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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In females over 65 with chronic low back pain, is pain neuroscience education combined with therapeutic exercise more effective than therapeutic exercise alone in improving functional outcome scores? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| The patient is a 67-year-old female who has had low back pain for >10 years (“I can’t remember what it was like when I didn’t have it”). She believes her pain began when she was moving furniture in her home, and she was not able to go see physical therapy initially for it due to financial reasons. She is now in physical therapy through UNC’s charity care program. She said that there are some days she is unable to get out of bed due to the pain and only heat has helped reduce it. This patient has had MRI imaging done that showed mild spinal stenosis and therapeutic exercise paired with manual therapy has not led to major changes in pain level reports. Part of the issue is that the patient is limited in the exercises she can do during session because of pain and will stop doing exercises at home immediately if she feels pain with the exercises. Due to her fear avoidance due to high levels of pain and irritability displayed during treatment sessions, I want to know if pain neuroscience education would be a suitable adjunct to the current therapeutic exercise in her treatment plan. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| 8 studies met the inclusion and exclusion criteria including 3 systematic reviews and 5 RCTs. One systematic review used its data to conduct a meta-analysis.   * Pain neuroscience education can help decrease a patient’s pain levels, disability level, fear avoidance, and change their perception of their pain.7,8 * Kinesiophobia (fear of movement) is a key predictor of chronic pain outcomes.7 * Pain neuroscience education is more effective when paired with another physical therapy treatment including therapeutic exercise, manual therapy, and dry needling.7,8 * Pain neuroscience education content and formatting can be individualized for the patient to fit their specific needs. 7,8 |

**CLINICAL BOTTOM LINE**

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| Patients who display fear avoidant behaviours and identify pain as a barrier to exercise can benefit from pain neuroscience education paired with physical therapy interventions. PNE can decrease fear avoidance and increase participation in therapeutic exercises, which will improve the patient’s functional ability. Since various formats of PNE have shown to be effective in decreasing disability, the specific format of the PNE can be catered to the patient’s needs. PNE should be paired with physical therapy treatments such as therapeutic exercise to have the greatest effect on pain levels. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** | | | |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| low back pain  >65 years of age  chronic pain | pain neuroscience education  therapeutic neuroscience education | therapeutic exercise | functional outcome measure scores |

**Final search strategy (history):**

*Show your final search strategy (full history) from PubMed. Indicate which “line” you chose as the final search strategy.*

low back pain AND (pain neuroscience education OR therapeutic neuroscience education) AND therapeutic exercise AND Oswestry

low back pain AND (pain neuroscience education OR therapeutic neuroscience education) AND Oswestry

**chronic back pain AND (pain neuroscience education OR therapeutic neuroscience education) AND physical therapy**

*In the table below, show how many results you got from your search from each database you searched.*

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **Pubmed**  **Cochrane Library**  **CINAHL** | 78->31  22  8 | **Systematic reviews and RCT only within the last 10 years, 31 results** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| -In treatment for chronic low back pain  -Pain neuroscience education used as intervention  -Peer reviewed |
| **Exclusion Criteria** |
| -Published prior to 2000  -Not published in English  -Case study |

**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

*For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).*

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| **Author (Year)** | **Risk of bias (quality score)** | **Level of Evidence** | **Relevance** | **Study design** |
| **Louw et al (2016)** | **Quality Assessment of Systematic Review\*: Good (7/7)** | **1** | **High** | **Systematic review** |
| **Barbari et al (2020)** | **Quality Assessment of Systematic Review\*: Good (7/7)** | **1** | **High** | **Systematic review** |
| **Bodes et al (2018)** | **Cochrane risk of bias: some concerns (no blinding of outcome assessment and high risk of reporting bias)** | **2** | **Mod** | **RCT** |
| **Malfliet et al (2018)** | **Cochrane risk of bias: low risk of bias** | **2** | **Mod** | **RCT** |
| **Tellez-Garcia et al (2015)** | **Cochrane risk of bias: low risk of bias** | **2** | **Low due to inclusion of dry needling** | **RCT** |
| **Sillevis et al (2021)** | **Cochrane risk of bias: some concerns (small convenience sample size)** | **2** | **Low; short intervention (5 min video) and not specifically targeting low back pain** | **RCT** |
| **Mafliet et al (2018)**  **(blended learning)** | **Cochrane risk of bias: low risk of bias** | **2** | **Mod** | **RCT** |
| **Wood et al (2019)** | **Quality Assessment of Systematic Reviews and Meta-analyses\*: Good (8/8)** | **1** | **High** | **Systematic review and meta-analysis** |

