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Designing and Implementing a Telehealth Simulation for Pain Neuroscience Education in a Doctor of Physical Therapy Curriculum: A Pilot Study

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ABSTRACT

There is continuing debate over the best pedagogical approach to deliver modern pain science knowledge. Experiential learning, such as simulation, may better promote application and retention of curricular material. This study investigated changes in knowledge of pain neurophysiology, attitudes, beliefs and clinical recommendations towards chronic low back pain (CLBP) after participation in a telehealth simulation for pain neuroscience education (PNE). A convenience sample of twenty-one Doctor of Physical Therapy (DPT) students, age 23.6 (± 3.60), completed the simulation. Students completed a pre- and post-questionnaire consisting of the Revised Neurophysiology of Pain Questionnaire (rNPQ) Healthcare Providers' Pain and Impairments Relationship Scale (HC-PAIRS) and clinical vignette. Additionally, the post simulation survey included the Simulation Effectiveness Tool Modified (SET-M). Descriptive statistics were utilized to analyze all data. Pre- and post-rNPQ mean (SD) scores improved from 5.38 ±1.24 (44.8%) to 6.48 ±1.36 (54%). HC-PAIRS mean (SD) scores lowered from 51.76 ± 9.64 to 47.14 ±5.41, indicating a positive shift in attitudes and beliefs relating to CLBP. All appropriate clinical recommendations improved after post simulation. The mean (SD) SET-M score was 54.9 ±3.66. Experiential learning via a PNE telehealth simulation improved knowledge of pain neurophysiology, positively shifted attitudes and beliefs towards CLBP, while also improving appropriate clinical recommendations. The SET-M scores present the learners perspective and provide guidance in adapting the simulation in the future. Further research should include a longitudinal design with a long-term follow up, a larger sample size across different curricula and a qualitative component to explore the student experience.

Keywords: pain neuroscience, physical therapy, simulation, telehealth, chronic low back pain

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1. Introduction

Pain neuroscience education (PNE) can alter perceptions of pain and improve physical therapy outcomes. PNE has been shown to improve pain knowledge in healthcare professions, including physical therapists (PTs).(L. Moseley, 2003) There is strong evidence for PNE in musculoskeletal (MSK) disorders, as it can help reduce reported pain levels, improve knowledge of pain, decrease catastrophizing, fear avoidance, and decrease poor attitude and behaviors regarding pain. Ultimately, PNE can help improve physical movement and decrease healthcare over utilization.(Louw et al., 2011, 2016) In chronic MSK pain, PNE can modify self-efficacy beliefs, pain intensity, interference, and anxiety.(Louw et al., 2011; Rondon-ramos et al., 2020) If PNE can improve these previously mentioned outcomes in patients, it is only logical to promote the importance of PNE education among healthcare students.

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2. Literature Review

2.1. PNE and Learning

In academia, didactic lectures are a cornerstone of education and involve the instructor giving information to the learner, hoping that it is retained for future practice. This approach is more short-term in nature and may not lead to long-term retention or application even if knowledge is improved.(Strauss et al., 1998) Lectures have been predominantly studied on PNE delivery for students and clinicians, despite lacking higher levels of analysis and synthesis. These lectures ranged from forty-five minutes to twenty-six hours.(Colleary et al., 2017; Cox et al., 2017; Mankelow et al., 2020; Talmage et al., 2020) However, lecture is a pedagogical approach that limits student participation and does not require processing or adapting of the information by students.(Clark L, 2018) A study by Jensen et al.(Jensen et al., 2017) recommends that practice-based learning will simulate what students need to demonstrate in patient-centered care and communication. Accordingly, if education is not purposeful in its approach to exposing students to challenging experiences, they likely will not have changed views, experiences or understanding, thus leaving them ill-prepared to practice.(Richardson et al., 2002) Simulation, a form of experiential learning, may allow for a transformation of the experience to clinical experiences and practice.

2.2. Simulation in DPT Education

Recently, simulation activities are being effectively implemented in physical therapy curricula, often, augmenting the learning experience.(Mori et al., 2015) It has been suggested that physical therapy students are consistently unprepared to practice in a dynamic healthcare environment, especially after graduation, and approaches other than lecture may help support students for clinical practice.(Macauley, 2018) In a study by Macauley,(Macauley, 2018) after one simulation, physical therapy students demonstrated statistically significant improvement in clinical decision-making skills. Experiential learning through simulation can also improve a student's confidence and overall potential to thrive in clinical experiences, while also promoting reflection on practice.(Smith & Crocker, 2017) If used to improve practice, simulation allows learners to move from knowledge or comprehension to application, which is a higher level on Bloom's Taxonomy, such as with analysis or synthesis. Furthermore, in a study by Maddry et al.(Maddry et al., 2014) the authors compared lecture and simulation-based learning immediately after intervention and three months post-intervention. The authors found that lecture-based instruction resulted in improved short-term knowledge, but simulation-based instruction led to superior retention of knowledge at three months (Maddry et al., 2014).

