Changes in Clinical Status after Completion of an Interdisciplinary Pain Management Programme Incorporating Pain Neurophysiology Education

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ABSTRACT

Purpose: The purpose of this study was to observe the clinical outcomes of people who completed a 6-week outpatient interdisciplinary pain management programme and to determine whether a change in pain knowledge predicts these clinical outcomes (pain interference, pain severity, depression, and opioid intake). **Method:** A single-group, pretest–posttest analysis was conducted on data from 102 participants; five *t*-tests and three hierarchical multiple regressions were carried out. **Results:** Participants experienced significant improvements in pain knowledge, pain interference, pain severity, depression, and opioid intake between intake assessment and discharge, but change in pain knowledge did not significantly predict any clinical outcomes. **Conclusions:** This study provides valuable evidence to inform interdisciplinary pain management. Knowledge of pain neurophysiology, despite its potential contribution to positive clinical outcomes, did not predict clinical success. Psychosocial factors are proposed as a candidate for effectiveness of the pain neurophysiology education classes.

Key Words: chronic pain; pain management; patient education.

RÉSUMÉ

Objectif : la présente étude visait à observer les résultats cliniques de personnes qui avaient suivi un programme ambulatoire interdisciplinaire de gestion de la douleur de six semaines et à déterminer si des modifications aux connaissances sur la douleur permettaient de prédire ces résultats (interférence à la douleur, gravité de la douleur, dépression et prise d'opioïdes). **Méthodologie :** les chercheurs ont procédé à une analyse prétest-posttest auprès d'un seul groupe de données provenant de 102 participants. Ils ont effectué cinq tests de Student et trois régressions hiérarchiques multiples. **Résultats :** les participants ont beaucoup amélioré leurs connaissances sur la douleur, l'interférence à la douleur, la gravité de la douleur, la dépression et la prise d'opioïdes entre le moment de leur évaluation lors de leur hospitalisation et leur congé, mais ces connaissances n'ont pas été des prédicteurs significatifs de leurs résultats cliniques. **Conclusions :** la présente étude fournit des données précieuses pour corroborer la gestion interdisciplinaire de la douleur. Les connaissances sur la neurophysiologie de la douleur, malgré son apport potentiel à des résultats cliniques positifs, n'étaient pas des prédicteurs d'une réussite clinique. Les facteurs psychosociaux pourraient être proposés comme des éléments pour assurer l'efficacité des cours sur la neurophysiologie de la douleur.

Pain is a complex perceptual experience, commonly defined as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.”^{1(p.210)} A widespread issue for Canadians, pain is often poorly managed.² Currently available treatments rarely resolve symptoms completely,³ and many (e.g., pharmacological treatments, surgery) target only the biological aspects of pain and are associated with negative side effects.⁴

Interdisciplinary pain management (IPM)—whereby services from a variety of health care professionals are coordinated toward one goal⁵—has gained significant support in the past 15 years. IPM uses the bio-psychosocial

model of pain⁶ to address the multidimensional nature of pain and its consequences, focusing especially on psychological, social, and environmental determinants. A conservative treatment with few adverse events,⁴ it is the treatment approach recommended by the International Association for the Study of Pain for patients with chronic pain of all etiologies.⁷ In many clinics, IPM yields favourable outcomes for depression,⁸ anxiety,⁹ quality of life¹⁰, severity of pain,¹⁰ physical functioning,¹¹ and use of health care resources.⁹ Components of an IPM programme can include physical rehabilitation, exercise therapy, cognitive restructuring, behavioural treatment, vocational rehabilitation, and drug management.³

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The optimal programme structure and components have not been established, and programmes with various structures have shown clinical effectiveness. Closely tied to essential programme components are process variables, which are patient behaviours or cognitions that are the essential elements of a positive treatment outcome in IPMs.¹² Significant process variables reveal “critical or pivotal changes that determine improvement from treatment.”^{12(p.180)} For example, improvements in pain-related anxiety, catastrophizing, and helplessness have been found to predict improved clinical outcomes (including pain interference, pain severity, depression, and general activity) in interdisciplinary chronic pain management.^{12,13}

