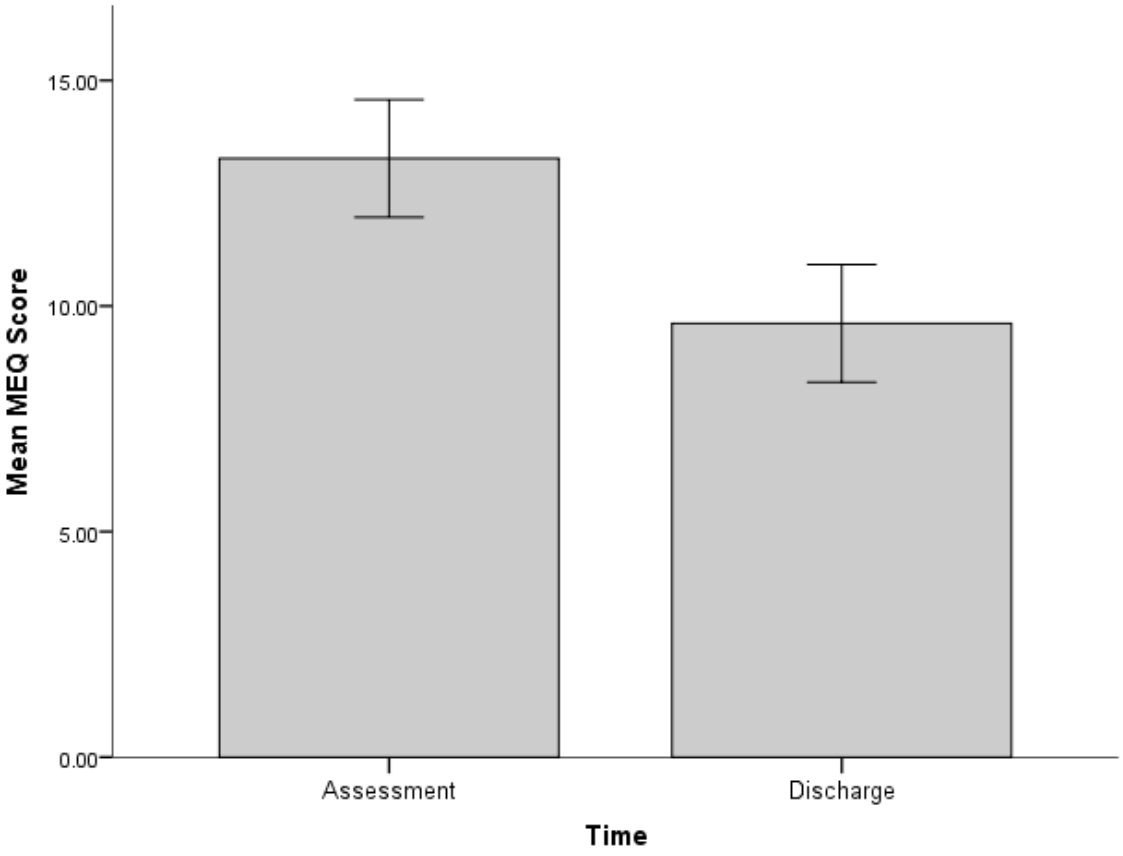

Figure 5. Differences in opioid intake for program completers at assessment and discharge, including participants with 0mg opioid intake at assessment and discharge. Error bars represent confidence intervals that have been adjusted to remove between subject variance (Cousineau, 2005). $p = 0.006$.

2.8.3 Analysis 2.

Three hierarchical multiple regressions were run to determine if the addition of pain knowledge change improved the prediction of clinical outcome scores at discharge over and above assessment scores and demographic variables. Full details of each regression model for all three tests are in Table 5. Covariates were chosen based on previous research on process

variables in the context of interdisciplinary chronic pain management (McCracken & Gross, 1998).

