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Original Article

Chronic pain education delivered with a virtual reality headset in outpatient physical therapy clinics: a multi-site exploratory trial

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Abstract: Objective: Chronic pain is multidimensional, requiring expanded interventions for optimal management. Pain education, mindfulness training, and virtual reality (VR) are showing promise, but barriers remain for implementation by clinicians. The purpose of this study was to explore the experiences with a pain education and mindfulness intervention for patients with chronic low back pain and their treating clinicians. Methods: This was a prospectively designed exploratory trial registered at ClinicalTrials.gov: NCT04777877. Patients were identified by study staff and consented. Baseline and follow-up questionnaires and surveys were collected with quantitative and qualitative data. Patients viewed five videos explaining key pain concepts and guided imagery nature videos using a VR headset. Results: Twenty patients consented, and 15 patients completed the intervention. Patients and clinicians rated their experiences with the program as excellent; however, concerns were raised related to logistical challenges around use of the VR headset in busy clinic settings. Percentage changes in patient pain knowledge occurred in the desired direction in 8 out of 9 key concepts. Conclusions: Delivering educational and mindfulness content with a VR headset to patients with chronic low back pain was feasible and acceptable to patients and clinicians. Concerns remain regarding the increased time burden with use of this technology in a busy clinic setting weighed against potential benefits. Alternative delivery methods are needed to reduce logistical challenges and increase patient access to content outside of the clinic setting.

Keywords: Chronic pain, physical therapy, rehabilitation, virtual reality, pain education

Introduction

Have you ever had difficulty progressing, educating, motivating, or empowering a patient experiencing chronic pain? Have you struggled to find the right words, enough time, and the best resources for this complex multidimensional problem? Maximizing functional movement in patients experiencing chronic pain bedevils the rehabilitation process. An inaccurate or incomplete understanding of pain can create a vicious cycle of fear, low motion, and more pain, ultimately contributing to a host of adverse health outcomes including increased medical expenditures, and a decreased quality of life.

To address this challenge, we developed the Change Your Pain video series consisting of educational content paired with guided meditation videos. The intervention coincided with outpatient physical therapy appointments and was delivered using a virtual reality (VR) headset. The primary objective of this study was to explore the feasibility and acceptability of the delivery of pain science education using a VR headset during an outpatient physical therapy course of care for chronic low back pain (CLBP). Our aims were to collect both qualitative and quantitative data regarding: 1) feasibility, specifically the practicality of implementing this intervention in an outpatient physical therapy clinic (drop-out rates, tolerability for the dose

and training mode); 2) acceptability (approval of the educational messaging, guided imagery content, and the VR training mode) of both the content and delivery method from the clinician and patient perspectives; 3) patient attributes to characterize the study population and 4) patient changes in pain knowledge.

Background and rationale

The prevalence and impact of chronic pain in adults in the US is rising. Yong, et al. estimates that 1 in 5 Americans experience chronic pain and that individuals with chronic pain compared to those without report significantly greater limitations in daily functioning, social activities, activities of daily living, and more workdays missed, resulting in an estimated $79.9 billion in lost wages [1].

Increasingly, rehabilitative professionals understand the multi-dimensional nature of chronic pain, acknowledging that consideration must be given to the physiological, cognitive, emotional, and social aspects of the unique pain experience [2]. Concurrently, we recognize the inadequacy of comprehensive professional pain education. In a survey study involving physical therapists who attended pain education continuing education courses, 91% reported not receiving such education in their schooling and 71% reported their need for additional pain education. Additionally, reported barriers to implementation in clinical practice settings can include time constraints, uncertainty around content, patient non-compliance, and fear that the message may be negatively received by patients [3]. Diffusion into the clinical practice setting has been slow. In an informal survey of physical therapists in our hospital-based outpatient network conducted in 2020, we asked physical therapists to identify the top three barriers to implementing pain education strategies in the clinic. The most frequently chosen barrier was not knowing the content well enough. This was followed by non-compliance of patients to recommendations. Time constraints was third. Innovative approaches are needed to augment traditional manual or movement-based strategies. Pain neuroscience education (PNE) utilizing behavioral change is one such validated approach [4-8].

This project was designed as the first steps in implementing pain education strategies in a network of hospital-based outpatient rehabilitation clinics. We developed 5 micro-learning [9-11] videos on key pain topics. Micro-learning focuses on small time units and focused topics, decreasing information overload and promoting enhanced retention [12]. These standardized messages delivered in a systematic way ensured consistency and provided a method of delivery intended to free up clinician time.

Evidence suggests that biopsychosocial interventions delivered during physical therapy care may be more effective than education alone [13]. The patient views and practices the information while receiving support from the physical therapist. Support personnel could deliver the content, freeing the physical therapists' time. The VR head mounted display allows for immersive viewing, improving focus, minimizing distraction, promoting adherence, and reinforcing the message. We developed a workbook with activities and recommendations to enhance the learning process (copies available on request).