Pain knowledge, specifically knowledge of the neurophysiology of pain, is a plausible process variable to predict positive outcomes in interdisciplinary treatment. Pain neurophysiology education (PNE), introduced to complement physical therapy for chronic pain,¹⁴ targets pain knowledge and may be an essential component of IPM programmes. Few studies have investigated the effectiveness of PNE; two recent reviews reported the results of only two and eight studies on the topic, respectively.^{14,15} Even so, there is promising evidence that PNE leads to improvements in return to work (RTW), physical performance, disability, and pain,^{12,13,16} both alone and in the context of a pain management programme. More important, PNE is associated with improvements in maladaptive pain beliefs such as catastrophizing and perceived disability.^{12,14} The rationale of PNE is to allow patients to increase their understanding of chronic pain and to reconceptualize pain by explaining the neurobiology and neurophysiology of pain.^{15–17} Explaining pain to patients alters their negative pain beliefs, such as the perception of nociceptive input as threatening; this can lead to an increased pain threshold or decreased somatic vigilance (vigilance or attentiveness to somatic inputs).¹⁸ Although patients are able to substantially increase their knowledge through a PNE session,¹⁹ whether changes in pain knowledge predict clinical outcomes has not been established. Therefore, pain neurophysiology knowledge is a potential process variable to investigate in the context of IPM.

OrionHealth Vancouver, the setting for this study, is a rehabilitation centre that offers an IPM programme, which is referred to at the clinic as the Pain Management Program. The core interdisciplinary component typically takes place over 6 weeks, with options for extension. As part of the programme, patients receive daily education sessions, including two 90-minute classes on pain neurophysiology.

We selected OrionHealth Vancouver as the setting for this study because it is one of the few clinics in Vancouver that offers an IPM programme. We collected de-identified data from OrionHealth patient charts during the study period of June 30, 2014–June 1, 2015. Our study had two primary purposes: first, to measure internationally recommended clinical outcomes for the OrionHealth

Vancouver Pain Management Program; second, to investigate whether changes in pain knowledge predict these outcomes.

METHODS

Ethics review

The University of British Columbia Clinical Research Ethics Board granted ethical approval for our study. Patient consent was required to enroll in the OrionHealth Vancouver Pain Management Program but not to be included in the study because the investigators had secondary access to non-identifiable data only.

Study design

We conducted a retrospective chart review examining the relationship between clinical outcomes and change in pain knowledge, using chart data that included responses to questionnaires collected by the assessing or treating clinicians at OrionHealth Vancouver. We had no contact with the clinical population, and all identifying information was removed from the chart data. Data were collected at initial assessment and at discharge. The term *assessment* refers to the interdisciplinary intake assessment and triage that takes place at OrionHealth Vancouver before admission. The goal of the assessment is to determine as an interdisciplinary team whether the client is appropriate for the programme. Once admitted, clients begin the Pain Management Program. There can be a delay between assessment and programme commencement depending on a variety of factors (i.e., referrer approval, pending medical clearance, client-specific issues). “Discharge” data are collected at the end of each patient’s time in the programme.

Programme description

This Pain Management Program at OrionHealth Vancouver focuses on physical and functional restoration, providing skills and strategies to manage pain and increase participation in vocational, recreational, and social activities. There is also a focus on medication management, sleep hygiene, education, and psychological wellness. The programme uses the bio-psychosocial model, emphasizing RTW as a determinant of health and a primary goal. All staff (case coordinator, psychologist, occupational therapist, physical therapist, kinesiologist, pharmacist, and physician) work together under one roof on the same patient file, practise ongoing communication, and coordinate their services toward the same goals. Some programme components are delivered in a group setting (e.g., pain education, exercise sessions); others are tailored according to individual assessments and are delivered one-on-one. The broader goals of the programme are individualized to each person’s specific situation through ongoing, collaborative goal setting.

Patients attend the clinic from Monday through Friday, 9:00 a.m.–3:00 p.m., with a 1-hour lunch break at noon, for a total of 150 clinic hours over the course of two

modules. Patients spend up to 3.5 hours per day, over three sessions, performing their physical programme in a fully equipped gym under the supervision and guidance of a kinesiologist, a physical therapist, and an occupational therapist. Each patient's individualized exercise programme is developed on the basis of the initial assessment findings; in general, the programme includes stretching, strengthening, cardiovascular conditioning, and work simulation, applying the principles of specific, measurable, achievable, realistic, and timely (SMART) goals set collaboratively by clinicians and patients to design the programme. Exercises are initiated gradually and at a lower intensity level than determined during the initial assessment to develop participants' confidence and their comfort with the daily routine.