2.3. Telehealth

During the COVID-19 global pandemic, physical therapy was thrust into digital practice and telehealth.(Lee, 2020) The lack of access to traditional in-person healthcare has allowed telehealth to be adopted as a solution to the crisis and has expanded exponentially.(Bettger et al., 2020) Health care via telehealth has shown comparable effectiveness in outcomes compared to standard practice.(Cottrell & Russell, 2020; Kumar et al., 2020; Lamplot & Taylor, 2021) Therefore, research utilizing simulation and telehealth for PNE in an entry-level DPT program could be beneficial in measuring learning outcomes and student experiences with this pedagogical approach. Such information may better guide pain education curricular development that is in alignment with current practice.

2.4. Purpose

Despite efforts by the International Association for the Study of Pain (IASP) and Academy of Orthopedics Pain Education Manual, poor guidelines and limited pedagogical studies on optimal strategies for implementing pain education limit the understanding on this topic and what healthcare students obtain prior to licensure.(IASP, n.d.; Louw et al., 2020; Shepherd et al., 2021) More research is needed to guide curricular development and demonstrate how simulation impacts student outcomes and experiences. By exploring the change in knowledge, attitudes, beliefs, and behavior from a quantitative perspective after simulation, educators may gain further data to support the benefits of simulation in a pain science curriculum and guide curricular development. Additionally, by adding a clinical vignette component, this study will be able to quantitatively assess any changes in treatment behavior. By further researching this pedagogical approach to PNE, there is potential to change physical therapy practice by improving critical thinking, patient outcomes and minimizing over utilization of healthcare services.(Clarke et al., 2011; Louw et al., 2011, 2016; Macauley, 2018; Malfliet et al., 2017) Therefore, the purpose of this pilot study was to examine the feasibility of a PNE telehealth in a simulation for CLBP that can be included in a DPT curriculum.

3. Materials and Methods

Changes in knowledge, attitudes and beliefs, clinical recommendations and overall perceived effectiveness were measured to guide criteria for feasibility. The following research questions will guide criteria for feasibility and potential exploration in a larger study.

3.1. Research Questions

1. What is the feasibility of a PNE telehealth simulation and its impact on knowledge of pain neurophysiology, attitudes and beliefs and clinical recommendations for CLBP?
2. What is the overall perceived effectiveness of a PNE telehealth simulation for CLBP?

3.2. Setting and Sample

Convenience sampling was used for this study of students enrolled in a late-term MSK course in the DPT curriculum. The simulation was a required lab activity for all students including observers, but was not graded. Students completed an informed consent form to release data collected within the course. Institutional Review Board (IRB) approval was obtained from the university (#PT-0928-448) and informed consent was obtained from all individuals for use of data. Any student not willing to sign the informed consent to allow data release was excluded.

3.3. Study Design

Using a pre- and post-survey design, this quantitative pilot study collected data to provide sufficient evidence that using a PNE telehealth simulation would be beneficial for utilization within a curriculum. Pilot studies are crucial in research as it helps both the researcher and others to gain an understanding of the process, resources, management and scientific approach needed for implementing an intervention.(Thabane et al., 2010) Simulations in education have copious benefits, but instructional simulation design is time-intensive and requires resources to execute. Therefore, a pilot study is beneficial (Collins et al., 2021).

3.4. Intervention

One session of a simulation lab activity was conducted and delivered according to International Nursing Association of Clinical Simulation and Learning (INACSL) guidelines using a male standardized patient (SP).(INACSL Standard Committee, 2016) The primary investigator had undergone training in simulations within the institution's Center for Innovative in Clinical Practice (CICP). Learning objectives and critical actions for the simulation can be found in Appendix. The simulation was broken down into three telehealth sessions on which the student PTs educated the patient via telehealth: (a) central sensitization or the alarm system, (b) factors that can affect pain, and c) what can be done to address pain. Three students were randomly chosen via a Microsoft Excel™ random number generator to be participants in delivery of the sessions prior to the start of the simulation. All other students were observers in the simulation.