Table 5. ***Hierarchical multiple regression analyses predicting outcome variables from changes in pain knowledge scores.***

Criterion Predictor	N	B	Beta	R^2 cum	ΔR^2	F change	Significance of F change (p)
Depression							qqq
1. Assessment score	74	.471	.557	.310	.310	32.786	.000
2. Covariates	69			.354	.044	.923	.472
Pain severity		-.315	-.062				
Language		1.034					
Gender		2.469	.132				
Time since injury		-.021	-.134				
Age		-.001	-.001				
3. Pain Knowledge Change	68			.354	.000	.004	.949
Pain Severity							
1. Assessment score	89	.428	.392	.154	.154	15.987	.000
2. Covariates	85			.182	.029	.734	.571
Language		-.556	-.170				
Gender		.092	.024				
Time since injury		-.002	-.056				
Age		.002	.010				
3. Pain Knowledge Change	84	-.071	-.094	.190	.008	.828	.366
Pain Interference							
1. Assessment score	88	.711	.541	.284	.292	35.916	.000
2. Covariates	83			.323	.031	.744	.593
Pain severity		.008	.006				
Language		-.177	-.043				
Gender		-.204	-.041				
Time since injury		-.008	-.172				
Age		.006	.026				
3. Pain Knowledge Change	82	-.065	-.067	.327	.004	.497	.483

2.8.3.1 Predicting depression.

Assumptions were tested for the hierarchical multiple regression predicting depression scores at discharge. The assumptions of linearity, independence of errors, multicolinearity, unusual points, and normality of residuals were met. The assumption of homoscedasticity was threatened upon visual inspection of a scatterplot plotting the studentized residuals plotted

against the unstandardized predicted values. However, the scatterplot was not extremely heteroscedastic, and transformations failed to bring it closer to perfect homoscedasticity. The violation was judged to be not significant enough to warrant a different type of analysis, so the analysis was conducted on non-transformed variables.

Depression discharge scores were predicted at step one with depression assessment scores, at step two with demographic variables, and at step three with pain knowledge change (Table 5). The first model was the only significant model, where depression assessment scores significantly predicted depression discharge scores in this model). Neither the addition of demographic variables nor the addition of pain knowledge change led to a statistically significant increase in R^2. These results indicate that pain knowledge does not significantly predict depression scores over and above pre-treatment scores and covariates.

2.8.3.2 Predicting pain severity.

The multiple hierarchical regression predicting discharge scores for pain severity met the assumptions for independence of errors, homoscedasticity, unusual points, and normality of residuals. The assumption of linearity between pain knowledge change and pain severity at discharge was threatened – the scatterplot created for the two variables approximated normal but was somewhat U-shaped. When a reflect and logarithmic transformation was performed on pain severity assessment and discharge scores, the relationship between pain knowledge change and pain severity at discharge appeared slightly more normal. A sensitivity analysis was conducted, and the multiple hierarchical regression was performed on the transformed and non-transformed data. The results remained the same for both analyses, and the results from the non-transformed test are presented here for ease of interpretation (Table 5).

The only significant model was the first, with pain severity assessment scores as the only significant predictor of pain severity discharge scores. The model with demographic variables added and the model with demographic variables and pain knowledge change added did not significantly increase R^2. These results indicate that pain knowledge change does not predict pain severity over and above pretreatment scores and demographic variables.

2.8.3.3 Predicting pain interference.

The multiple hierarchical regression predicting pain interference scores at discharge met the assumptions for linearity, independence of errors, homoscedasticity, multicolinearity, unusual points, and normality of residuals.

Only the first model with pain interference assessment scores as the predictor was significant. The addition of demographic variables and pain knowledge change did not significantly increase R^2. These results indicate that pain knowledge change does not significantly predict pain interference over and above assessment scores and covariates.

2.8.4 Analysis 3.

The Barriers to Knowledge Update (BKU) questionnaire was analyzed using quantitative techniques and a content analysis to determine participants' perceived barriers to the uptake and use of pain knowledge in the two neurophysiology of pain education sessions. Eighty-seven participants provided data for version one, two, or three of the BKU.

Quantitative analysis involved recording the frequency of responses to the Likert and check box items of all three BKUs. Eighty-six participants provided a response for the Likert item "I feel that the information and techniques provided in these sessions will be valuable in managing my pain" across all three BKUs. Sixty-eight (79.1%) of these respondents agreed or strongly agreed with the statement. By far the most selected barrier for the intake of information

was pain intensity interfering with the ability to concentrate (25.3%), followed by pain medication interfering with ability to concentrate (11.4%), language/content of the sessions too difficult to follow (10.3%), too much information in the education sessions (8.0%), and "other" (10.3%). Remaining items that were selected more than once included the session was not compatible with learning style (3.4%), and not enough sleep (4.6%). Not enough sleep was the only frequently mentioned barrier that was recorded freely by participants, as there was no checkbox item for this barrier. The participants who indicated that lack of sleep was a barrier recorded it in the "other" checkbox item. Thirty-nine (44.8%) participants indicated that they had no barriers for knowledge intake.