A group walk and morning activation and stretch class begins each programme day. Typically, patients complete three sets of their exercises over the duration of their gym time; the number of repetitions is determined by the goal for each muscle group, either increasing endurance (higher repetitions, lower resistance) or increasing strength (lower repetitions, higher resistance). Programme participants are encouraged to pace activities and incorporate micro-breaks. Exercise progression is based on frequent physical reassessments, observations, and review of the tracking sheets on which participants record their activity. These sheets include both pictures and a written description of the prescribed exercises and can be used as one indication of adherence to the exercise programme. Patients receive ongoing psychological supports to address issues such as kinesiophobia and fear of re-injury; the psychologist often works individually with patients in the gym to address these barriers.

Patients attend 1-hour classes on rotating topics four times per week. These classes are led by the psychologist, the occupational therapist, the physical therapist, and the kinesiologist. 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 RTW. Topics change on a regular basis as part of the clinic's ongoing improvement efforts. Twice during the programme, patients attend a 90-minute PNE class; these classes are a focus of this study.

Pain management programme population

Patients in the OrionHealth Vancouver Pain Management Program have a variety of diagnoses, including myofascial pain, other musculoskeletal pain, neuropathic pain, mixed pain, psychological diagnoses (pain disorder), and complex regional pain syndrome.

Inclusion criteria

De-identified charts from all patients who completed and were discharged from the programme during the study period (June 30, 2014–June 1, 2015) were reviewed

by the investigators. The included charts were for patients who (1) met the programme-specific enrollment criteria, (2) enrolled in and completed that programme and were therefore exposed to the PNE sessions, and (3) completed any or all of the questionnaires analyzed in this study. During the study period, the programme's enrolment criteria were as follows: agreement of the interdisciplinary team (physician, psychologist, physical therapist, occupational therapist, and pharmacist), after a 2-day interdisciplinary assessment, that the patient could benefit from an interdisciplinary intervention; patient's consent to participate in the programme; patient's medical stability, as assessed by a physician; patient's psychological stability; and the presence of difficulty with coping with pain or the existence of psychosocial barriers to returning to work that could not be adequately addressed by an occupational rehabilitation (OR) programme. OrionHealth Vancouver offers an OR programme at the same facility and uses an interdisciplinary model of treatment of more acute work-related injuries.

The programme has no defined cutoff for time since injury. Patients may be admitted because of significant psychosocial risk factors that put them at risk for developing chronic pain, as determined by the programme staff. Even though chronic pain is usually considered to be pain that lasts a minimum of 3 months, we chose to include all participants regardless of pain duration, because pain duration is not part of the OrionHealth Vancouver Pain Management Program's enrollment criteria. When patients are admitted to the programme within 3 months of injury, it may be because a workers' compensation source referred them directly for irritation of a prior injury or because treatment in an OR programme revealed patient-specific barriers to success, risk factors for chronic pain, or both. For the purposes of our study, we chose to include all programme completers who met the admission criteria, because we expected that all admitted patients would have pain beliefs or conceptualizations of pain that would be appropriately addressed by an interdisciplinary programme including PNE.

Exclusion criteria

Data for patients who did not meet the programme's inclusion criteria were not used in the study. During the study period, patients were not eligible for the programme if they required additional medical intervention or investigation, engaged in behaviour that would interfere with the programme, or were being treated with injected opioids.

Variables

All quantitative outcome measures were assessed at programme intake and discharge. Primary outcome measures (Table 1) were depression (Beck Depression Inventory [BDI]);²¹ pain severity²² (Brief Pain Inventory [BPI], item 5); pain interference (BPI), which measures how much pain interferes with a variety of daily activities;²²

Table 1 Primary and Secondary Outcome Measures Used in This Study

Outcome	Name of Measure	MCID	Author (Year)
Depression	BDI	5-point change ²⁰	Beck et al. ²¹
Pain interference	BPI (Pain Interference subscale)	1-point change ²⁰	Cleeland ²²
Pain severity	BPI (item 5, average pain)	10% change ²⁰	Cleeland ²²
Pain knowledge	NPQ–R	Not available	Catley et al. ²³
Opioid intake	MEQ	Not available	WorksafeBC ²⁴

MCID = minimal clinically important difference; BDI = Beck Depression Inventory; BPI = Brief Pain Inventory; NPQ–R = Neurophysiology of Pain Questionnaire–Revised; MEQ = morphine-equivalent dose.