Preparation activities before participating in the simulation sessions included a Voice Over Power Point™ (VOPPT) reviewing pain science and education concepts based on the book *"Why Do I Hurt"* provided within the required course content.(Louw, 2014) The main themes of this educational approach have been used in prior research and its efficacy is well documented.(Phillips et al., 2021; Puentedura & Flynn, 2016; Rufa et al., 2019) Before the start of each separate telehealth session a pre-brief audio-visual recording was played. During each session a student discussed content associated with the objective relating to PNE. After completion of one session, the next debriefing was played and the second student completed the telehealth session relating to the seconds objective. The final session was completed in the same manner with the third student.

Ground rules for psychological safety, confidentiality, and trust were established among faculty and students. The SP, trained within the institution's CICP, used a generic script to achieve a consistent but organic interaction within the simulation. After completing the PNE session, students were instructed to reflect briefly, followed by a debriefing using the Promoting Excellence and Reflective Learning in Simulation (PEARLS) debriefing framework.(Eppich & Cheng, 2015) The simulation lasted approximately 60 minutes which included the pre-brief prior to each telehealth session, the actual simulation activity, and debriefing.

3.5. Data Collection Instruments

One week into term and immediately after completion of the simulation, students completed the RNPQ, HC-PAIRS, clinical vignette, and SET-M. The original NPQ was developed to assess how individuals conceptualize their pain. This questionnaire evaluates how and why a person perceives pain and its biological mechanisms. The original NPQ consists of 19 closed-ended questions answered as true, false, or undecided. Correct responses are awarded one point, and incorrect (or undecided) responses are awarded zero points. Scores can range from 0 to 19, with higher scores indicating greater pain neurophysiology knowledge. The original NPQ is a valid and reliable measurement for health care professionals, patients, and physical therapy students with a Pearson Separation Index of .84 and an acceptable test-retest reliability of 0.97.(G. L. Moseley, 2004; L. Moseley, 2003) The 12-item RNPQ was developed after Rasch Analysis and has been deemed reliable and valid with good test-retest reliability of .989 in patients with chronic spine pain.(Catley et al., 2013) The RNPQ, with seven items removed, has demonstrated superior psychometric properties.

To evaluate attitudes and beliefs towards CLBP, HC-PAIRS was utilized and consists of 15 items using a 7-point Likert rating scale *('Completely disagree' = 1 to 'Completely agree' = 7)*. Scores can range from 7 to 105, with lower scores suggesting positive beliefs and attitudes that pain complaints do not justify impairment or disability. Cronbach's alpha for the HC-PAIRS is 0.78, with good validity relating to work and activity recommendations.(Rainville et al., 1995) Latimer et al.(Latimer et al., 2004) found that HC-PAIRS is responsive to changes in a physiotherapy student's HC-PAIRS scores after a module on chronic back pain.

A case vignette was given to participants to evaluate their behavior or clinical recommendations. The vignette and questions were adapted from previous studies.(Maguire, N; Chesterton & ; Ryan, 2019) The participants answered four multiple-choice questions and were instructed to indicate their recommendations regarding usual daily activity, work, exercise, and bed rest based on the case information. The percentage of appropriate recommendations, consistent with clinical guidelines, was recorded.

To evaluate the student's perceived effectiveness of the simulation, SET-M was utilized. The original simulation effectiveness tool consisted of 19 items using a 3-point Likert scale with 3 = strong agree and 1 = do not agree.(Cordi et al., 2012) A modified version was developed to be current with simulation standards.(Leighton et al., 2015) The modified version includes 13 items and other components that measure prebriefing, learning, confidence, and debriefing using the same 3-point Likert scale. The current intraclass correlation coefficient (ICC) is 0.83 for prebriefing, 0.85 for learning, 0.913 for confidence, and 0.90 for debriefing. Further, SET-M demonstrates construct validity and a similar factor structure to the original SET after modifications (Leighton et al., 2015).

3.6. Data Analysis

Designed as a pilot study, the emphasis was on feasibility rather than statistical significance.(Thabane et al., 2010) Therefore, descriptive analysis was utilized for all data pre- and post-using SPSS 26 (IBM, New York).

3.7. Results

A convenience sample of twenty-one DPT students, age 23.6 (± 3.60) completed the simulation pre- and post-surveys. This sample included both the simulation participants and all observers. Of the twenty-one students (male n = 9; female = 12), none were excluded. No other demographic data was collected as all other data was deidentified prior to data analysis. Pre- and post-RNPQ mean (SD) scores improved from 5.38 ± 1.24 (44.8%) to 6.48 ± 1.36 (54%). HC-PAIRS mean (SD) scores decreased from 51.76 ± 9.64 to 47.14 ± 5.41, indicating a positive shift in attitudes and beliefs relating to CLBP. Appropriate recommendations in the clinical vignette improved post-PNE simulation, as shown in Table 1. Finally, the mean (SD) SET-M score was 54.9 ± 3.66, indicating that the simulation experience effectively met student learning needs.