**\***Quality Assessment of Systematic Review and Meta-analyses link: <https://documentcloud.adobe.com/link/track?uri=urn:aaid:scds:US:26fce90d-8851-469a-9fbe-ce7da5d59470>. This assessment was developed by the National Heart, Lung, and Blood Institute of the NIH. It includes 7 criteria questions for systematic reviews and 8 criteria questions for systematic reviews that include a meta-analysis.

**BEST EVIDENCE**

The following 2 studies were identified as the ‘best’ evidence and selected for critical appraisal. Rationale for selecting these studies were:

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| * The systematic review and meta-analysis by Wood and Hendrick was chosen because it was rated as a high-quality student by the NIH’s quality assessment and included a meta-analysis. It was the only systematic review that included a meta-analysis, which increases the number of observations and the statistical power of the data.It was highly relevant to the clinical scenario as all the RCTs included in the review used PNE as part of the intervention for patients with chronic low back pain. * The Mafliet et al RCT that utilized blended learning was chosen because it was the highest quality RCT based on multiple risk of bias assessments and the only one that used blended learning. It had a larger sample size compared to other RCTs and also assessed the effect of PNE on fear of movement as well as disability. |

**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of A systematic review and meta-analysis of pain neuroscience education for chronic low back pain: Short-and long-term outcomes of pain and disability by (Wood and Hendrick, 2018)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of the systematic review and meta-analysis by Wood and Hendrick was to find the effectiveness of pain science neuroscience in treating low back pain in the short and long term. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| Systematic review and meta-analysis  Search strategy:  -Databases: CINAHL, Medline, Cochrane, and Web of Science  -Search terms: ((“low\* back” OR lumbar OR sciatic\* OR  “low back pain” OR “back pain” OR “back ache” OR  backache OR spinal OR spine) AND (education OR “pain  education” OR “neuroscience education” OR “pain biology  education” OR “pain physiology education” OR “neurophysiology  education”))  Selection Criteria:  -Inclusion criteria:   * RCTs from 2011-2017, * Participant characteristics: adult populations (>18 years old), chronic non-specific back pain for at least 3 months * Intervention: Pain neuroscience education or therapeutic neuroscience education, PNE could be used in conjunction with another PT treatment including therapeutic exercise, manual therapy, acupuncture, or dry needling   -Exclusion Criteria:   * Diagnoses excluded: cauda equina, spinal tumours, spinal fractures, spondyloarthopathies, multiple areas with chronic pain, and systematic pain conditions (fibromyalgia, chronic fatigue, rheumatoid arthritis, polymyalgia rheumatica) * Control group included PNE   Methods:  -Selection of articles: lead author did preliminary elimination and remaining articles were reviewed and approved by both authors  -Cochrane Risk of Bias was used for quality assessment of RCTs (>6/12 score= low risk of bias)  -Meta-analysis software: RevMan 5.1  -Both short term (6 weeks-12 weeks) and long term (>12 weeks) results were assessed |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| Setting varied from study to study, but patients were from outpatient clinics regardless of study location |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| 6,761 articles were found through the initial search strategy and after removing duplicates and screening titles and abstract 27 articles made it to full text review. Four trials were included from this search. A secondary search was conducted based on review of literature from experts in the field that may have been missed in the initial search. The secondary search produced three articles and one additional RCT was included after correspondence with the authors. All 8 studies were RCTs with participants >18 years old who have had chronic low back pain >3 months. Sample sizes ranged from n=12 to n=216. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The specific control treatment utilized varied between studies and included manual therapy with Maitland mobilizations biomedical education, anatomical education, aquatic exercises, dry needling, and standard PT treatment with therapeutic exercise. All followed the inclusion criteria, so the control group could not include pain neuroscience education. |
| *Experimental* |
| The experimental group all included pain neuroscience education in various presentation forms in conjunction to the control treatment. 6/8 studies included multiple sessions of PNE, but the frequency varied between studies. |
| **Outcome Measures**  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| 5/8 studies utilized numeric pain scale, while one study used the visual analog scale. 5/8 studies also used the Roland Morris Disability Questionnaire. 6/8 studies measured short term outcomes with 6 weeks, while 2 studies performed long term follow up at 12 months. All tests were given to patients by physical therapists in an outpatient setting.   |  |  |  |  | | --- | --- | --- | --- | | Test | Scoring Range | Type of Outcome Measure | # of studies utilized | | Numeric pain scale | 1-10 | Subjective patient report | 5/8 | | Roland Morris Disability Questionnaire | 0-24 | Patient reported outcome | 5/8 | | Visual Analogue Scale | 100 mm | Subjective patient report |  | | Quebec Back Pain and Disability Scale | 0-20 | Condition Specific Patient reported outcome | 1/8 | | Oswestry Disability Index | 0-50 points | Condition Specific Patient reported outcome | 1/8 | | Patient-Specific Functional Scale | 0-10 for each activity | Patient Reported Outcome | 1/8 | | Pain Disability Index | 0-70 | Patient reported outcome | 1/8 | |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.] |