Very few participants indicated barriers for using knowledge gained in the education sessions. Eighty-two (94.2%) indicated that they planned to use the information provided. The most frequently selected barriers included an already established method of pain management (3.4%), information that was not applicable to the participant's pain experience (2.3%), and awaiting medical intervention to relieve pain (2.3%). No other barriers were selected more than once.

A content analysis was conducted to investigate participants' written responses to the final item of the BKU. The item asked participants if they had any other comments about the education session and an open space was provided for written responses. Fifty-one participants provided responses to this item. The most common comments were feedback about the structure and content of the pain management classes. Most of these comments were general positive reactions about the information presented in the classes, for example "very informative" and "I appreciate all the info I received" (12 comments). There were also suggestions for improvement that were neutral in tone, requesting handouts for future reference and more opportunity for

hands-on learning and discussion (6 comments). Notably, one client requested the presentation to be earlier in the program "to better explain the methodology of the clinic". There were also general feedback responses with a negative tone, but fewer in this category than positive and neutral, and the only negative comments overall (4 comments). Most of these were requests for more information and more clear information.

Several participants provided pain management tools related to the neurophysiology of pain that could be applied to their everyday lives (6 comments). Examples of these are: meditation and mindfulness, retraining the brain and nervous system to interpret incoming signals differently, self-awareness, and positive thoughts and beliefs. This theme (tools) and the remaining themes extracted from the data – personal impact, staff comments, and difficulty concentrating, were most common after general feedback and relatively equally represented.

Participants made comments about how the course impacted them personally, providing a sense of hope, eliminating stress, and altering negative thoughts. Some commented that it helped them to understand the experience of chronic pain generally, and their own experience with pain specifically (7 comments)

Many clients had comments about the program staff (7 comments). All comments were positive, and were split evenly between statements of gratitude toward specific staff members who taught the pain neurophysiology courses, and toward the treatment team as a whole.

The final theme elicited from analysis of the BKU comments was difficulty concentrating in the classes (5 comments). Most comments in this theme included positive sentiments about the information presented in the classes, combined with a concern that the information was not or could not be retained. No comments gave direct reasons why concentration was difficult; statements included "it does take time to absorb all of the programs with so much on the brain",

"when I am in a different frame of mind [I will be] able to concentrate better", "I can't think now", and "I need to... really try to focus".

Most comments were one to two sentences, and only addressed a single theme. However, a few comments were longer and encompassed many of the themes mentioned above. They are included here:

Participant 1

> *I needed to concentrate more and really try to focus. This part was more difficult – however this was a very good opportunity to learn more in depth. These sessions help me understand what is going on for me. I feel that the information is very good. There is lots to learn. I liked how it was presented in a down to earth method. The second session was a one to one which allowed me to delve into my situation. The sessions were very helpful in helping me to understand what is going on.*

Participant 2

> *Very well informed, it helps this process become not only a little easier but makes you more comfortable to trust the trainers/physios/OTs etc. help you on this process. This class explains a lot more in detail about your brain and how you can re-train it.*

Participant 3

> *The information provided helped me to understand pain and divert attention from pain to perform the activities and exercises with concentration. If the activities and information is related to job/work, it would be beneficial.*

2.9 Discussion

This anonymous chart review was conducted to determine the impact of an interdisciplinary pain management program on clinical outcome variables and pain knowledge of 102 participants who completed the pain management program at OrionHealth Vancouver. Pain neurophysiology education was addressed through investigation of the process variable pain knowledge and by collecting patient feedback regarding pain neurophysiology education sessions.

Only 11% of patients had a substantial improvement in pain, experiencing at least a 50% reduction in pain severity (Dworkin et al., 2008). Similarly, only 16% improved their pain severity by at least 30%, which is a moderate improvement (Dworkin et al., 2008). There was participant overlap within the 30% improvement category, as participants who improved by at least 50% also fit the 30% criteria. Although the number of substantial and moderate improvers are quite low, it is known that no currently available treatment, including pain rehabilitation programs, decreases pain for all patients, and many chronic pain patients still have significant pain after they complete the program (Turk, 2002) . The substantial and moderate improvers were generally similar to the larger analytic sample.