Table 1.
Clinical Vignette Percentages of Correct Recommendations Pre- and Post- Simulation

Clinical Vignette Appropriate Recommendation	**Pre**	**Post**
Work		
• Return to normal work	11 (52.4%)	12 (57.1%)
• Return to part-time or light duties	15 (71.4%)	17 (81%)
Exercise		
• Return to normal exercise routine	8 (38.1%)	12 (57.1%)
• Return to light class participation	17 (81%)	19 (90.5%)
Activity		
• Perform usual activities	8 (38.1%)	8 (38.1%)
• Perform activities within patient's tolerance	21 (100%)	21 (100%)
Bed Rest		
• Avoid bed rest entirely	7 (33.3%)	14 (66.6%)
• Avoid resting in bed as much as possible	4 (19%)	10 (47.6%)

4. Discussion

The overall mean of RNPQ scores, both pre-test 5.38 (44.8%) and post-test 6.48 (54%), were lower than those reported in physical therapy curricula outside the United States.(Alodaibi et al., 2018; Marques et al., 2016) However, baseline scores (44.8%) are similar to a study by Cox et al.(Cox et al., 2017) conducted within a United States DPT curriculum. Overall, direct comparisons in curricula can be limited due to different regulatory entities for curriculums within the United States and overseas. Most studies were completed overseas. Timing for assessing knowledge of pain neurophysiology could also be a factor. Studies have shown that as students' progress through the curriculum their knowledge improves.(Marques et al., 2016; Wassinger, 2021) Yet in this case pre- and post-scores were similar to first year DPT students in the United States, despite participants being in their last didactic term in this pilot study. This may be due to limited content within the curriculum, hence the need for implementation.

HC-PAIRS scores were lower pre (51.76) and post (47.14) compared to other studies. The current studies scores are lower than what Cox et al.(Cox et al., 2017) reported for first-year DPT students' scores using the extended version of the HC-PAIRS at baseline, which was 61.81. The difference may be explained again by students in the current pilot study who were in their last didactic course, whereas those in the study mentioned above were earlier within the curriculum. This improvement is consistent with findings that there is a shift to a more biopsychosocial prescriptive to CLBP as a student progresses through a DPT curriculum.(Leysen et al., 2021; Wassinger, 2021) However, interventions such as one time or threaded passive and active learning should also be compared to the current pilot study.

After participating in the PNE telehealth simulation, there were gains in knowledge and a change in attitudes and beliefs that were different than for those who participated in passive learning or active learning.(Colleary et al., 2017; Cox et al., 2017; Helms et al., 2021; Maguire, N; Chesterton & ; Ryan, 2019; Mankelow et al., 2020; Marques et al., 2016) During passive lectures, gains in knowledge ranged from 31-34% which is higher than the current study, while changes in HC-PAIRS were similar.(Colleary et al., 2017; Maguire, N; Chesterton & ; Ryan, 2019; Mankelow et al., 2020) During active learning for pain science, scores were significantly improved, up to 90% correct, which is significantly different than the current study.(Marques et al., 2016) However, in the Marquese et al.(Marques et al., 2016) study, active learning was threaded through an entire course. Similar to the current pilot study active learning within an IASP designed 8-week course by Helms et al.(Helms et al., 2021) resulted in an improvement in biopsychosocial attitudes and beliefs toward CLBP. Overall, although there were positive gains in the pilot study, generally they were not as significant as other studies.

First, greater gains may have occurred if participants were in the first term due to a lack of foundational knowledge. Additionally, the objectives of this simulation were primarily to communicate and execute PNE to a standardized patient with CLBP via telehealth. The goals may explain why the gains on the RNPQ and HC-PAIRS were smaller than those reported in prior studies for both passive and active learning pedagogical approaches. Although students are asked to recall and understand pain science concepts, they are only sometimes requested to engage actively in communication regarding these topics with patients. Finally, greater gains in knowledge over a more extended period and with repetition are not surprising. Studies have shown that active or passive repetition improves scores and long-term content retention.(Kooloos et al., 2020) In the current study, knowledge was gained, but not to the extent reported in the two studies mentioned above. Again, this may not be remarkable as the present study included only one intervention, the simulation, at one-time point.