| For pain, a meta-analysis was conducted based on the 10-point PNE scale compared to control groups at 31.8 days for the 6 studies that utilized short term outcomes. The different between the control and experimental groups were not found to be statistically significant and there was significant heterogeneity, but the subgroup analysis showed that the difference from the addition of PNE to standard physical therapy interventions was statistically significant. As a result, although there is low level evidence that PNE in isolation or combination with another treatment may increase pain relief in the short term, there is moderate level evidence that PNE combined with physical therapy interventions leads to a difference that is statistically significant compared to control groups. For disability, a meta-analysis was conducted using results from the Roland Morris Disability Questionnaire at 32.8 days. The mean difference of 2.28 overall was both statistically and clinically significant based on the MCID of 2 points. The results were not statistically significant for long term (12 months) differences in pain or disability. |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| The authors concluded that pain neuroscience education was beneficial in improving disability in participants when used alone and when paired with various PT interventions in the short term. Pain neuroscience education was beneficial when used in conjunction with physical therapy interventions in decreasing pain rating scores. They were unable to find strong evidence for PNE on disability or pain in the long term. They did not have specific recommendations for frequency or duration of PNE. They assert that the variety of PNE interventions in this study is a strength because it shows that multiple variations work and the specific type of PNE intervention can be adjusted to fit each patient’s specific needs. |
| **Critical Appraisal** |
| **Validity**  [Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| All the studies included in this systematic review and meta-analysis are RCTs, which is the highest level of evidence for research studies. They used the GRADE classification to measure risk of bias and found 1 article was a high level of evidence, while the other 7 articles were moderate quality of evidence. Given that all the studies included were moderate to high quality RCTs, moderate to strong evidence was used to create the systematic review. For the systematic review itself, it scored an 8/8 on the NIH’s Quality Assessment for Systematic Reviews (attached to this assignment) as the eligibility criteria was included, the literature search was comprehensive, full text articles were rated independently by both authors, and publication bis and heterogeneity were both assessed. There is also the potential for publication bias in that 3/8 studies in that systematic review were authored by prominent PNE authors who do receive monetary benefits from promoting PNE. For the meta-analysis, the heterogeneity in the data between studies was high for measurements regarding pain outcomes, which decreases the strength of the meta-analysis for this study. |
| **Interpretation of Results**  [This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| While I was initially primarily focused on how PNE could change pain outcomes in patients, Wood and Hendrick’s finding that there is moderate evidence that PNE could be effective in the short term in improving disability is very important because decreasing a patient’s disability could help them improve their functional status and help them become more involved in their activities of daily living. There was both statistical significance and clinical significance in the difference in change in disability based on the average improvement in the Roland Morris Disability Questionnaire score found following a meta-analysis using 5/8 studies and comparing it to its MCID of 2. While the potential for publication bias does exist due to the use of 3 articles authored by prominent PNE experts including Louw and Moseley, their articles were graded using the GRADE classification and were found to be of moderate quality with scores >6/12 and Louw et al 2016 article fulfilled 9/12 criteria. Although there was not statistical significance for long term improvement, there were also only 2 studies that investigated long term improvement, which shows an area that use additional research. |
| **Applicability of Study Results**  [Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| The results of Wood and Hendrick’s systematic review and meta-analysis show the impact PNE can have on improving disability outcomes both when combined with physical therapy treatments and when used alone. For my patient, short term improvement could help with patient buy in and improve her functional ability so that she could participate in more therapeutic exercise and will not be as limited by central sensitivity. There is also moderate evidence that PNE will decrease reported pain levels when paired with therapeutic exercise, which shows evidence for using PNE to decrease pain levels, which can also help decrease the patient’s barrier to exercise. Since PNE does not require any special equipment, it is a feasible intervention, and the main cost will be the time used to implement it. Since other interventions have only had mild improvements in pain levels, the evidence from this article shows that the addition of PNE could help improve the patient’s pain and disability outcomes in the short term. Since rapport has already been developed with the patient, introducing PNE will be easier to introduce to this patient. |