VR is an emerging technology showing some promise in addressing pain in various patient populations and settings [14-18]. However, less is known about use of this technology in the context of outpatient clinical care delivery. Additionally, guided imagery may be a useful tool for pain management [19]. The benefits, feasibility, and acceptability of this cognitive behavioral therapy technique which are delivered in an immersive VR headset in a clinical setting are still unknown.

Methods

This study is a prospective multicenter exploratory trial registered at ClinicalTrials.gov: NCT04777877. Ethics approval was provided by the Mass General Brigham Human Research Committee-Institutional Review Board protocol number: 2020P001455. Eligible patients were identified from individuals referred for care at three hospital-based outpatient clinics. Inclusion criteria: 1) pain lasting ≥3 months and 2) ≥18 years of age. Exclusion criteria: 1) inability to understand and communicate in English and 2) inability to provide informed consent. The treating physical therapist provided a brief explanation of the study. If interested, they received a study information sheet and the full consent form for review. Patients verbally consented by phone to approved study staff. Once they consented to participation in the study,

the treating physical therapist was notified. The schedule of content delivery was established by the patient and the treating physical therapist.

The intervention coincided with about four scheduled physical therapy visits. Each session consisted of 1-2 pain education videos and a guided 360-degree nature video. The educational videos (viewing links included) covered these topics: 1) Motion is Lotion (5:37 minutes); 2) Mindfulness (2:24 minutes); 3) What is Pain (7:45 minutes); 4) Hurt Does Not Equal Harm (5:38 minutes) and 5) Roadmap for Change (7:47 minutes). The 360-nature content (with or without voice guidance) included images from: 1) Ocean (5:20 minutes); 2) Harbor (5:44 minutes); 3) Lake (10:10 minutes); 4) Stream (5:44 minutes) and 5) Meadow (7:58 minutes). All content was viewed in an untethered standalone VR headset (Oculus Go, Facebook Technologies, China). No effort was made to control treatments used outside of the study intervention.

Data collection

Demographic information was collected from the electronic health record (EHR) such as: age, gender, educational level, past medical history, results of relevant images, and pertinent physical therapy evaluation and treatment information. Feasibility was explored by drop-out rates, tolerability for the dose and training mode, and physical therapists' clinical decision making. Acceptability was examined by recording patient and physical therapists' experiences with the educational messaging, guided imagery content, and the VR training mode.

The Keele StarT back questionnaire was completed at baseline to characterize the sample and to explore the use of the tool in the physical therapy clinic. This risk stratification tool identifies prognostic indicators that can inform clinical decision making in primary care settings [20, 21]. The 9-item user-friendly tool explores eight domains: referred leg pain, comorbid pain, disability (2 items), bothersomeness, catastrophizing, fear, anxiety, and depression with a psychosocial sub-scale. All questions are answered by agree (1) or disagree (0), except the question regarding bothersomeness "Overall, how bothersome has your back been the last two weeks?" which is answered on a 5-point Likert scale with response alternatives: not at all (0), slightly (0), moderately (0), very much (1) and extremely (1) (bothersome). Individuals are classified as low (total score 0-3), medium (total score of ≥4 and ≤3 on the psychosocial sub-scale), and high risk (≥4 and ≥4 on the psychosocial subscale) for future disabling back pain. Higher-risk individuals are considered suitable for management with a comprehensive psychosocial intervention.

The Knowledge/Belief Survey was designed by the authors to explore the individuals' understanding of key pain concepts and was completed at baseline and at intervention completion. Our interest was to capture changes from baseline knowledge. Responses were presented on a 5-point Likert scale: strongly agree; agree; neutral; disagree; and strongly disagree. Patients were also allowed to enter qualitative comments for each question.

Patient and therapist feedback surveys used open ended questions to probe positive/negative experiences and provide an overall program rating of excellent, good, fair, or poor. Patients were asked how likely they were to increase their activity in everyday life (very likely, somewhat likely, and not likely). Patients provided feedback on the relevance of program recommendations made and their plan for implementation. We theorized that patients who provided specific plan details would be more likely to implement them. Examples included setting goals for healthier habits and using a wearable activity tracker. In addition, patients were asked to identify barriers to increasing their physical activity level, indicate their level of confidence in safely increasing their activity level, and rate the program effectiveness in changing their pain.

The therapist feedback survey designed by the authors was completed by the study physical therapist for each of their patients in the program. We rationalized that clinician experiences with the program might vary with each patient. They indicated how helpful the program was in reinforcing their usual chronic pain education strategies, encouraging engagement in appropriate exercise/movement, and empowering their patient with tools for self-management. Additionally, we asked for feedback on the workbook. Logistical challenges and adverse events were logged. Lastly, patients were asked to provide open-ended feedback

for each of the guided 360-degree guided nature videos they watched.

