

**Title:** The effect of pain neurophysiology education on healthcare students' knowledge, attitudes and behaviours towards pain: a mixed-methods randomised controlled trial.

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## Abstract

**Objective:** 1) To investigate the effects of a brief pain neuroscience education (PNE) lecture on multi-disciplinary healthcare students' knowledge, attitudes and behaviours towards people with pain post intervention and at 6-months follow-up, 2) To explore students' perceptions of PNE.

**Design:** Mixed-methods randomized controlled trial

**Setting:** UK university.

**Participants:** Thirty-seven students (30♀, mean age 30years) from six healthcare disciplines.

**Intervention:** 70-minute PNE lecture (intervention group) or a 70-minute control education.

**Main outcome measures:** 1) Knowledge: The Revised Pain Neurophysiology Quiz (RPNQ); 2) Attitudes: Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS); 3) behaviours: A case vignette to assess clinical recommendations; and 4) thematic analysis of semi-structured interviews (n=12).

**Results:** The intervention group increased knowledge compared to the control, post-intervention [mean difference 3.7 (95% CI, 2.4, 5.0),  $P < 0.001$ ] but not at 6-months (0.1 (-1.1, 1.3),  $P = 0.860$ ). Greater improvements in attitudes for the intervention group were seen post-intervention [-10.4 (-16.3, -4.6),  $P < 0.001$ ] and at 6-months [-5.8, (-11.5, -0.2),  $P < 0.044$ ]. There was no difference in behaviours between groups. Thematic analysis identified increased patient empathy, partial and patchy reconceptualisation of pain and increased confidence in recommending an active management programme following PNE.

**Conclusion:** This study adds to existing knowledge by demonstrating that a 70-minute PNE lecture can have a short-term effect on knowledge and positively shift attitudes towards people with pain in the short and medium-term. It also resulted in some students' reconceptualisation of pain, increased empathy, and confidence to recommend activity. The effect of PNE on clinical behaviours was unclear.

## **Introduction**

Chronic pain can affect patients' daily activities, quality-of-life, social, workplace and family environments (Duenas et al 2016) and sense of personal identity (Crombez et al 2003). Patients with pain often report problems with their pain management including struggling to access healthcare support, as well as stigma and bias (Driscoll et al 2018; Toye et al 2013). Up to 28 million people in the UK have chronic pain (Fayaz et al 2016) and the cost of pain to the British economy in terms of workforce alone is estimated at £10.7 billion (NICE 2018). Thus, it is vital that health care professionals (HCPs) are well trained to understand and manage pain in keeping with guidelines such as the National Institute for Clinical Excellence (NICE) guidelines for low back pain (2016).

Pain is taught in a variety of ways within different disciplines and different institutions (Briggs et al 2011). In many cases it is not formally taught (Thompson et al 2018). An extensive UK survey by Briggs et al (2011) described pain education in higher education as 'woefully inadequate'. The International Association for the

Study of Pain (IASP) provides detailed discipline specific guidelines for pain education curricula, but uptake is poor (Briggs et al 2015). Thus, there is an urgent need to enhance undergraduate pain education training. Furthermore, as pain management is a collaborative process between multiple disciplines, organisations such as the British Pain Society (BPS 2018) and IASP (2018) advocate interdisciplinary pain education.

Pain neurophysiology education (PNE) is commonly used clinically with patients to facilitate a better understanding of their pain (Watson et al 2019). It aims to reconceptualise patients' understanding of pain from a biomedical to a biopsychosocial perspective (Moseley and Butler 2015). PNE for patients could be tailored to healthcare students because it maps to important components of the IASP curriculum (eg 1c and 3f) (<https://www.iasp-pain.org/Education/CurriculumDetail.aspx?ItemNumber=2057>) and given their early educational stage and limited physiology/biology background, the metaphorical approach to explaining neuroscience-based principles of musculoskeletal pain may be quite useful.

A number of studies have investigated the effect of PNE upon student HCPs' understanding of pain (Colleary et al 2017; Cox et al 2016; Maguire et al 2019; Zimney et al 2018). Only two of these studies were Randomised Controlled Trials (RCTs). Both were limited to physiotherapy/sports therapy students with no follow-up assessment beyond the immediate post-education point (Colleary et al 2017; Maguire et al 2019). These studies were quantitative in nature, with no qualitative

exploration of student experiences of the education to allow deeper insight into their understanding of pain. This study will add to the existing knowledge by measuring the medium-term effect of 70-minutes of PNE on a multidisciplinary student group's knowledge, attitudes, and behaviours towards pain.