Table 2 Continuous Demographic Characteristics of All Participants and by Pain Severity Improvement Status

Characteristic	Total sample (<i>n</i> = 102)		By pain severity improvement status			
	Mean (SD)	Median (IQR)	≥30% (<i>n</i> = 16)		≥50% (<i>n</i> = 16)	
			Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Age, y	45.9 (11.7)	–	45.44 (12.5)	–	44.8 (13.8)	–
MEQ pre, mg/d	15.4 (30.4)	0.0 (14.3)	20.45 (37.4)	0.0 (26.3)	21.6 (38.1)	0.0 (30.0)
Time since injury, mo	22.3 (52.8)	8.0 (13.25)	17.88 (26.6)	8.5 (10.5)	16.3 (24.0)	9.0 (10.0)

IQR = interquartile range; MEQ = morphine equivalent.

and pain knowledge (Neurophysiology of Pain Questionnaire—Revised [NPQ–R]).²³ The first three outcomes, their minimal clinically important difference (MCID) values, and the items used to evaluate them were chosen according to recommendations of the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT).²⁵ In addition to primary outcome measures, we recorded demographic information (Tables 2 and 3), programme start and end dates, and completion status for all participants.

Beck and colleagues²¹ validated the BDI by comparing inventory scores with independent clinical ratings, and its reliability (internal consistency and stability) was confirmed. The BPI has been validated in several studies, including studies with chronic pain populations, and both subscales (Pain Severity and Pain Interference) have demonstrated high test–retest and alternate form reliability.²² IMMPACT has recommended using a numerical pain rating scale (NPRS) to measure pain intensity;²⁵ we captured this outcome using BPI item 5. A more recent review of three pain measures reports that the NPRS has moderate to high test–retest reliability and excellent concurrent validity with the visual analogue scale.²⁶ The original Neurophysiology of Pain Questionnaire has demonstrated good psychometric properties, including acceptable internal consistency and good test–retest reliability.²³ The NPQ–R, used in our study, has only 13 items²³ because 7 poorly functioning items were removed to improve the psychometric properties of the questionnaire.

IMMPACT has recommended reporting programme completers who improve on the BPI Pain Severity subscale (item 5) by increments of 30% and 50% (representing moderate and substantial improvements in pain, respectively).²⁵ IMMPACT has also recommended use of rescue analgesics as a secondary outcome measure; we captured this outcome as oral morphine equivalent dose (MEQ; mg/day).²⁵ Our MEQ calculations are consistent with conversions used by the clinic's primary referrer.²⁴ All opioid analgesics were recorded by the pharmacist, and we converted these into an MEQ score for each patient.

Statistics

To compare baseline and discharge values for pain severity, pain interference, depression, pain knowledge, and opioid intake, we used five paired *t*-tests (analysis 1). To determine whether changes in pain knowledge can predict improvements in clinical outcomes over and above demographic variables, we conducted three hierarchical multiple regressions, with pain knowledge change and demographics as predictors at different steps (Analysis 2). Pretreatment (assessment) outcome variables were entered at step 1, demographic variables at step 2, and changes in pain knowledge (the independent variable of interest) at step 3. The dependent variable in each case was posttreatment (discharge) outcome.

Quantitative data were analyzed using IBM SPSS Statistics version 19 (IBM Corp., Armonk, NY). Statistical assumptions were tested and met for each *t*-test and regression.

Table 3 Categorical Demographic Characteristics of All Participants and by Completion Status and Improvement Status for Those Who Completed the Programme

Characteristic	Pain severity improvement status, no. (%)		
	Completed (<i>n</i> = 102)	≥30% (<i>n</i> = 16)	≥50% (<i>n</i> = 11)
Gender			
Male	57 (55.9)	10 (62.5)	7 (63.6)
Female	45 (44.1)	6 (37.5)	4 (36.4)
Language			
English	75 (73.5)	11 (68.8)	7 (63.6)
Other	20 (19.6)	2 (12.5)	1 (9.1)
Missing	1 (1)	0 (0)	0 (0)
>1 including English	6 (5.9)	3 (18.8)	3 (27.3)
>1 excluding English	0 (0)	0 (0)	0 (0)
Interpreter			
Yes	9 (8.8)	1 (6.3)	1 (9.1)
No	93 (91.2)	15 (93.8)	10 (90.9)
Education			
Some primary (1–7)	2 (1.9)	0 (0)	0 (0)
Some secondary (8–11)	11 (10.8)	0 (0)	0 (0)
Completed secondary	29 (28.4)	7 (43.8)	4 (36.4)
Some post-secondary	3 (2.9)	1 (6.3)	1 (9.1)
Completed post-secondary	31 (30.4)	3 (18.8)	1 (9.1)
Other	2 (2.0)	0 (0)	0 (0)
Missing	24 (23.5)	5 (31.3)	5 (45.5)
Referrer			
WorkSafeBC	96 (94.1)	15 (93.8)	10 (90.9)
Other	6 (5.9)	1 (6.3)	1 (9.1)
Pain site*			
Cervical	7 (6.9)	1 (6.3)	0 (0)
Upper shoulder, upper limbs	76 (74.5)	6 (37.5)	5 (45.5)
Thoracic region	7 (6.9)	0 (0)	0 (0)
Low back, lumbar spine, sacrum, coccyx	46 (45.1)	7 (43.8)	4 (36.4)
Lower limbs	30 (29.4)	3 (18.8)	2 (12.5)
>3 major sites	13 (12.7)	2 (12.5)	2 (12.5)