**(2) Description and appraisal of Blended-Learning Pain Neuroscience Education for People with Chronic Spinal Pain : Randomized Controlled Multicenter Trial by (Mafliet et al, 2018)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this study was to investigate if blended learning PNE (use of online PNE media in conjunction to traditional education methods) could help participants improve disability, decrease fear avoidance behaviors, and change perceptions of illness. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| Randomised controlled trial  Triple blind- The participants, the statistician who conducted data analysis, and the outcomes assessor who collected the data were all blinded. The participants and statistician did not know what the study’s hypothesis was and the outcomes assessor did not know the participants’ groups when collecting the data. The physical therapists who conducted the intervention were not blinded but only worked with the experimental group and not the control group.  Stratified permuted block allocation was used to randomize participants.  Outcome measure was given to participants at baseline and then following 3 PNE education sessions. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| University affiliated hospitals |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| n= 120  Diagnosis: nonspecific chronic spinal pain including low back pain, failed back surgery syndrome, chronic neck pain, chronic whiplash associated disorder; chronic low back pain comprised of the largest group in the study  Recruitment: flyers at universities, university hospitals, and primary care clinics and social media. Individuals who contacted the researcher filled out a screening questionnaire  Key demographics:  -mean age: experimental group: 37.5 years of age; control group: 42 years of age  -gender: 73 F, 47 M  -duration of illness/disease: experimental group: 97 months (8.08 years), control group: 67 months (5.58 years)  8 individuals dropped out before finishing the education sessions, but all participants were a part of analysis using the intention to treat principle |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| 3 educational sessions with information on mechanical causes of neck and back pain, anatomy, physiology, and biomechanics of spine, ergonometry and posture, lifting techniques, and education on the benefits of exercise with deliberately very little information on the nervous system. Educational sessions were conducted by physical therapists, but different PT compared to those that conducted the intervention treatment. The same format was provided for both groups, which was 3 sessions within a 2 week timeframe conducted by a PT. Session one was a small group session with a PowerPoint presentation with an educational booklet given. 2nd session comprised of an online learning that participants completed at home. 3rd session was a one-on-one session with a PT that was based on the participant’s individual needs. |
| *Experimental* |
| 3 sessions of PNE education using the same format listed above. PNE comprised of information involving the nervous system, especially the pain pathways and central and peripheral sensitization. It also covered the harm vs hurt principle and how pain does not always equate MSK tissue damage. |
| **Outcome Measures**  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| |  |  |  | | --- | --- | --- | | **Test** | **Purpose** | **Range** | | Pain Disability Index\* | how pain affects ADLs | 0-70; higher score= greater disability | | Tampa Scale for Kinesiophobia | rating fear of movement | 17-68; higher score= greater fear of movement | | Illness Perception Questionnaire | self-perception of illness including causes, controllability, and consequences | 7 subscales where each subscale is scored separately. 37 total items in questionnaire. | | Pain Catastrophizing Scale | measures degree of catastrophic thoughts | 0-65; higher score= higher degree of catastrophic thoughts | | Pain Vigilance and Awareness Questionnaire | assesses awareness and attention to pain | 0-80; higher score= greater awareness and preoccupation with pain |   \*Primary outcome measure  All outcome measures were administered by physical therapist at the university affiliated hospitals where the intervention took place. The outcome measures were administered prior to the intervention or control and then again following the three education sessions. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.] |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | Test | Mean Group Difference (post education) | 95% confidence interval | MCID | Effect size of PNE group | | Pain Disability Index | 1.84 | -2.8 to 6.47 | 7.04 | 0.07 | | Tampa Scale for Kinesiophobia | 5.42 | 2.86 to 7.97 | 3.49 | 0.56 | | Illness Perception Questionnaire for Timeline acute/chronic | 1.67 | 0.02 to 3.31 | 1.95 | 0.86 | | Pain Catastrophizing Scale | -0.58 | -4.06 to 2.89 | 5.08 | 0.12 | | Pain Vigilance and Awareness Questionnaire | 0.07 | -4.34 to 4.47 | 6.15 | 0.28 |   For the Illness Perception Questionnaire, each subscale is interpreted individually, so a total for the entire questionnaire could not be used. Instead, each subscale was calculated, and I chose the subscale with the most significant findings and that was relevant to my clinical scenario. Notable results: The mean group difference for the Tampa Scale for Kinesiophobia was greater than the MCID for the test. There was a large effect size for the Timeline subscale that assessed how long the patient felt the pain or symptoms were going to last. |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| While the authors found that pain neuroscience education alone may not have large effects on the patient’s disability due to the chronic pain, they did find that it could decrease fear of movement and improve their perception of the timeline of their pain. While the authors found that the mean difference in Tampa Scale for Kinesiophobia following PNE was greater than the MCID, there was only a medium effect size for the group. As a result, the authors concluded that pain neuroscience education can change a patient’s fear of movement and their perception of their pain and should be used in conjunction with other treatment rather than used alone. In their conclusion, the authors also discussed how the small to medium effect size and lack of statistical significance regarding the primary outcome measure may be due to the specific outcome measures used (i.e., using the Pain Disability Index rather than Roland Morris Disability Questionnaire) or the short follow up period. |
| **Critical Appraisal** |
| **Validity**  [Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| This RCT scored a low risk of bias using the Cochrane risk of bias assessment. It also scored an 8/10 on the PEDro scale, which ranks it as a high-quality study. The trial met all criteria, except baseline comparability and blind therapists. It is difficult for a physical therapy research study to blind the PTs, since the PTs must know what treatment, they are conducting. The differences in baseline comparability included a 3-year difference in length of chronic pain between the experimental group and the control group. On average, the experimental group had a longer duration of chronic pain compared to the controls. Another strength of the study is the large sample size compared to previous PNE studies and the exploration of blended learning. All outcome measures used were reliable and valid measures and fit the study’s goals. |
| **Interpretation of Results**  [This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| Although the study did have small to medium effect sizes for many of the outcome measures, including their primary measure (the Pain Disability Index), the use of a broader disability outcome measure rather than a disability measure more specific to the chronic spinal pain population could contribute to smaller effect sizes. The RCT was rated as a high-quality study using multiple risk of bias assessments and scales, including the GRADE assessment (10/12), the Pedro scale (8/10), and the Cochrane risk of bias assessment (low risk of bias), so the findings that were clinically significant have a low risk of being biased. The findings that were clinically significant, including decreasing fear of movement, were salient to the clinical scenario and this specific patient’s circumstances. While improvements in the disability outcome were not clinically significant with 3 sessions of PNE alone, decreasing fear of movement with 3 PNE session can decrease barriers to exercise and improve the patient’s participation in physical therapy. Also, the study focused on the effect of PNE alone when in clinic it would be paired with therapeutic exercise. |
| **Applicability of Study Results**  [Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| The main takeaway from the study for this patient is that PNE can be beneficial for patients who fear movement will harm their tissues and worsen their pain. For these patients, PNE can decrease their fear of movement, so that they can participate in more physical therapy exercises and stay in compliance with their HEP. A difference that was clinically significant was found following just three sessions of PNE, which is definitely feasible for this patient, especially because the specific duration and content of the PNE can vary. As a result, PNE can be easily added into a patient session and can be adjusted over multiple sessions as well. |