Interestingly, although greater short-term gains were made on outcomes after education on PNE in passive learning studies, such gains were predominantly not maintained over time.(Cox et al., 2017; Talmage et al., 2020) Studies that included active learning did not examine long-term retention.(Helms et al., 2021; Marques et al., 2016) Most researchers reported maintenance or a slight decrease in knowledge at six months after passive learning. Students are asked to recall and understand pain science concepts, but they need to consistently be asked to demonstrate the newly gained knowledge during a patient encounter in DPT curricula.(Helms et al., 2021) Although this pilot study did not measure long-term outcomes, research has shown that active learning, such as simulation, can improve long-term gains compared to passive learning.(Maddry et al., 2014) Thus, additional future research should be conducted in this area.

Appropriate clinical vignette scores and their change pre- and post-simulation improved after participating in the simulation, but not to the degree of prior studies.(Colleary et al., 2017; Maguire, N; Chesterton & ; Ryan, 2019) Possible explanations can include lack of threading in the current curriculum and the objectives of the simulation. Generally, PTs recognize the importance of physical activity compared to bed rest and active learning allows the learner to take the new information and "apply" the knowledge gained to a new situation, such as a clinical vignette.(Kolb, 1984) Studies utilizing active learning did not specifically use an outcome measure to examine a clinical recommendation. Further, variations exist within clinical vignettes. Therefore, generalizations must be made cautiously. However, the future use of clinical vignettes can be improved by integrating other factors, such as psychosocial components, to allow for better context and analysis by the participant.(Fourré et al., 2023)

4.1. Limitations

There are several limitations to this pilot study. First, pilot studies are limited by design in which the focus is on feasibility rather than statistical significance at one time point within the curriculum. Further, a small sample size which was a convenience sample from one institution limits generalizability. Increasing the sample size to various campuses or institutions in conjunction with data collection in a more longitudinal manner would improve the ability to further analyze significant changes pre- and post-simulation. Internal validity could be impacted from familiarity with outcome measures pre- and post-simulation. Finally, the clinical vignette to measure clinical behavior or recommendations was a proxy and not a gold standard for clinical observation. Further research should study clinical behavior during clinical experiences as well as potentially include randomized controlled trials.

5. Conclusion

To the best of the author's knowledge, this pilot study is the first to investigate simulations as a pedagogical approach for pain neuroscience education (PNE). Students had a positive experience during this specific pedagogical approach to PNE in an entry-level DPT curriculum. Knowledge of pain neurophysiology, attitudes and beliefs and appropriate clinical recommendations all improved following the simulation experience. The finding is consistent with recommendations that while modern pain science concepts should be implemented with traditional learning, such education also benefits when supplemented with experiential learning via simulation. However, the literature needs to be more comprehensive on which experiential or active learning approach is optimal. Generally, entry-level DPT students would benefit from more experiential education and training before licensure.

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Appendix

Simulation Summary

In this scenario, your clinical instructor (CI) completed an initial evaluation and thought a patient would benefit from pain neuroscience education (PNE). The CI would like you, the student, to complete the initial session of PNE and you will follow up with 2 additional sessions. The patient requested a telehealth session as he is out of town on travel often but is eager to learn about his pain. The student will begin PNE utilizing metaphors, images, and examples to improve overall pain and function. on topics of:

- Central sensitization (alarm system)
- External/Internal factors that can affect pain (nerve sensors, why pain spreads and other external factors such as stress)
- What can be done to address the pain (education, medicine, and exercise)

Simulation Learning Objectives

1. Students will use professional, clear, and empathetic communication skills when completing the PNE discussion.
2. Students will execute PNE with the patient.
3. Students will describe and educate the patient on components of pain neuroscience using metaphors and examples to explain to improve overall pain and function on the topics below:
    - Central sensitization (alarm system)
    - External/Internal factors that can affect pain (nerve sensors, why pain spreads and other external factors such as stress)
    - What can be done to address the pain (education, medicine, and exercise)

Critical Action Checklist

CLO 3 (ILO3/PLO3): Synthesize and evaluate all the clinical findings from a comprehensive musculoskeletal examination using biopsychosocial model to develop clinically effective management strategy.	**Y/N**	**Comments**
The student demonstrates a level of professionalism and communication to be expected in a clinical setting. This includes using professional language and non-verbal body language, asking permission (i.e., eye contact, hand gestures, facial expression).		
The student appropriately modifies their communication based on the response from the patient.		
The student acknowledges and addresses both patient during communication with mutual respect and inclusiveness.		
Student will explain components of PNE using metaphors, examples, images: • Central sensitization (alarm system) • External/Internal factors that can affect pain (nerve sensors, why pain spreads and other external factors such as stress) • What can be done to address the pain (education, medicine, and exercise)		
The student will give the patient “homework” to complete prior to next session regarding PNE		