Note: Percentages may not total 100 because of rounding.

*Participants could list >1 pain site, so percentages will exceed 100.

We excluded different subsets of participants from analyses on a test-by-test basis: Participants for whom we did not have sufficient data to conduct a given test were excluded from analysis of that test only. Data for depression were considered sufficient if the participant answered all BDI questions. Pain severity was measured with one item, so data were considered sufficient if that item was answered. Data for pain interference were considered sufficient if more than 50% of the questions were answered.²³ Pain knowledge data were considered sufficient if at least 10 of 13 NPQ–R items were answered. No imputations were conducted because we could not be confident that data were missing at random. If a participant was missing between 1 and 3 items on the NPQ–R, 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 using items that were answered.

A common definition of chronic pain is pain that lasts 3–6 months or more,¹ but OrionHealth Vancouver (and

therefore this study) does not require patients or participants to have experienced pain for a specified period. With the common definition in mind, we conducted a sensitivity analysis for all *t*-tests and regressions by including only patients injured at least 3 months before admission; patients with pain of less than 3 months duration at admission (*n* = 6) were excluded. With one exception, all results of the sensitivity analysis were in line with those of the whole-group analyses and are therefore not reported. The exception, change in pain severity, is reported in the Results (analysis 1).

Sample size

Initially, we estimated the minimum sample size for the proposed analyses using effect sizes from a similar study that used pain-related anxiety as a final predictor in a hierarchical regression model.⁸ With a power of 0.80, an α of 0.05, and seven predictors in total and using G*Power software,²⁰ the minimum sample size for this study was determined to be 51 participants. However, in anticipation of incomplete charts and based on common

Table 4 Descriptive Statistics and *t*-Test Results for Primary Outcome Variables and Opioid Intake

Variable	Mean (SD)		Pre-post change, mean (95% CI)	<i>t</i> (df)	<i>p</i> -value
	Assessment	Discharge			
Pain knowledge	4.59 (2.12)	6.27 (2.48)	1.68 (1.16, 2.21)	6.337* (91)	<0.001
Depression	21.31 (10.78)	16.07 (9.68)	−5.24 (−7.37, −3.10)	−4.868* (80)	<0.001
Pain severity	5.84 (1.73)	5.41 (1.98)	−0.43 (0.85, −0.01)	−2.038† (96)	0.044
Pain interference	6.76 (1.86)	5.87 (2.45)	−0.89 (1.30, −0.46)	−4.175* (96)	<0.001
Morphine equivalent intake‡ (mg/day)	13.27 (26.49)	9.61 (27.10)	−3.66 (−6.26, −1.05)	−2.781§ (98)	0.006

* $p < 0.001$.† $p < 0.05$.‡ Results of the *t*-test including all participants who provided data, including $n = 52$ with 0 recorded morphine-equivalent dose at intake and at discharge.§ $p < 0.01$.

sample sizes in similar research,^{8,9,16} we aimed instead to collect data for 100 programme completers.

RESULTS

Demographics

The characteristics of the study sample are shown in Tables 2 and 3. Of note, participants who experienced moderate or substantial improvements in pain severity appear to have had slightly higher opioid intake at assessment than the total group of enrolled participants. For the entire sample of 102 patients, the number referred by a workers compensation board was 96, average time since injury was 22 (median 8) months. Not included in the tables is our finding that 89% of the total sample had been injured less than 3 years before assessment, many (28%) had been injured between 3 and 6 months before assessment, and 6% had been injured less than 6 months before assessment.

Analysis 1: change in clinical status

The results of statistical analysis 1 are presented in Table 4 and Figure 1. Of a total of 102 patients, 92 completed the necessary components for the pain knowledge variable, 81 for the depression variable, 97 for the pain severity variable, and 97 for the pain interference variable. Improvements were clinically significant for depression but not for pain severity or pain interference.