**SYNTHESIS AND CLINICAL IMPLICATIONS**

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

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| Both studies reviewed above show the potential impact PNE can have on a patient’s pain levels, disability, and fear of movement when used alone and in conjunction with physical therapy interventions, such as therapeutic exercise. The first study included in this CAT was a systematic review and meta-analysis of 8 RCTs that all involved using PNE in the intervention compared to a control group that received either no intervention or the physical therapy intervention alone. The meta-analysis allowed for data from multiple studies to be integrated to increase the statistical power and the volume of data utilized. Many PNE studies have had small sample sizes, so increasing the number of observations is important for increasing the validity of the results. Wood and Hendrick found that that the difference in disability outcomes (Roland Morris Disability Questionnaire) was statistically and clinically significant post PNE intervention when it was isolated and greater clinical improvement when combined with physical therapy. They also found that pain ratings decreased with PNE intervention when it was combined with PT intervention. The study fulfilled the criteria of a high quality systematic review and meta-analysis using the NIH’s quality assessment for systematic reviews and meta-analyses.  The 2nd study by Mafliet et al was a RCT that compared the effects of 3 PNE sessions to 3 biomedical education sessions. It is the only PNE study to utilize blended learning and combine in person education with online modules. The testing of the online module is especially salient during the time of this CAT as online learning and appointments have been increasingly relevant during the pandemic. This RCT utilized a larger sample size compared to other PNE studies and was also the highest quality RCT in this CAT based on the Pedro scale, GRADE assessment, and Cochrane risk of bias assessment. While the RCT found small to moderate effect sizes for four out of five outcome measures assessed, it did find that PNE alone showed a clinically significant difference in improving fear of movement. Decreasing fear of movement in patients is extremely important as it decreases barriers to exercise and improves their prognosis.  Both studies show the applicability of PNE for chronic pain physical therapy interventions, especially for patients who show fear avoidance behaviours. Many patients stop moving due to pain when movement and exercise in the long-term help alleviate pain symptoms. Future studies should consider blended learning combined with physical therapy intervention and an increased number of PNE sessions in their studies. Studies that combine physical therapy intervention with PNE would benefit from larger sample sizes across multiple centres. |

**REFERENCES**

[List all references cited in the CAT]

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