Data analysis

All analyses were performing using Microsoft®Excel, version 16.63.1. Descriptive statistics were used to characterize the shape, central tendency, and variability of the sample at baseline. Changes in pain knowledge/beliefs were explored using percentage changes pre/post. As this was a small observational study, no inferential testing was done. Qualitative data was analyzed to characterize feedback on the content and use of the VR headset from the patient and clinician perspectives. Qualitative information was analyzed around the two main aims of feasibility and acceptability. Themes were identified and coded initially by LB using an excel format. This information was provided to TE, TD, AB, and GM for review and coding. Agreement was reached and results were presented in a descriptive format. All study researchers have a range of 5 to 40 years of physical therapy practice experience and an interest in chronic pain management.

Results

Sociodemographic and clinical characteristics for completers and non-completers are presented in **Table 1**. A combined (completer/non-completer) 55% were obese, 30% were diagnosed with an anxiety disorder, 40% with a depressive disorder, and 60% had multi-region pain complaints. MRIs were reported in 60% of patients. Sixty-five percent reported multiple physical therapy interventions and 50% had received US/Xray guided injections. The highest use medications were NSAIDS at 45%, 35% for anti-depressants, and 30% for Acetaminophen and Neurontin/Gabapentin. Regarding the Keele STarT Back screening tool (**Table 2**), combined completers/non-completers: 28% were characterized as low risk, 44% as medium risk, and 28% as high risk for future disabling back pain.

Feasibility

Patients were recruited from March 2021 to March 2022. Seventeen patients were seen for CLBP as the primary treatment diagnoses and 3 as a secondary diagnosis (2 for foot pain and 1 for cervical pain). Chronicity of condition was the most frequent reason (73%) clinicians gave for identifying patients likely to benefit from the intervention. Receptivity to learning new information was the next most frequent reason (47%). Other reasons included motion limitations around fear and anxiety and multi-region pain issues. Of the 20 patients identified and consented, 15 of them completed the intervention (**Figure 1**). Of the five who did not complete (25%), 3 were due to interruption of care due to family issues or moves. One was related to concerns about the time needed to view content, and one was concerned that the VR headset might exacerbate a pre-existing eye infection. Limited baseline data was collected from all non-completers. All non-completers withdrew prior to beginning the intervention. Study completers viewed all 5 educational videos and from 3 to 4 of the guided relaxation 360-degree nature videos. All patients and physical therapists completed all study forms except for missing guided relaxation feedback from 2 patients and missing questions regarding barriers to increasing physical activity on 1 patient.

Physical therapists and support study staff reported that logistical challenges around use of the VR headset were encountered 93% of the time. Time constraints around VR headset management emerged as the main barrier to use of this technology in the clinic. Streamlining the VR headset set-up and operation were the most frequent physical therapist comments regarding areas needing improvement. Location of available office space for intervention delivery was mentioned twice. Lack of available support staff to trouble shoot or assist with the VR headset was an ongoing challenge in two of the clinics.

Acceptability

From both the patient and physical therapist perspective, 10 (67%) rated their overall experience with the intervention as excellent, 4 (27%) as good, and 1 (6%) as okay. What physical therapists liked best was the systematic/comprehensive presentation of pain concepts (8 comments). The adjunctive nature of the intervention to supplement care was mentioned 6 times. The “pain can be changed”, “start small”, “pain is produced in the brain”, and “hurt does not always equal harm” messages were mentioned by patients as particularly