Pain knowledge

Participants increased their pain knowledge scores by an average of 1.68 points (95% CI: 1.16, 2.21), or 13%.

Depression

Participants decreased their depression scores by an average of 5.24 points (95% CI: −7.37, −3.10), or 8%. Of 81 patients who provided complete data for the depression variable, 27 (26% of all patients) decreased their BDI scores by at least 5 points, meeting the MCID for this measure.²⁵

Pain severity

Participants decreased their scores on BPI Item 5 by an average of 0.43 points (95% CI: 0.85, −0.01), or 7%. Of the 97 participants who provided data for the pain severity variable, 47 (46% of all participants) decreased their pain by at least 10%, the MCID for this measure.²⁵

In the sensitivity analysis (excluding patients with <3 mo of pain), pain severity at discharge did not significantly differ from pain severity at assessment, $t(85) = -1.801$, mean −4.18 (SD 2.16).

Pain interference

Participants decreased their pain interference by an average of 0.89 points (95% CI: 1.30, −0.46), or 13%. Of 97 participants who provided data for the pain interference variable, 46 (45% of all participants) decreased their pain interference by at least 1 point, the MCID for this measure.²⁵

Opioid intake

After an extreme outlier was removed from analysis, assumptions were met for the paired samples *t*-test for opioid intake. With the outlier removed, we performed a *t*-test (results described here), which was confirmed with a non-parametric test on the same data.

Patients significantly decreased their opioid intake ($Z = 3.635$, $p < 0.001$). Median MEQ score was 0 at assessment and discharge, but 35 patients decreased their opioid intake, and 6 increased it. We confirmed this finding with a *t*-test, which found that patients decreased their opioid intake by an average of 3.66 milligrams per day (95% CI: −6.26, −1.05), or 28%.

Analysis 2: change in pain knowledge as a predictor of clinical outcomes

The full details for each regression model are given in Table 5. Neither demographic variables nor change in pain knowledge significantly predicted any clinical outcomes.

Figure 1 Differences in clinical status of program completers at initial assessment and discharge: (a) NPQ-R (Neurophysiology of Pain Questionnaire), $p < 0.01$; (b) BDI (Beck Depression Inventory), $p < 0.01$. (c) BPI (Brief Pain Inventory), pain severity score, $p < 0.05$; (d) BPI, pain interference score, $p < 0.01$; (e) MEQ (Morphine Equivalent Score), $p < 0.01$. Note: Error bars represent CIs that have been adjusted to remove between subject variance.

Predicting depression

Assessment depression scores significantly predicted discharge depression scores ($n = 74$ in this model), but neither adding demographic variables ($n = 69$) nor adding pain knowledge change ($n = 68$) led to a statistically significant increase in R^2 .

Predicting pain severity

Assessment pain severity was the only significant predictor of discharge pain severity ($n = 89$). Neither adding demographic variables ($n = 85$) nor adding demographic variables and pain knowledge change ($n = 84$) significantly increased R^2 .

Predicting pain interference

The pre-programme pain interference assessment score was a significant predictor of post-programme pain interference ($n = 88$). Adding demographic variables ($n = 83$) and pain knowledge change ($n = 82$) did not significantly increase R^2 .

DISCUSSION

This study examined the potential relation between changes in pain knowledge and changes in clinical outcome variables in 102 participants who completed an IPM programme that incorporated pain education.

Regarding the demographic results, further research is needed to determine whether the difference in opioid intake at assessment between the entire sample and those who experienced moderate and substantial improvements in pain severity is significant; to discover whether those who substantially improved have additional, unique characteristics; and to determine the significance of higher opioid intake at assessment. A few additional points stand out after investigation of the entire sample's demographic and background variables.

First, almost all patients in this sample (94.1%) were referred to the programme by a workers' compensation board. Second, the time since injury in this sample (mean = 22 mo, median = 8 mo) was short relative to

Table 5 Hierarchical Multiple Regression Analyses Predicting Outcome Variables from Changes in Pain Knowledge Scores