There were notable differences between two sets subgroups (organized by pain severity and by completion status) on demographic variables. The group who did not complete the program had slightly higher opioid intake at assessment and a higher median length of injury than completers, perhaps indicating a more severe condition at assessment. The groups who experienced moderate or substantial improvements in pain severity also had a slightly higher opioid intake than the total group of program completers, with a similar length of time since injury. This result is more difficult to interpret, but could indicate a more dedicated attempt to

control pain at assessment, or perhaps this subgroup had a higher overall opioid reduction, which may have covaried with outcome scores. This result needs further research to determine additional unique characteristics of substantial improvers and to determine the significance of higher opioid intake at assessment.

A few points stood out following investigation of the demographic and background variables for the entire sample. The vast majority of clients in this sample (94.1% of program completers) were referred to the program by a workers compensation board (WorkSafeBC). In addition, the time since injury in this sample – average 15.4 months, median 8 months for program completers – is very short compared to the general population of chronic pain sufferers in Canada, where two-thirds of pain sufferers have lived with chronic pain for at least 5 years (Schopflocher et al., 2011). The pain duration is also short compared to patients in most other interdisciplinary pain management programs in the literature – participants in Garven and colleagues' study (2011) had had pain for over 3.5 years, while participants in Oslund and colleagues' (2009), Becker and colleagues' (2000), and Dysvik and colleagues' (2004) work had been with pain on average around 10 years. In this study, over one third of participants had been injured for fewer than 6 months previous to assessment for the program.

In line with hypothesis 1, there was a statistically significant difference between pre- and post-program scores for all primary and secondary outcome variables. Participants significantly improved their clinical outcomes (depression, opioid intake, pain severity, pain interference) and pain knowledge following completion of an interdisciplinary program. Contrary to hypothesis 1, of the primary outcome variables, only depression showed a clinically significant difference between assessment and discharge scores. IMMPACT (Dworkin et al., 2008) has recommended clinically significant change values for depression, pain interference, and pain severity. While

the mean BDI change of 5.24 points in this study exceeds the recommended clinically important change of 5 points, the pain severity change of 7% in this sample did not meet the 10% threshold for minimally important difference, and pain interference of .88 points on the BPI interference subscale did not meet the 1 point threshold for minimally clinically important change. There are no minimally clinically important differences reported in the literature for the secondary variables of pain knowledge and opioid intake, but changes in both were substantial. The pain knowledge increase of 37% was the variable that improved the most in this study, and the MEQ change of 28% was second largest improvement for participants. When clients with pain less than 3 months were removed from analysis, the improvement in pain severity became non-significant. These clients may have been driving the significant change in pain severity due to factors such as a weaker neurological signature of pain or higher pain severity at baseline. Regardless, pain severity remains clinically non-significant in the larger analytic sample.

The observed reductions in pain severity in the entire analytic sample are low, and fall below the range of 14-60% pain reduction from interdisciplinary pain management (Gatchel & Okifuji, 2006). The results of this study are, however, comparable to those reported for samples with similar demographic characteristics. Gagnon and colleagues evaluated the impact of a 4 week, 8 hour per day, 5 day per week outpatient interdisciplinary pain management program in the United States for workers compensation patients. While the referral source for their program is similar to this study, the length of time since injury was slightly longer (this study avg 2.3 years, their study avg 3 years). At the end of treatment, patients experienced pain severity levels that decreased by just over 20%, between a minimal and moderate improvement, slightly more than our sample but on the lower end compared to other interdisciplinary programs. Similarly to our sample, depression decreased by much more, around 30-40%. Notably, 49.1% of patients

returned to work following program completion, a 37% improvement from assessment. Bosy and colleagues (2010) evaluated the impact of a 7-8 week, 4-6 hour/day, 5 day/week outpatient interdisciplinary program on outcomes for Canadian chronic pain sufferers, the majority of whom received funding through the Workplace Safety and Insurance Board of Ontario. Patients in this study had a shorter time since injury compared to others in the literature, median 1.5 years (this study median 10 months), average 2.2 years (this study average 2.3). Similarly to this study, patients saw a lower decrease in pain severity of 16.4%. Patients reduced depression by nearly 17% on the Hospital Anxiety and Depression Scale, and 61% reduced or eliminated their opioid intake. Seventy-five percent of completers made positive changes in their work status.