Table 1. Baseline demographics and attributes. 15 Completers; 5 Non-completers

Characteristic	N (%)		Mean (SD)		Range	
	Completer	Non-completer	Completer	Non-completer	Completer	Non-completer
Age			59.7 (13.6)	57.2 (18.5)	25-75	34-76
Gender-female	10 (66.6)	3 (60.0)				
Race						
White	10 (66.6)	2 (40.0)				
Black	1 (6.6)					
Asian	1 (6.6)					
Not recorded	3 (20.0)	3 (60.0)				
Ethnicity						
Hispanic or Latino		1 (20.0)				
Not Hispanic or Latino	12 (80.0)	3 (60.0)				
Not recorded	3 (20.0)	1 (20.0)				
BMI			31.1 (6.0)	29.4 (4.8)	20.4-44.9	24.2-36.5
Normal	1 (6.6)	1 (20.0)				
Overweight	6 (40.0)	1 (20.0)				
Obese	8 (53.3)	3 (60.0)				
Co-Morbidities						
Anxiety disorder	4 (26.6)	2 (40.0)				
Depressive disorder	6 (40.0)	2 (40.0)				
Mental health issues	2 (13.3)					
Multi-region chronic pain	9 (60.0)	3 (60.0)				
Sleep disorder	3 (20.0)	1 (20.0)				
Spinal Imaging						
Xray	5 (33.3)	1 (20.0)				
MRI	8 (53.3)	4 (80.0)				
CT scan	1 (6.6)					
None recorded	5 (33.3)	1 (20.0)				
Prior Treatments						
Trigger point injections	0 (0)	0 (0)				
Physical therapy	9 (60.0)	4 (80.0)				
US/Xray guided injections	7 (46.6)	3 (60.0)				
Acupuncture	1 (6.6)	0 (0)				
Pain program	3 (20.0)	0 (0)				
Spinal surgery	4 (26.6)	2 (40.0)				
Dry needling	1 (6.6)	0 (0)				
Chiropractic	1 (6.6)	0 (0)				
Medications						
NSAIDS	6 (40.0)	3 (60.0)				
Corticosteroids	0 (0)	0 (0)				
Acetamino-phen	4 (26.6)	2 (40.0)				
Opioids	2 (13.3)	1 (20.0)				
Muscle Relaxants	3 (20.0)	2 (40.0)				
Anticonvulsant (Neurontin/Gabapentin)	4 (26.6)	2 (40.0)				
Anxiolytics	3 (20.0)	1 (20.0)				
Antidepressant	7 (46.6)	0 (0)				

helpful. Physical therapists indicated the content was “extremely helpful” with 8 patients and “somewhat helpful” with 7 patients in reinforcing the pain education strategies they typically use with their chronic pain patients. They felt the program was “extremely helpful” with 10 patients and “somewhat helpful” with 5 patients in helping them engage in appropriate exercise/movement. The program was “very effective” with 9 patients and “somewhat effective” with 6 patients in empowering them with tools for self-management.

There were no adverse events reported related to VR use, however, one patient mentioned initial feelings of claustrophobia. VR headset

Table 2. Keele STarT Back Screen. 15 completers; 3 non-completers

Item	Agreement N (%)	
	Completer	Non-completer
1. My back pain has spread down my leg(s) at some time in the last 2 weeks.	9 (60)	3 (100)
2. I have had pain in the shoulder or neck at some time in the last 2 weeks.	13 (87)	2 (67)
3. I have only walked short distances because of my back pain.	7 (47)	1 (33)
4. In the last 2 weeks, I have dressed more slowly than usual because of back pain.	8 (53)	2 (67)
5. It is not really safe for a person with a condition like mine to be physically active.	2 (13)	1 (33)
6. Worrying thoughts have been going through my mind a lot of the time.	10 (67)	3 (100)
7. I feel that my back pain is terrible and it's never going to get any better.	4 (27)	1 (33)
8. In general, I have not enjoyed all of the things I used to enjoy.	12 (80)	2 (67)
9. Overall, how bothersome has your back pain been in the past 2 weeks.		
Not at all	0 (0)	0 (0)
Slightly	2 (13.3)	1 (33.3)
Moderately	5 (33.3)	2 (66.6)
Very much	6 (40)	0 (0)
Extremely	2 (13.3)	0 (0)
Total Score		
*Low risk**	5 (33)	0 (0)
*Medium risk***	6 (20)	2 (67)
*High risk****	4 (27)	1 (33)

*0-3 on total score.

**≥4 on total score AND ≤3 on subscale.

***≥4 on total score AND ≥4 on subscale.

Indicates level of risk for future disability.

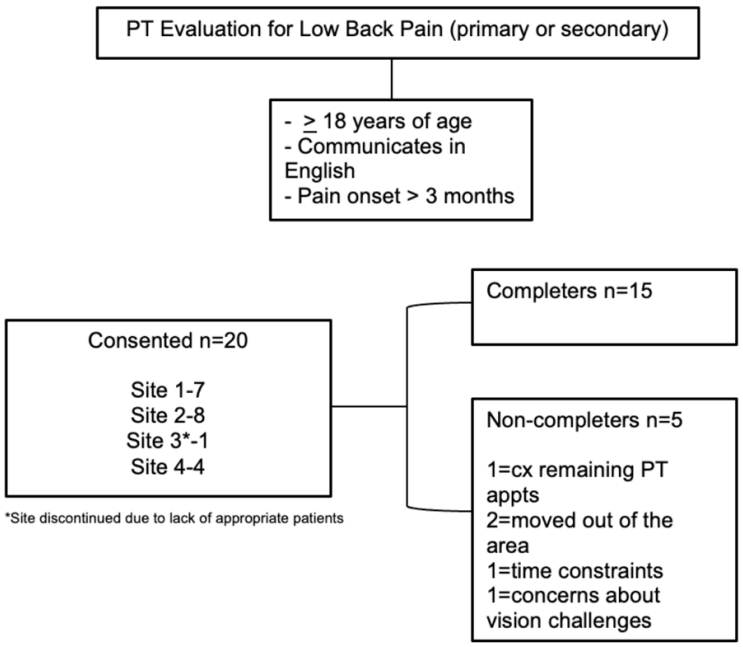

Figure 1. Recruitment and Retention.

weight was mentioned as potentially problematic in patients with cervical symptoms, although this was not observed. Challenges for patients wearing glasses was mentioned twice. One patient reported that initial unfamiliarity with the headset operation interfered with the experience.