Predictor	N	B	95% CI for B	R	R ² cum	ΔR^2	F change	Sig of F change (p)
Depression at discharge								
Assessment score	74	0.471	0.307, 0.635	0.557	0.310	0.310	32.786	<.001
Covariates	69			0.595	0.354	0.044	0.923	0.47
Pain severity		−0.315	−1.305, 0.675					
Language		1.034	−2.029, 4.097					
Gender		2.469	−1.204, 6.142					
Time since injury		−0.021	0.052, 0.011					
Age		−0.001	−0.170, 0.168					
Pain knowledge change	68	0.026	−0.769, 0.821	0.595	0.354	0.000	0.004	0.95
Pain severity at discharge								
Assessment score	89	0.428	0.215, 0.641	0.392	0.154	0.154	15.987	<0.001
Covariates	85			0.427	0.182	0.029	0.734	0.57
Language		−0.556	−1.235, 0.124					
Gender		0.092	−0.682, 0.867					
Time since injury		−0.002	−0.009, 0.005					
Age		0.002	−0.035, 0.038					
Pain knowledge change	84	−0.071	−0.228, 0.085	0.436	0.190	0.008	0.828	0.37
Pain interference at discharge								
Assessment score	88	0.711	0.475, 0.947	0.541	0.284	0.292	35.916	<0.001
Covariates	83			0.568	0.323	0.031	0.744	0.59
Pain severity		0.008	−0.264, 0.281					
Language		−0.177	−0.972, 0.617					
Gender		−0.204	−1.119, 0.712					
Time since injury		−0.008	−0.016, 0.001					
Age		0.006	0.037, 0.049					
Pain knowledge change	82	−0.065	−0.249, 0.119	0.572	0.327	0.004	0.497	0.48

cum = cumulative; sig = significance.

that of the general population of Canadians with chronic pain in Canada, two-thirds of whom have lived with chronic pain for at least 5 years.²⁵ Finally, duration of pain was also short relative to that of patients in most other IPM programmes in the literature, who have been reported to have had pain for between 3.5 and 10 years on average.^{9,10,16,27} In our study, by contrast, more than one-third of participants had been injured less than 6 months before assessment for the programme.

Our analysis found a statistically significant difference between pre- and post-programme scores for all primary and secondary outcome variables. Participants significantly improved their clinical outcomes (depression, opioid intake, pain severity, pain interference) and pain knowledge over the course of the interdisciplinary programme. Of the primary outcome variables (depression, pain severity, pain interference, pain knowledge), however, only depression showed a clinically significant difference between assessment and discharge scores. No MCIDs are reported in the literature for pain knowledge and the secondary variable of opioid intake, but changes in both these variables were substantial. Of the variables examined in our study, pain knowledge improved the most (37%), followed by MEQ change (28%).

Only 11 and 16 patients, respectively, had a substantial (50%) or moderate (30%) improvement in pain severity.²⁸ For programme completers, the mean decrease in pain severity was small but statistically significant at 7%. The observed reductions in pain severity were low and fell below the range of 14%–60% pain reduction from IPM observed in other studies.²⁵ The results of this study are, however, comparable to those reported for samples with similar demographic characteristics. Gagnon and colleagues²⁹ evaluated the impact of an outpatient IPM in the United States for workers compensation patients that ran for 8 hours per day, 5 days per week, for 4 weeks. In that study, the average time since injury was 3 years (vs. 2.3 years in our study). At the end of treatment, patients experienced decreases in pain of just more than 20%, decreases in depression of 30%–40%, and improvements in RTW of 37%.²⁹ Bosy and colleagues⁸ evaluated the impact of an outpatient interdisciplinary programme (4–6 h/d, 5 d/wk, for 7–8 wk) on outcomes for Canadian chronic pain sufferers, the majority of whom received funding through the Workplace Safety and Insurance Board of Ontario. In that study, mean time since injury was 2.2 years, with a median of 1.5 years (vs. 8 mo in our study). As in our study, patients experienced on average

a small decrease in pain severity (16.4%). Patients also reduced depression by nearly 17% on the Hospital Anxiety and Depression Scale, 61% reduced or eliminated their opioid intake, and 75% of completers made positive changes in their work status.

The goals of the IPM programme described here were to give patients tools to effectively manage their pain in the long term, to increase activity during the programme, and to RTW at discharge. The improvements we observed in cognitive and behavioural variables (e.g., depression, opioid intake), along with the minimal change in pain severity, are in keeping with those of other studies with similar patient groups (i.e., workplace insurance claimants).^{8,29} Teasell³⁰ has reported that workers' compensation status combined with higher pain severity is associated with a longer time to recovery; it is possible that with longer follow-up, we would have seen further improvements in pain severity in our sample. Despite the lack of substantial improvements in pain severity for most of the patients, behavioural and cognitive variables such as depression, opioid intake, and RTW should be considered important outcomes in chronic pain clinical trials to support these results and to align with the goals of interdisciplinary programmes.