The results of this study and of Bosy and colleagues' (2010) and Gagnon and colleagues' (2013) demonstrate that patients with workers compensation claims and lower pain durations complete interdisciplinary pain management programs with smaller reductions in pain severity compared to other samples, but with substantial improvements in cognitive and behavioural variables such as depression, opioid intake, and return to work. Teasell (2001) reported that workers compensation status combined with higher pain intensity is associated with a longer time to recovery after rehabilitation programs, and Bosy and colleagues (2010) stress that the goal of interdisciplinary pain management is not to decrease pain, but to manage activity with pain, including a focus on return to work. These factors in combination may lead workers compensation patients to have significant improvements in negative affect and pain management strategies in the short term, with pain severity remaining the stable in the short term and possibly being further reduced in the long term. The focus of the program in this study was to provide clients with the tools to effectively manage their pain in the long term, to increase activity during the program, and return to work, home activities, and recreational activities at discharge. In line

with this goal, negative cognitive outcomes and the single behavioural outcome of opioid intake improved, while pain severity did not change as substantially. Behavioural and cognitive variables should be considered as important outcomes in chronic pain clinical trials to support these results and to align with the goals of interdisciplinary programs.

Pain interference did not clinically improve after discharge from the program, which runs contrary to the hypothesis outlined above. This variable was not investigated in Bosy and colleagues' (2010) and Gagnon and colleagues' (2013) studies, and should be investigated further in similar samples to determine if these results are replicable and whether pain interference improves in unison with pain severity, possibly after cognitive and behavioural variables improve.

Contrary to hypothesis 2, pain knowledge did not significantly predict improvements in any of the other primary variables (depression, pain severity, or pain interference) for program completers, and so was not considered a significant process variable in the context of this study. Similarly to previous research (McCracken & Gross, 1998), background and demographic variables also weren't significant predictors of outcome variables. It is implied in the literature (Catley et al., 2013; Moseley, 2004) that understanding the biological and physiological mechanisms of chronic pain leads to improvements in pain beliefs, which are known to predict improvements in clinical outcomes (e.g. Burns et al., 2003; McCracken & Gross, 1998). The results of this study indicate that understanding the biological mechanisms that underlie pain do not directly predict improved outcomes, and may not predict improvements in pain beliefs.

Pain neurophysiology knowledge was measured in this study using a questionnaire where most items focus on the biological mechanisms of chronic pain (Catley et al., 2013). Examples of these items include "when you are injured, special receptors convey the danger message to your

spinal cord", "nerves adapt by increasing their resting level of excitement", "nerves adapt by making ion channels stay open longer", and "descending neurons are always inhibitory". While some items capture the way clients conceptualize their pain, for example "pain occurs whenever you are injured", "when you injure yourself, the environment that you are in will not affect the amount of pain you experience, as long as the injury is exactly the same", and "chronic pain means an injury hasn't healed properly", pain neurophysiology knowledge scores may not systematically co-vary with negative pain beliefs or cognitions. That is, clients who learn more about their pain may not necessarily experience comparable improvements in negative pain cognitions such as catastrophizing and pain related anxiety. This is not to say that exposure to PNE does not cause reductions in negative pain cognitions. However, increases in pain knowledge do not directly predict these improvements.

Moseley (2004) suggested that Pain Neurophysiology Education (PNE) aims to provide sufferers with an understanding of the neurophysiology of pain rather than directly targeting their cognitive responses to pain. However, the single available study measuring pain knowledge alongside cognitive variables (Meeus et al., 2010) found that while pain knowledge and rumination increased significantly more following a PNE session than a control education session, pain thresholds, and most pain beliefs (i.e. kinesiophobia, pain coping and the helplessness and magnifying subscales of the pain catastrophizing scale) did not. The results of Meeus and colleagues' (2010) study and of the current study indicate that clinical improvements can occur after PNE, but it is not necessarily a specific treatment effect from the content of the session. Similarly to the current study, increases in pain knowledge did not systematically vary alongside cognitive or clinical changes in Meeus and colleagues' (2010) work.