Areas for content improvement from the physical therapist's perspective were enhancing the capability of targeting messages for identified educational deficits, decreasing the complexity of the educational messages, and including more relatable everyday activities as examples in the behavior change video. One patient said that the content should be segmented for delivery based on where one is on their pain "journey". One patient stated that the concept of pain being produced in the brain left her with a bit of "your pain is not real" feeling. Five patients expressed an interest in

Table 3. Guided Imagery comments (edited for brevity)

Positive	Negative
"It worked. I felt very relaxed at the end, less pain and dropped shoulders. Actually, started to deep breathe on my own first 5 minutes in".	"This GR (gratitude) focused on gratefulness to ancestors, ones who went through hard times. I am the child of a Holocaust survivor, so I was really jarred and a little upset".
"I came in with shoulder pain at a 10 and the ocean mindfulness brought that down to a 4. The waves made me breathe naturally. Excellent".	"The narrator spoke too long. I wanted more silence, his voice pulled me out of the moment".
"Good, immersive, engaging, liked the pace of it. I focus on the setting and sounds more than the words".	"Too many people on the beach. Stitch lines were distracting".
"Meadow was amazing, the sound more so than the visual. but the VR was also amazing. When I closed my eyes, the sound was peaceful".	"The voice took me out of the experience. Maybe more time to simply take in the moment on my own would be more effective".
"I did the meadow again because it's my favorite. In fact, it was so relaxing I fell asleep this time. Beautiful! Thanks for the experience. Back's less sore as well now".	"There was also a bit of a strong feeling like something was off a bit like in the Truman show".
"Very serene feeling after video. Will practice this daily".	"There was a bird that seemed to have very unnatural zippy flying patterns that was very distracting and took me out of the relaxing and peaceful feeling of meditation".
"I really liked this Guided Relaxation the best (Meadow). I find that nature in the spring/early summer can be transportive".	"This one was good to look at! But the noise bothered me. It definitely brought me when the trout were running".
"I think that the visual piece is really helpful. I do GR at home, but only with audio, and I would love a visual component as well. I liked the sounds of the harbor".	"These two videos did less to relax me, but at least provided awareness that my ability to be still is something I need to work at".
"Peaceful, engaging, relaxing, unaware to most of pain. Felt more hopeful when I was feeling really depressed".	
"Truly a wonderful change. Very nice. Will listen to water lapping at bed tonight".	
"I felt very calm and I was able to follow along the directions. Felt myself breathing naturally and sometimes in tune to the guided relaxation".	

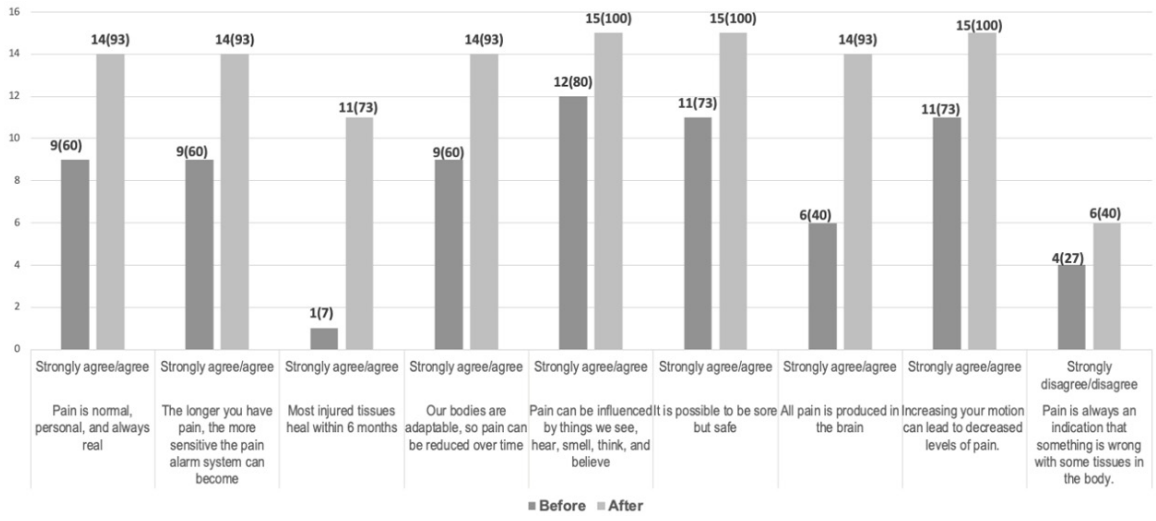

Figure 2. Pain Knowledge/Beliefs Change. N=15, n (%).

having the content available to them for home viewing. Two patients felt the content should be more interactive. One patient suggested a "check-in" session 2-3 months after discharge. One patient suggested additional sessions with the physical therapist to focus on the pain education messages. The patient handbook (available upon request) was very effective with 1 patient, somewhat effective with 1 patient and made no difference or was ineffective with 13 patients because it wasn't used.