The aims of this mixed-methods RCT were to: 1) investigate the effects of a brief PNE lecture on multidisciplinary healthcare students' knowledge, attitudes and behaviours towards pain in the immediate and medium-term, and 2) explore multidisciplinary healthcare students' perceptions of PNE.

## **Methods**

### **Design**

In this single-site, single-blind RCT, student HCPs were randomised to receive either a 70-minute PNE lecture or a 70-minute control lecture based on red-flags. This study protocol was registered at ClinicalTrials.Gov (NCT03710837). Twelve students from the PNE group were also interviewed to explore their experience of the intervention. The following outcome measures were collected before, immediately after, and 6-months after the education sessions:

- Revised Pain Neurophysiology Quiz (RNPQ) (Catley et al 2013) for pain knowledge.

- Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) (Houben et al 2004) to measure attitudes and beliefs towards people with pain.
- Case vignette to measure behaviour (clinical recommendations).
- Red-flag knowledge questionnaire (Colleary et al 2017 and Maguire et al 2019)

Qualitative data collected after PNE was analysed using thematic analysis (Braun and Clarke, 2006). Pragmatism was the philosophical approach to this mixed-methods study, wherein the quantitative data was further informed by qualitative data (Cresswell et al, 2018).

## **Participants**

Students of pre-registration physiotherapy, occupational therapy, radiography, paramedic, nursing or midwifery in their first or second year at XXXXXXXX University in England were invited to participate in this study. Students were excluded if they had received PNE previously. Potential participants were invited by email, an advertisement was placed on campus and the lead author delivered 5-minute presentations to all eligible student groups during routine lectures to raise awareness of the study. Participants were also invited to take part in a semi-structured interview to explore their experience of the intervention. Data collection occurred between 10/2018-10/2019. At 6-months post-intervention data was collected using onlinesurveys.com (Bristol, UK), with a reminder at two weeks. An a-

priori sample size calculation estimated that 24 participants in total were required to identify an effect size of 1.83 with a power of 99% and an alpha = 5%. Effect size was calculated using G\*Power based upon HC-PAIRS data from a previous study (Colleary et al 2017). To allow for a drop-out rate of 20% (Bell et al 2013), a target sample of 30 participants was sought. Participants who returned their follow-up survey at 6-months received a £30 voucher. Ethical approval for this study was obtained from the Research Ethics and Governance Committee of the School of Health and Life Sciences at XXXXXX University, participants gave informed consent.

## **Interventions**

Both PNE and control lectures were delivered by one individual (CR), a physiotherapist trained and experienced in PNE delivery. Both groups received a 70-minutes didactic group-lecture using PowerPoint. Post-lecture questions were permitted but limited due to a lack of time.

The control group received education about red-flags which are special screening questions for serious pathology, (NICE, 2018). The red-flags education discussed tissue pathology and Waddell's triage (2004) for back pain classification.

Neurophysiology and the biopsychosocial model were not discussed. This provided a professionally relevant attention-control (Aycock et al 2018) which had face-validity for pain education but was different to PNE. This education has previously been used successfully by our group as a control education for PNE (Colleary et al 2017; Maguire et al 2019). The intervention group received a PNE lecture based on the

explanations used in *Explain Pain* (Butler and Moseley, 2003). Free hand drawings, interactive exercises, metaphors and stories were used to convey messages about pain science and theory (appendix 1).

## **Outcomes**

Before, immediately after, and 6-months after the education session participants completed four questionnaires, the RNPQ, the HC-PAIRS, a case vignette and the red-flags questionnaire. Additionally, participants were asked to identify their healthcare discipline, level of study, year of study, age and gender.

## **RNPQ**

The 12-item RNPQ was used to assess knowledge of pain neurophysiology.

Responses are marked yes, no or undecided. One point is awarded for correct answers. Scores range from 0-12, with high scores indicating good knowledge. The RNPQ is a valid and reliable tool for assessing pain knowledge (Catley et al 2013).

There is no established minimally clinically important difference (MCID) for the RNPQ. However, this can be tentatively estimated as half the baseline SD presented in previous studies (Dworkin et al 2008); based upon data from Catley et al (2013) the MCID was set at 0.9 points or 7.3%.