Despite the lack of evidence for pain knowledge as a process variable, pain neurophysiology education may be an effective therapy for a number of other reasons. Perhaps most convincingly, the mechanism behind PNE may be a deep learning that is not systematically related to pain knowledge but is related to good outcomes.

Deep learning is associated with a reconceptualization of pain (Moseley, 2004; Nijs, Paul van Wilgen, Van Oosterwijck, van Ittersum, & Meeus, 2011), perhaps as less threatening and as a sensation that is not directly linked to tissue damage. While deep learning is proposed to be associated with improved knowledge (Nijs et al., 2011) and a retention and understanding of pain neurophysiology information (Moseley, 2004), it is possible that this deep learning and subsequent reconceptualization can take place without a similar increase in pain knowledge. PNE may lead directly to improvements in pain beliefs and in negative cognitive variables for some clients without a concurrent and similar increase in pain knowledge. In these cases, the process variable implicated with interdisciplinary pain management that includes PNE may be a cognitive variable usually targeted by cognitive behavioural approaches (i.e. catastrophizing or pain related anxiety), which have shown evidence as process variables in interdisciplinary programs in the past (Burns et al., 2003; McCracken & Gross, 1998).

Another possible explanation for clinical improvements following PNE may be nonspecific factors; organizational factors such as high levels of treatment contact or the structure of the program (Bruehl, 2006). There is some evidence for these nonspecific factors in the content analysis of the BKU, described in the results section and reinforced in the paragraph below. More research needs to be conducted on pain neurophysiology classes to replicate limited findings that PNE is effective in improving clinical outcomes in the context of an

interdisciplinary program and to determine the mechanism of change in these classes, whether they are cognitive factors or nonspecific ones.

Although pain knowledge was not found to be a significant process variable, the PNE courses should not be abandoned because they clearly have some value for clients. Participant feedback on the pain neurophysiology education session demonstrated high satisfaction with the class - 79% felt it was valuable for managing pain, and many reported that the class had a personal impact on their pain experience. The majority (44%) of participants had no barriers to taking in knowledge presented in the class, and most (94%) indicated that they had no barriers to use the knowledge presented. The most commonly reported barriers to knowledge intake were pain severity and use of pain medication. Lack of sleep was an unanticipated barrier most commonly freely provided by participants, and should be considered by clinicians as an important factor in the treatment of chronic pain (Garven et al., 2011); sleep problems are often reported for patients on the waiting list for multidisciplinary treatment (Choinière et al., 2010). Despite these few barriers, there were many positive messages about the PNE from participants, unexpectedly that the class may have improved rapport with staff. These results support nonspecific factors as a candidate for an essential part of pain neurophysiology education.

The results of this study suggest that PNE should be retained, as "carving out" certain treatment components as a cost savings measure is associated with compromised outcomes (Robbins et al., 2003). Despite this, extra resources may be better allocated to other program components rather than to increasing pain knowledge. More research must be conducted to determine important process variables for interdisciplinary pain management, with special attention to any process variables that are systematically and specifically related to PNE.

This study is not without limitations. Perhaps most important is the lack of an adequate control group. With a quasi-experimental study design, it is difficult to determine whether there is a causal association between the intervention and outcome variables. Specifically, alternative explanations for changes in the outcomes are not explored as a part of the study design (Harris et al., 2006). The choice of outcome measures was limited for this study, and many important behavioural outcomes such as return to work were not analyzed. RTW is a major focus of this pain management program and many others, and may have seen substantial improvements if included as an outcome in this study. Detailed information about pain location was not ascertained, and may have been an important predictor of pain or descriptor of this sample. Education status was not collected for a significant portion of the sample, and was not able to be used as a demographic predictor.

Investigating process variables is a valid way to determine essential mechanisms of change in interventions, but results that support process variables do not necessarily support program components that target them. Any conclusions drawn by the predictive value of the process variable pain knowledge do not directly translate to the pain education classes – although it seems valid that PNE should increase pain knowledge, it is possible for clients to gain knowledge from any other part of the program, and for the PNE class to impact a different process variable much more (e.g. pain anxiety). While this study lends support to the fact that pain knowledge is not an essential mechanism of change in this interdisciplinary pain management program, firm conclusions about the PNE sessions cannot be made based on the results of this study. Additionally, the Neurophysiology of Pain Questionnaire – Revised (Catley et al., 2013) is a new tool, and its psychometric properties have not been investigated in an independent sample. The BKU questionnaire was designed specifically for this study and

although it underwent consistent revision throughout the study period, it was not validated and has not been used in another sample.