Examples of guided video feedback are presented in **Table 3**. The most frequently viewed videos were the meadow and ocean with 13 views. The lake and stream were viewed 8 times each, and the harbor 6 times. Positive feedback centered around the guided imagery

Table 4. Activity recommendations with relevance and plan details

Recommended activity	Relevance			Plan	
	yes	no	unsure	N	Details
Increase physical activity	13	1	1	9	Walking (7) Gym use (3) Yoga (1)
Use of wearable technology to track steps or activity	7	5	3	7	Fit bit (4) Watch (2) Pedometer (1)
Online/paper tracker	6	5	4	6	Calendar (1) Wearable linked with online tracker (4)
Eat healthier foods	14	1		7	Decrease sugar (3) Increase protein, fruits, veges (2) Use food diary (1)
Practice mindfulness or guided relaxation	13	1	1	7	Add to schedule (4) Use of apps (1) Qigong (1) Yoga meditation (1)
Improve sleep	14		1	5	Increase activity=better sleep (1) Stick to a sleep schedule (1)
Decrease sedentary behavior by moving more throughout day	13	2		6	Move when prompted by Fitbit (1) Decrease sustained sitting (5)
Goal setting for healthier habits	13		2	8	Eating (4) Stress management (1) Sleep (3) Movement (3) Regular reassessment (1)
Find an accountability partner	2	3	9	2	Family/partners (2)
Other					Gaining new information Weighing myself daily

videos being immersive/transportive (7 comments), relaxing (24 comments), pain relieving (6 comments), and breath-enhancing (3 comments).

Five patients found the audio guidance distracting, preferring the non-audio versions. Three patients found extraneous visual images distracting. One patient mentioned boredom with the meadow video as there was "not much going on, or to look at". One patient reported being distressed by the gratitude guided audio that mentioned ancestors, as some of their ancestors included holocaust survivors.

Changes in pain knowledge are presented in **Figure 2**. Nine pain education concepts were probed at baseline and program completion. Shifts to or from neutral are not included. All concepts shifted in the desired direction. The largest shift was seen in the concept of "most injured tissues heal within 6 months" from 7% to 73% agreement at program completion. The "all pain is produced in the brain" shifted from 40% to 93% agreement at completion. A shift from 60 to 93% agreement occurred in the concept of "our bodies are adaptable, so pain can be reduced over time". Ten patients said they were "very likely" and 5 were "somewhat likely" to increase their physical activity in everyday life. Two patients who were "somewhat likely" reported a high degree of physical activity at baseline. **Table 4** explores the relevance and plans for implementation of recommendations. The most relevant recommended activities identified were healthier eating, better sleep, increasing motion, and goal setting. Finding an accountability partner and use of an online/paper activity tracker were least relevant. Articulation of specific plans was highest for increasing physical activity and goal setting. Barriers to increasing physical activity were pain (8), time constraints (7), lack of motivation (6), lack of resources (2), and lack of knowledge/guidance (1). Six patients indicated they were "much more confident", 6 were "somewhat more confident", and 2 had "no change in confidence" that they could safely increase their activity level gradually over time. Regarding

the effectiveness of the program in helping change their pain, 4 were “excellent”, 8 were “good”, and 2 were “okay”.

Discussion

Our intention was not to produce highly generalizable information, but to take a deeper dive into the experiences of chronic pain patients and physical therapists who treat them in busy outpatient clinics. Our feasibility results are mixed. While all patients viewed all 5 educational messages and at least three of the 360-degree guided imagery videos, 25% of consented patients did not begin the intervention. Interruptions in care do occur for a variety of reasons and these disruptions interfere with projected outcomes. Limiting educational interventions exclusively to the clinic setting can diminish the value of the information. While stand-alone educational content may be less effective than content delivered in the context of clinical care [13], educational resources should be available in print form and/or on web-based, app-based, or cloud platforms that can be accessed outside of the clinic setting. This would enable repeat viewing of content to re-enforce concepts and sharing of content with significant others who may be assisting patients with behavior change strategies.

The 360-degree guided imagery content is optimally viewed on a VR headset. While the use of VR headsets is growing, they are far from being mainstream devices for home use [22]. Limiting the interventional content to in-clinic VR headset delivery creates access barriers that may interfere with more durable improvements over time.