## **HC-PAIRS**



The modified HC-PAIRS (Houben et al, 2004) was used to measure attitudes and beliefs towards patients with chronic pain and their ability to function. This 13-item questionnaire uses a 7-point Likert scale (strongly disagree to strongly agree). Scores range from 13-91 with lower scores suggesting more positive attitudes. The HC-PAIRS has demonstrated good levels of validity and reliability (Cross 2010; Moran et al 2017). There is no established MCID for the HC-PAIRS. However, in previous studies we have estimated this to be 4.2 points [or 4.6%](#) (Mankelov et al in submission).

### **Case vignette**

Participants were given a case vignette featuring low back pain to assess their behaviour (clinical recommendations). Recommendations about daily activities, work, exercise and bed rest were assessed. Questions and possible responses are shown in Table 1. The vignette and questions were adapted from a previous study (Bishop et al, 2008), and has been used previously by our group (Colleary et al 2017; Maguire et al 2019). The number and percentage of recommendations in keeping with clinical guidelines were recorded.

### **Red-Flag Quiz**

The Red-Flag quiz is a 10-item quiz, with yes/no answers that assesses knowledge of red-flags (appendix 2). Scores range from 0-10. This questionnaire was developed

within our team and has been used in two previous studies with students HCPs (Colleary et al 2017; Maguire et al 2019). This is not a validated questionnaire and was intended to facilitate participant blinding, rather than to be used as an outcome measure. However we have reported upon it in the interest of full disclosure.

### **Statistical analysis for Quantitative Data**

The distribution of the data was explored visually and using the Shapiro-Wilk test. All continuous data was normally distributed and presented as mean [standard deviation (SD)]. Categorical data was presented as percentages. Between-group differences in the change scores for the RNPQ and the HC-PAIRS were undertaken using ANCOVA adjusting for age, gender and baseline values. For the vignette analysis, groups were compared using Fisher's exact test with appropriateness of the recommendation as the dependent variable and group as the independent variable.

### **Blinding and randomisation**

Participants were randomised into either group by a researcher external to our research team, using an online random number generator ([www.random.org](http://www.random.org)).

Participants were blinded to the specific aims of the study. They were informed the study was comparing two different educations rather than explicitly stating that PNE was the intervention of interest.

### **Qualitative data collection**

All participants within the PNE group were invited to attend a semi-structured interview within two weeks of receiving the education. Participants were asked about their experience of PNE, and how PNE influenced their understanding about the nature, cause and experience of pain (appendix 3). During the interview the case vignette was also discussed with participants to explore their clinical reasoning processes. All interviews were undertaken by the lead author, audio recorded and transcribed verbatim.

### **Qualitative Data Analysis**

NVivo software (version 12) and paper transcripts were used for inductive thematic analysis (Braun and Clarke 2006). The transcripts were read multiple times and statements provisionally coded by JM. Coded statements were then grouped together into emergent themes. All views were treated equally. A second researcher (CR) also read all the transcripts to ensure the themes were logical and rooted in the data and all authors reviewed the final conclusions.

### **Reflexivity**

Researcher background may influence data, collection, analysis and interpretation (Jootun et al 2009). Two of the four researchers (JM and CR) have experience of delivering PNE and are physiotherapists who regularly deliver PNE to patients and

students. DM and PT do not have experience of PNE delivery. A reflexive journal was kept.

## **Results**

Forty-six students volunteered to participate however thirty-seven students attended the lectures. Nine participants did not attend the lecture; four did not make contact, five cited time conflicts. There were no drop-outs between the education delivery and the 6-month follow-up (Figure 1). There was no difference between the groups at baseline for any outcome measure (Table 2).

Three participants had missing data in knowledge and attitude outcomes, specifically one question was left unanswered on one HC-PAIRS questionnaire and one question was missing on two RNPQ questionnaires. As per Houben et al (2004) the single missing answer for the HC-PAIRS was imputed with a neutral response of four while the missing answers for the RNPQ were imputed with a zero.

### **Quantitative results**

Immediately post-education the PNE group had a significantly greater increase in pain knowledge compared to the control group, but there was no significant difference between groups at 6-months (Table 3). Attitudes towards people with pain in the PNE group were significantly improved (lower) compared to the control group both immediately post-education and at 6-months (Table 3).

At no point after the education was there a significant difference between groups in any of their clinical recommendations for the case vignette. The majority of recommendations made in both groups were in keeping with guidelines (Table 4). There were a number of missing answers on the vignette-based recommendations. These are illustrated in Table 4.