Despite these limitations, this study used validated and recommended outcome measures for the primary outcomes, and well-designed non-RCT studies do have value to increase understanding effectiveness of different chronic pain treatments (Okifuji, 2003).

Chapter 3: Conclusion

3.1 Program Recommendations

The results of this study indicate that this particular population improves on a number of important variables following completion of the interdisciplinary pain management program at OrionHealth Vancouver. It would be beneficial to implement a similar program (as described in this document) in similar populations with outcomes being tracked to assure replicability.

OrionHealth Vancouver should retain the PNE classes, as many clients found the classes valuable. As well, they add to the active and organized structure of the program. However, resources should not be focused on increasing pain knowledge in these classes, and instead should be spent on the organizational/nonspecific factors that clients report as beneficial. The BKU should continue to be collected, with special attention paid to responses that indicate parts of the classes that clients found helpful, in order to tailor the PNE sessions to best benefit clients, and to uncover additional candidates for process variables in interdisciplinary pain management.

In addition to the outcomes collected for this study, the administrative staff at OrionHealth should continue to collect and report behavioural and cognitive variables that align with their program goals, such as work status, return to activity, physical function, and pain-related anxiety. These should be collected in at assessment and discharge (as they are currently) and in long-term follow up (e.g. 1 year). Pain related variables (e.g. pain severity, pain interference) should be investigated to see if they improve later after discharge, once cognitive and behavioural pain management techniques are maintained.

3.2 Future Directions

Future studies should collect outcomes suggested in the preceeding section, with special attention to the addition of cognitive and behavioural outcome variables alongside the outcomes

suggested by IMMPACT (Dworkin et al., 2005). As outlined in the discussion section, future research should investigate the following: unique characteristics of substantial (pain severity) improvers in interdisciplinary pain management programs, long term outcomes in similar populations following discharge from a pain management program, the effectiveness of PNE in the context of interdisciplinary programs, and significant process variables in PNE and in interdisciplinary programs in general.

3.3 Conclusions

Chronic pain patients with relatively short-term chronic pain and workers compensation referrals significantly improved their pain severity and pain interference and substantially decreased their depression and opioid intake after completion of an intensive 6-week interdisciplinary pain management program. Pain knowledge does not appear to be a significant process variable to predict changes in clinical outcomes for this sample. However, Pain Neurophysiology Education may be an essential interdisciplinary program component that leads to changes in cognitive process variables associated with CBT such as pain catastrophizing and pain related fear, or unique benefits from the PNE sessions may be attributed to a nonspecific treatment effect. Further research must be conducted to determine whether additional behavioural variables improve in this population following participation in the interdisciplinary pain management program, if PNE is an essential program component, and which, if any, process variables are associated with PNE.

The results of this study provide further support for interdisciplinary pain management for chronic pain in a unique sample, do not support pain knowledge as an important process variable, raise important considerations about pain neurophysiology education, and provide patient perspectives on PNE.

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Appendix

Appendix A

A.1 BKU V1. Developed February 2013.

Pain Neurophysiology Educational Feedback

Instructions

This questionnaire is about your experience with the pain neurophysiology education sessions. Your answers will be kept confidential, and will be used to help us improve our education sessions.

Questionnaire

1. I feel that the information and techniques learned in these sessions will be valuable in managing my pain.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

2. There were factors that prevented me from <u>taking in</u> the information presented in these sessions

- ☐ Yes
- ☐ No

  If no, check any of the factors below that may have prevented you from <u>taking in</u> the information provided in these sessions