While the Keele STarT back screening tool might lead to enhanced decision-making in this population in physical therapy clinics, this study was not designed to test this hypothesis. In this sample, all patients were deemed appropriate by expert clinicians for an expanded psychosocial intervention, however, only 28% of all consented patients scored in the high-risk category. This highlights the difficulties of using population averages to accurately classify individual patients and the importance of using screening tools to supplement, not replace clinical decision making [21]. The clinical utility of this screen in physical therapy practice requires further study.

Interventions are often evaluated on the practicality of implementation in clinic settings, therefore, the burden (expense and time) associated with using VR technology in physical therapy clinics should be weighed against the potential benefits. Logistical challenges of using the VR headset were encountered 93% of the time. Device operation of the Oculus Go VR headset ($299) is relatively simple, nevertheless, it added to the burden of equipment maintenance, trouble shooting, and patient device training. If this technology is to be adopted in the clinic, streamlined procedures and use of support staff is highly recommended. It is not clear whether the potential benefit of improved focus of the immersive nature of a VR headset outweighs the burden of the technology. While there is some evidence regarding the effectiveness of guided imagery/mindfulness training in chronic pain [19], what is less clear is the impact of this type of training utilizing a VR headset. Wiederhold, et al. studied the impact of VR nature environments on chronic pain [23]. They concluded that chronic pain patients achieved reduction in subjective pain ratings, however, the durability of pain relief is unknown. Additionally, we are uncertain if the VR method of guided relaxation/mindfulness training is more effective than other methods such as guided audio training commercially available through various smart phone apps.

Healthcare interventions are often explored for their acceptability. If an intervention is not acceptable, patients are unlikely to adhere to recommendations and therapists may not deliver interventions with fidelity. However, defining and measuring acceptability is complex [24]. There were no patients who withdrew from the study after starting the intervention. Overall, the patient and physical therapists’ experience with the intervention was good to excellent. The pain education messages landed without evoking negative reactions in all but one patient and there were several messages that patients called out as being particularly helpful. Comments regarding the guided 360-degree content were generally positive. Patients reported enjoying the novel, immersive VR experience and found it relaxing. However, there is significant variability in what individuals find relaxing and engaging, highlighting the need to provide a variety of content patients can choose from.

Conclusion

Overall, the content and standardized messaging of the "Change Your Pain" program was well received and acceptable to both patients and physical therapists, with important concerns raised around the practicality of using VR technology in busy clinic settings. Physical therapists identified the systematic messages delivered as a supplement to typical care as the greatest strength of the intervention. Desired shifts in pain knowledge occurred from baseline to program completion. Additional content delivery methods are needed to improve access beyond the clinic and streamline clinic implementation. We have gained valuable insights regarding program content, design, and mode of delivery that will inform the next iteration of the intervention. The chronic pain experience is unique. A "one-size-fits-all" approach won't work. This project represents important first steps in crafting a systematic pain education intervention that can be implemented as an adjunct to rehabilitative care to assist clinicians in addressing the complex biopsychosocial experience of chronic pain.

Limitations

Respondent bias threatens the confidence in our findings. The patient-therapist relationship could have influenced responses. The relationship between the study physical therapists and the main author could have influenced survey responses. This small convenience sample limits its generalizability. In addition, this sample included some patients who expressed a willingness to learn additional information and an openness to trying new tools. This patient attribute could have contributed to the high experience ratings recorded. The lack of a comparator group does not allow us to evaluate superiority or non-inferiority with other methods of delivery of pain education content. Additionally, no effort was made to control or account for additional education/instruction that occurred outside of the intervention, so it is not possible to attribute changes in pain knowledge solely to the program. We are unable to assess the durability of any changes observed due to a lack of follow-up.

Future directions

As Socrates said, "Knowing is not the same as doing". Even if we can impart sound knowledge about the experience of chronic pain in a way that is feasible and acceptable, we must do more to address the disconnect between knowledge and action. Moving forward, our intention is to refine the educational videos, improve the handbook, increase the interactivity, enhance accountability for implementation of program recommendations, and expand the intervention to include additional methods for dissemination outside of the VR headset such as tablets, laptops, or smart phones. Ultimately, we hope to design larger studies with a comparator group and follow up measurement time points to explore the durability of outcomes.

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References

[1] Yong RJ, Mullins PM and Bhattacharyya N. Prevalence of chronic pain among adults in the United States. Pain 2022; 163: e328-e332.

[2] Sluka KA and George SZ. A new definition of pain: update and implications for physical therapist practice and rehabilitation science. Phys Ther 2021; 101: pzab019.

[3] Louw A, Puentedura EJ, Zimney K, Cox T and Rico D. The clinical implementation of pain neuroscience education: a survey study. Physiother Theory Pract 2017; 33: 869-879.