### **Qualitative results**

Twelve participants from the PNE group volunteered for interview (1 male, 11 female, mean age 32yrs). The disciplines represented were: paramedic n=3, occupational therapy n=5, physiotherapy n=1, nursing n=2, diagnostic radiography n=1. The average interview time was 24 minutes (range 14-33 minutes). The three themes identified within the data were: 1) partial reconceptualisation of pain 2) empathy for pain patients 3) increased willingness to make active, evidence-based recommendations.

### **Theme 1: Empathy for pain patients**

Empathy can be defined as an experiential way of grasping another's emotional states, [Halpern 2003] combining affective, cognitive, behavioural and moral

dimensions (Jeffrey 2016). All participants showed evidence of increased empathy, some overtly stated that they had more empathy (P6), while others implied it (P11):

*“I’ll have greater empathy now, when there’s chronic low back pain.” (P6)*

## **Theme 2: Willingness to make active, evidence-based recommendations to patients**

All participants evidenced the intention to provide active, evidence-based, recommendations, however many referred to the notion of making return to activity ‘palatable’ to patients (P8) thus the majority advised gradual return to activities. Only Participant 9 recommended immediate return to all activity but defended this approach by suggesting,

*“If you tell them [patients] to gradually build it up you are implying that there is something more, a problem.” (P8)*

A number of participants acknowledged the role the new information would play in future decision-making. They were more confident about the health of the tissues and thus more confident to recommend a more active approach to management such as physical activity and socialising at work, and could see the merit in a more psychologically informed approach. A number of participants highlighted that they would not recommend passive approaches such as bed-rest.

*“So I feel like him [the patient] [I can] push him a little bit more. I’m like let’s try this or let’s do that...” (P1)*

*“There’s no reason she [the patient] can’t go back and do it. You know pain is danger signals ... tissues heal so there’s no reason why she can’t, it’s not all in her head but it’s more that, it’s more of a psychological thing,...” (P1)*

In contrast, one participant in particular, showed little change in their approach to making clinical recommendations. This participant expressed the most established biomedical thought processes.

*“You can probably buy an OTC [over-the-counter] back support. ... you’re going to have to see what’s wrong cos she [the patient] has had an injury four years ago but there’s no history of trauma. She does need to carry on...” (P11)*

### **Theme 3: Partial reconceptualisation of pain**

Pain reconceptualisation can be described as increased awareness that 1) pain is not a measure of tissue damage, 2) persisting pain does not mean tissues have not healed, 3) pain is a conscious correlate of the perception of tissue danger, 4) pain is influenced by biological, psychological and social factors (Moseley, 2007).

All participants showed signs of partial reconceptualisation of pain, though, the extent was, to use a term previously coined by our group, ‘partial and patchy’ (Robinson et al, 2016, King et al, 2018).

*“If you worry about something too much it (pain) will just get worse. It’s better to think it will pass. Your brain is quite able to deal with it.” (P5)*

*“It’s hard to remember what he [the lecturer] said but it’s not always damage....even when something has healed it can have a knock-on effect in the long term.” (P6)*

In contrast to the rest of the participants, participants 8 and 11 retained views heavily biased towards the biomedical model:

*“If you’re standing all day doing a job [previously referring to supermarket work] you’re not going to be free of the risks of standing and lifting, picking stuff up.” (P8)*

And referred to an area of chronic pain as:

*“A weakened spot. I kind of know I have to work through it... very much in pain on Tuesday so knew I should wear my back brace on Wednesday. So I wore it for 2 days and the pain eased. My pain theory is if it hurts the next day, it’s maybe a little too much.” (P11)*

Participant 11 had had considerable previous personal experience of musculoskeletal injury management and though there were signs of patchy reconceptualisation, there was an absence of ‘personal relevance’ or relating the information to self. Nevertheless this individual stated:



*“...Chronic pain it won’t tell you about the cause of the pain now because the tissue damage will have mended.” (P11)*

## **Discussion**

This study investigated the effects of a short 70-minute PNE lecture upon student HCPs’ pain knowledge, attitudes, clinical behaviours, and their perception of PNE. The PNE group increased knowledge compared to the control group post-intervention but not at 6-months. The greater increase in pain knowledge for the PNE group immediately post-intervention is in keeping with previous RCTs in physiotherapy/sports injury students (Colleary et al 2017; Maguire et al 2019). The mean difference in knowledge between groups in the Colleary et al (2017) and Maguire et al (2019) RCTs of 30% and 25% improvement, respectively, is comparable to the mean difference in knowledge in this study of 31% (3.7 points). Our findings demonstrate that students from a range of disciplines can take on the information provided in PNE. Furthermore this change exceeds the MCID proposed earlier of 0.9 points/ 7.3%. However, the change noted in this RCT drops considerably at 6-months and there is no longer a significant difference between groups. This suggests that a one-off session is not sufficient to increase knowledge in the medium-term and emphasises the importance of repetition of this information throughout the undergraduate course.