Bosy and colleagues⁸ stressed that the goal of IPM is not to decrease pain but to manage pain during activity while focusing on RTW. Although RTW status was not an outcome variable identified in our study, it should be noted that RTW data were positive for study participants. By the end of the programme, 44% had returned to work, either on a graduated RTW basis or having completed their graduated RTW, and 92% of programme completers were discharged as fit for RTW (either with or without limitations). Reasons why those who were deemed fit to RTW did not do so included, but were not limited to, seeking alternate work, early retirement, and returning to school.

Pain interference did not clinically improve after discharge from the programme. This variable should be investigated further in similar samples to determine whether these results are replicable and whether pain interference improves in parallel with pain severity, possibly after cognitive and behavioural variables improve.

Pain knowledge did not significantly predict improvements in any of the clinical outcome variables (depression, pain severity, or pain interference) for programme completers, and so we did not consider it a significant process variable in the context of this study. As in previous research,¹² background and demographic variables were also not significant predictors of outcome variables. The literature has suggested^{18,31} that understanding the biological and physiological mechanisms of chronic pain leads to reductions in kinesiophobia or sense of threat with movement, which are known to predict improvements in clinical outcomes.^{12,13} The results of our study, however, indicate that understanding the biological

mechanisms of pain does not directly improve clinical outcomes and may not predict improvements in pain beliefs. The authors of the NPQ-R have questioned whether the NPQ-R would function better as a measurement of knowledge change or of attitudes and beliefs, rather than both.²³ Explicitly differentiating between pain knowledge (e.g., pain physiology) and pain beliefs (e.g., kinesiophobia, catastrophizing) would be a beneficial emphasis for future research.

Despite the lack of evidence for pain knowledge as a process variable, PNE may be an effective therapy for several other reasons. Perhaps most convincing is that 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 a mechanism applied to the clinical impact of pain education^{18,32} and is associated with a reconceptualization of pain,^{18,32} perhaps as less threatening and as a sensation that is not directly linked to tissue damage. Although deep learning is proposed to be associated with improved knowledge³² and with retention and understanding of pain neurophysiology information,¹⁸ 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 negative cognitive variables for some patients without a concurrent and similar increase in pain knowledge. In these cases, the process variable implicated with IPM that includes PNE may be a cognitive variable usually targeted by cognitive-behavioural approaches (e.g., catastrophizing or pain related anxiety), which have shown evidence as process variables in interdisciplinary programmes in the past.^{12,13} In other words, with exposure to PNE, pain can be appraised as less dangerous without a necessary increase in a biological understanding of the pain process.

Although our findings lend support to the idea that change in pain knowledge was not an essential mechanism of change in this IPM programme, firm conclusions about the utility of the PNE sessions cannot be made on the basis of this study's results. Although it seems likely that PNE should increase pain knowledge, it is possible for patients to gain knowledge from any other part of the programme and for the PNE class to have a greater impact on a different process variable (e.g., pain anxiety).

A further limitation of this study is the sample size. The limitation of our approach to sample size calculation is that the effect size (if any exists) of PNE is unknown. It is possible that a smaller effect exists, and that this would be detected with a larger sample size (i.e., that our study was underpowered). Other limitations that should be kept in mind when weighing the evidence in this report stem from the nature of our study design (retrospective vs. prospective), the fact that we were not able to assess clinical change in people who

did not complete the programme, and our choice not to include data imputation.

CONCLUSION

Patients who completed a 6-week, outpatient IPM programme significantly improved their pain severity and pain interference and substantially decreased their depression and opioid intake. Change in pain knowledge does not appear to be a significant process variable to predict changes in clinical outcomes for this sample. Further research must be conducted to determine whether additional behavioural variables improve in this population after participation in the IPM programme, whether PNE is an essential programme component, and which, if any, process variables are associated with PNE.

KEY MESSAGES

What is already known on this topic

Interdisciplinary chronic pain management programmes have significant support from the literature. However, the optimal structure and components of these programmes are not known.

What this study adds

This study investigated pain neurophysiology education in the context of interdisciplinary chronic pain management and pain neurophysiology knowledge as a process variable, or an essential predictor of clinical success.

The results of this study provide further support for interdisciplinary pain management (IPM) for chronic pain in a unique sample, but do not support pain neurophysiology knowledge as a candidate for the effectiveness of IPM programmes, raising important considerations about pain neurophysiology education.

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