  - ☐ It was not compatible with my learning style (not enough/too much visual, audio, physical, social, or verbal presentation of information)
  - ☐ The environment was too distracting (room size, noise in room, interpreters present, etc.)
  - ☐ The session was held at an inconvenient time of day (too early/too late to focus)
  - ☐ The language was too difficult to follow
  - ☐ I don't have the appropriate background knowledge to understand the concepts
  - ☐ My pain medication interfered with my ability to concentrate
  - ☐ My pain intensity interfered with my ability to concentrate
  - ☐ The dynamics of this group weren't conducive to my learning
  - ☐ I prefer not to learn in groups
  - ☐ I used a translator, and using a translator made it difficult to take in the information
  - ☐ There was too much information
  - ☐ I already knew the information

☐ There were no barriers to taking in the information

☐ Other: _____

3. I'm likely to use the information provided in these sessions

☐ Yes

☐ No

If no, check any of the factors below that may prevent you from using the information provided in these sessions

- ☐ I don't agree with the techniques/information presented
- ☐ I don't think the information was valuable
- ☐ I don't want to use information that did not come from my primary physician
- ☐ I believe this information is not useful because I am awaiting a medical intervention to relieve my pain
- ☐ My family and friends believe that rest and medicine is the best treatment for my pain
- ☐ The information wasn't applicable to my experience with pain
- ☐ I am not interested in using these techniques to manage my pain
- ☐ I already have a pain management method

☐ Other: _____

4. Do you have any additional comments about the two pain neurophysiology sessions you would like to share?

_____

_____

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A.2 BKU V2. Revised June 2014.

PAIN NEUROPHYSIOLOGY EDUCATION FEEDBACK

Instructions:
This questionnaire is about your experience in the Pain Neurophysiology Education sessions. Your answers will be kept confidential, and will be used to help us improve our education sessions.

Questionnaire:

1. **I feel that the information presented in these Pain Neurophysiology sessions will be valuable in managing my pain.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

2. **Factors which prevented me from fully taking in the information included: (Please tick any that apply).**

- ☐ **The language was too difficult to follow.**
- ☐ **The material was too difficult to follow.**
- ☐ **The presentation did not fit with my learning style.**
- ☐ **My pain medication interfered with my ability to concentrate.**
- ☐ **My pain intensity interfered with my ability to concentrate.**
- ☐ **I prefer not to learn in a group setting.**
- ☐ **I used a translator and this made it difficult to understand or keep up with the information presented.**
- ☐ **There was too much information.**
- ☐ **Other factors _____**
- ☐ **There were no factors preventing me from fully taking in the information presented.**

3. **I plan to use the information provided in these sessions:**
   - ☐ **YES**
   - ☐ **NO**

If no, please check any comments which apply.

- ☐ **I don't agree with the information presented.**
- ☐ **I don't want to use information what did not come from my own physician.**
- ☐ **My family/friends believe that rest and medicine is the best treatment for me.**
- ☐ **The information presented was not applicable to my pain or situation.**
- ☐ **I already have a pain management method that works for me.**
- ☐ **I am awaiting a medical intervention to relieve my pain.**
- ☐ **Other_____**

Do you have any other comments regarding the two Pain Neurophysiology education sessions that you would like to share.

_____

_____

_____

A.3 BKU V3. Revised Feb 2015.

PAIN NEUROPHYSIOLOGY EDUCATION FEEDBACK

Instructions:

This questionnaire is about your experience in the Pain Neurophysiology Education sessions. Your answers will be kept confidential, and will be used to help us improve our education sessions.

1. I feel that the information and techniques learned in these sessions will be valuable in managing my pain.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

2. Please tick all that apply:

Understanding the Information

- ☐ The language was too difficult to follow.
- ☐ The material/concepts were too difficult to follow.
- ☐ My pain medication interfered with my ability to concentrate.
- ☐ My pain intensity interfered with my ability to concentrate.
- ☐ I used a translator and this made it difficult to understand or keep up with the information presented.
- ☐ There was too much information presented.
- ☐ Other factors stopped me from fully understanding the information:

_____

Using the Information

- ☐ I plan to use the information provided in these sessions.
- ☐ I will not use the information presented because it was not applicable to my pain or situation.
- ☐ I will not use the information presented because I am awaiting a medical procedure to relieve my pain.
- ☐ I will not use the information presented for a different reason:

_____

3. <u>What Worked:</u> What aspects of the education sessions helped you understand the information provided?

_____

_____

_____

_____

4. Do you have any other comments regarding the two Pain Neurophysiology education sessions that you would like to share?

_____

_____

_____

_____