The greater improvement in attitudes towards people with pain for the PNE group seen immediately post-treatment (19%) in this study is in keeping with previous RCTs in physiotherapy and sports injury students, 20% and 15.2% respectively (Colleary et al 2017; Maguire et al 2019). The mean difference change in HC-PAIRS between groups dropped to 10% (5.8 points) at 6-months. These figures are statistically and clinically significant at both measurement points.

The changes in attitude at 6-months within the PNE group of 8 points found in this study is comparable to previous studies which showed changes of 9-10 points over the course of a 4 year degree physiotherapy degree (Ryan et al 2010) and a five year medical degree (Morris et al 2012) using the original 15 point HC-PAIRS. Thus the changes seen in the current study are relatively large for a 70-minute session compared to the usual change achieved in a four/five year undergraduate program.

Both knowledge and attitudes gains were not sustained to the same level at 6-months suggesting that PNE should be repeated at multiple points in the curricula to sustain levels of knowledge about pain which reflect the current knowledge base and underpin effective management strategies. The education could be presented in different formats to refresh pain science knowledge and aid the application of the knowledge as it has been found amongst student HCPs (and qualified HCPs) that they are not always confident about applying the pain management knowledge acquired (Carroll et al 2020; Synott et al 2015; Pearson et al 2017). Skills such as active listening (Traeger et al 2019) and motivational interviewing (Nijs et al 2020) could be taught in conjunction with PNE whilst carefully integrating biomedical

information simultaneously delivered on the degree course, so that appropriate shifts towards a biopsychosocial understanding are not compromised by material from a different philosophical perspective. PNE could be considered a threshold concept (Jones and Hush 2011) and its teaching will thus need to be 'recursive' or repeated and 'excursive' or with the intention to reach a specific knowledge that is not expected to be a linear process (Cousin 2006). Characteristics of threshold concepts are defined by Meyer and Land (2003) as a) *transformative*, b) probably *irreversible*, c) *integrative* (layering new information with old), d) *bounded* (by conceptual terminal frontiers which may take the form of a discipline or academic frontier), e) potentially *troublesome* (as the bigger picture is not visible but the ability to execute some aspects of a new concept are developed). Meyer and Land (2003) also use the term potentially 'subversive' to describe threshold concepts which can be understood immediately or 'protracted over time' with a 'troublesome' journey. Furthermore they assert that understanding of a subject does not necessarily lead to a 'qualitatively different view of a subject matter.' This became evident in this study's qualitative data analysis. Finally, it is clear that there is not a simple, direct relationship between knowledge and attitudes as knowledge may not be sustained but attitudes remain improved. However, attitudes did reduce between the immediate and 6-month follow-up period and this tail-off may have been associated, at least in part, with a reduction in knowledge.

There was no statistically significant difference in active, evidence-based, clinical recommendations/ behaviours stemming from the vignette between the groups at baseline, post-intervention or at 6-months. This may have been due to a ceiling

effect as appropriate recommendations were at a good level (in excess of 60% appropriate) at baseline in both groups. This ceiling effect could be attributed to public education campaigns which advise 'keep active, don't stop' discussed by Participant 4, during interviews when asked why she would make her active, evidence-based recommendations. A similar degree of improvement in recommendations was seen in both groups, thus it could be argued that the improvement in the intervention group brought about by the PNE may have been masked by unexpected improvements brought about by the red-flags education. Additionally the vignette and associated questions may not be sensitive enough to detect small changes in behaviours stemming from knowledge acquisition, among those already performing well in terms of evidence-based recommendations. Baseline appropriate recommendations were consistently higher in this study than in Colleary et al (2017) and Maguire et al (2019).