[4] Clarke CL, Ryan CG and Martin DJ. Pain neurophysiology education for the management of individuals with chronic low back pain: a systematic review and meta-analysis. Man Ther 2011; 16: 544-549.

[5] Watson JA, Ryan CG, Cooper L, Ellington D, Whittle R, Lavender M, Dixon J, Atkinson G, Cooper K and Martin DJ. Pain neuroscience education for adults with chronic musculoskeletal pain: a mixed-methods systematic review and meta-analysis. J Pain 2019; 20: 1140.e1-1140.e22.

[6] Rondon-Ramos A, Martinez-Calderon J, Diaz-Cerrillo JL, Rivas-Ruiz F, Ariza-Hurtado GR, Clavero-Cano S and Luque-Suarez A. Pain neuroscience education plus usual care is more effective than usual care alone to improve self-efficacy beliefs in people with chronic musculoskeletal pain: a non-randomized controlled trial. J Clin Med 2020; 9: 2195.
[7] Louw A, Diener I, Butler DS and Puentedura EJ. The effect of neuroscience education on pain, disability, anxiety, and stress in chronic musculoskeletal pain. Arch Phys Med Rehabil 2011; 92: 2041-2056.
[8] Louw A, Zimney K, Puentedura EJ and Diener I. The efficacy of pain neuroscience education on musculoskeletal pain: a systematic review of the literature. Physiother Theory Pract 2016; 32: 332-355.
[9] Monturo CA and Brockway C. Micro-learning: an innovative strategy to cultivate a spirit of inquiry, step zero. Worldviews Evid Based Nurs 2019; 16: 416-417.
[10] Jahnke I, Lee YM, Pham M, He H and Austin L. Unpacking the inherent design principles of mobile microlearning. Springer Netherlands; 2020.
[11] De Gagne JC, Park HK, Hall K, Woodward A, Yamane S and Kim SS. Microlearning in health professions education: Scoping review. JMIR Med Educ 2019; 5: e13997.
[12] Bruck PA, Motiwalla L and Foerster F. Mobile learning with micro-content: a framework and evaluation. 25th Bled EConference - EDependability: Reliable and Trustworthy EStructures, EProcesses, EOperations and EServices for the Future, Proceedings 2012; 527-543.
[13] van Erp RMA, Huijnen IPJ, Jakobs MLG, Kleijnen J and Smeets RJEM. Effectiveness of primary care interventions using a biopsychosocial approach in chronic low back pain: a systematic review. Pain Pract 2019; 19: 224-241.
[14] Mahrer NE and Gold JI. The use of virtual reality for pain control: a review. Curr Pain Headache Rep 2009; 13: 100-109.
[15] Li A, Montano Z, Chen V and Gold J. Virtual reality and pain management: current trends and future directions. Pain Manag 2011; 1: 147-157.
[16] Shahrbanian S, Ma X, Korner-Bitensky N and Simmonds MJ. Scientific evidence for the effectiveness of virtual reality for pain reduction in adults with acute or chronic pain. Stud Health Technol Inform 2009; 144: 40-43.
[17] Brady N, McVeigh JG, McCreesh K, Rio E, Dekkers T and Lewis JS. Exploring the effectiveness of immersive virtual reality interventions in the management of musculoskeletal pain: a state-of-the-art review. Physical Therapy Reviews 2021; 26: 1-14.
[18] Brown L, Chen ET and Binder DS. The use of virtual reality for Peri-procedural pain and anxiety at an outpatient spine clinic injection visit: an exploratory controlled randomized trial. Am J Transl Res 2020; 12: 5818-5826.
[19] Di Giovani VI and Piatt JA. Guided imagery: a therapeutic intervention for clients with chronic lower back pain. Annual in Therapeutic Recreation 2016; 23: 64-72.
[20] Hill JC, Dunn KM, Lewis M, Mullis R, Main CJ, Foster NE and Hay EM. A primary care back pain screening tool: identifying patient subgroups for initial treatment. Arthritis Rheum 2008; 59: 632-641.
[21] Nitsch KP, Davis K and Stipp K. Psychometric measurement properties and clinical utility of the keele STarT back screening tool in people with low back pain. Arch Phys Med Rehabil 2016; 97: 2233-2234.
[22] Gilbert N. 74 virtual reality statistics you must know in 2021. https://financesonline.com/virtual-reality-statistics/.
[23] Wiederhold BK, Gao K, Sulea C and Wiederhold MD. Virtual reality as a distraction technique in chronic pain patients. Cyberpsychol Behav Soc Netw 2014; 17: 346-352.
[24] Sekhon M, Cartwright M and Francis JJ. Acceptability of healthcare interventions: an overview of reviews and development of a theoretical framework. BMC Health Serv Res 2017; 17: 88.