The qualitative data suggests that students in the PNE group were more confident in recommending active, guideline-compliant management and this may have been linked with a reconceptualised view of pain as not being a marker of tissue damage. However, it also reveals a less positive and more uncertain picture of appropriate active recommendations than the quantitative data suggests. This reflects the limitations of vignettes and the challenges of narrowing down complex clinical reasoning and decision-making into simple short-statement multiple-choice answers. It is logical perhaps to expect that if reconceptualisation is partial and patchy then appropriate active recommendations will be too as there is evidence that HCP attitudes affect their management of patients in pain (Darlow et al 2012).

The varying degrees of pain reconceptualisation was revealed by conflicting ideas/recommendations in the same sentence by study participants. This partial reconceptualisation has previously been identified in patients with persistent pain following similar single sessions of PNE (King et al 2016; Robinson et al 2016). The partial reconceptualisation may have contributed to the attitudinal changes.

Additionally, the qualitative findings of reconceptualisation corroborate the changes in both attitude and knowledge scores, indicative of an understanding of pain more in keeping with contemporary pain science.

The qualitative data also suggested an increase in empathy that was evident to some extent in all participants. Batson et al (1997) showed that increased empathy can improve attitudes towards a group. Thus, the increase in empathy within the PNE participants could have contributed to the positive shift in attitudes. Empathy has been identified as an important determinant of patient outcome (Mercer, Reilly and Watt 2002), thus, the increase in student empathy is an encouraging sign.

### **Limitations**

Data was not collected for red-flags at 6-months post-intervention due to human error which could have affected blinding of the control group at that point. Students given the attentional control did not have any questions relevant to their teaching, however the success of the blinding process was not assessed.

It would have been interesting to do another follow-up interview at the 6-month point to facilitate in-depth explorations of pain understanding beyond the immediate term. Future studies should consider longer-term qualitative follow-up.

Member checking was not carried out as quantitative data collection was pending at 6 months post-intervention and the research team did not wish to influence the recall of information from the intervention group. Member checking is not indicated for all types of research (Thomas 2017) and it can bias interpretation of interviews (Morse 1994; Angen 2000).

Interviewing 12 of the 19 participants in the intervention group within two weeks of the intervention, may have affected the results of the PNE group at 6-months by a process of recursive education. Whilst the interviewer (JM) was careful not to provide additional information during the interviews, the opportunity to recall and discuss the lecture may have reinforced some of the information.

This is the first RCT to follow students beyond the short/immediate term, 6-months is still a relatively short period and there is a need to investigate if the effects are maintained in the longer-term. Additionally, while a case vignette can be a useful proxy for clinical behaviour (Hrisos et al 2009), there is a need to investigate the implications of PNE-based education of students on actual clinical practice and patient outcomes. Nevertheless, a key strength of this work is its multidisciplinary focus, given the multidisciplinary nature of chronic pain management, and the uni-

disciplinary nature of previous PNE studies primarily restricted to physiotherapists/sports therapists (Colleary et al 2017; Cox et al 2016; Maguire et al 2019; Zimney et al 2018).

The transferability of these findings should be considered. The high mean age in this study is a reflection of the participant demographic in the north east of England where this study took place. This region has the lowest number of 18-19 year old students in the country (Bolton 2020) thus the majority, 70% of students, are not school leavers. However, the students are all on Health and Care Professions Council (HCPC) and professional body registered courses comparable to the rest of the UK.

### **Recommendations for educators**

The delivery of a 70-minute PNE lecture can have a significant impact on an interdisciplinary group of student HCPs' attitudes and knowledge in the short-term and attitudes in the mid-term. This is logistically relatively easy to provide for students and in keeping with international curriculum guidance (IASP, 2018). However, top up sessions throughout the programme appear warranted.

### **Recommendations for clinicians**

Students may benefit from clinical placement supervisors' support in applying biopsychosocial management of pain to consolidate their pain education.

## **Recommendations for researchers**

The long-term effects, effects within specific disciplines, and the effects of top-up sessions warrant further investigation. The impact of PNE upon clinician behaviour and patient outcome also requires further investigation.

## **Conclusion**


A brief PNE lecture can increase multidisciplinary student HCPs' pain knowledge and attitudes towards people with pain in the short-term. The impact on attitudes but not knowledge is still apparent at 6-months. The drop-off in knowledge and attitudes over time suggests that reinforcement of PNE throughout pre-registration HCP programmes may be warranted. The effect of PNE on clinical behaviours was unclear.




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**Table 1**

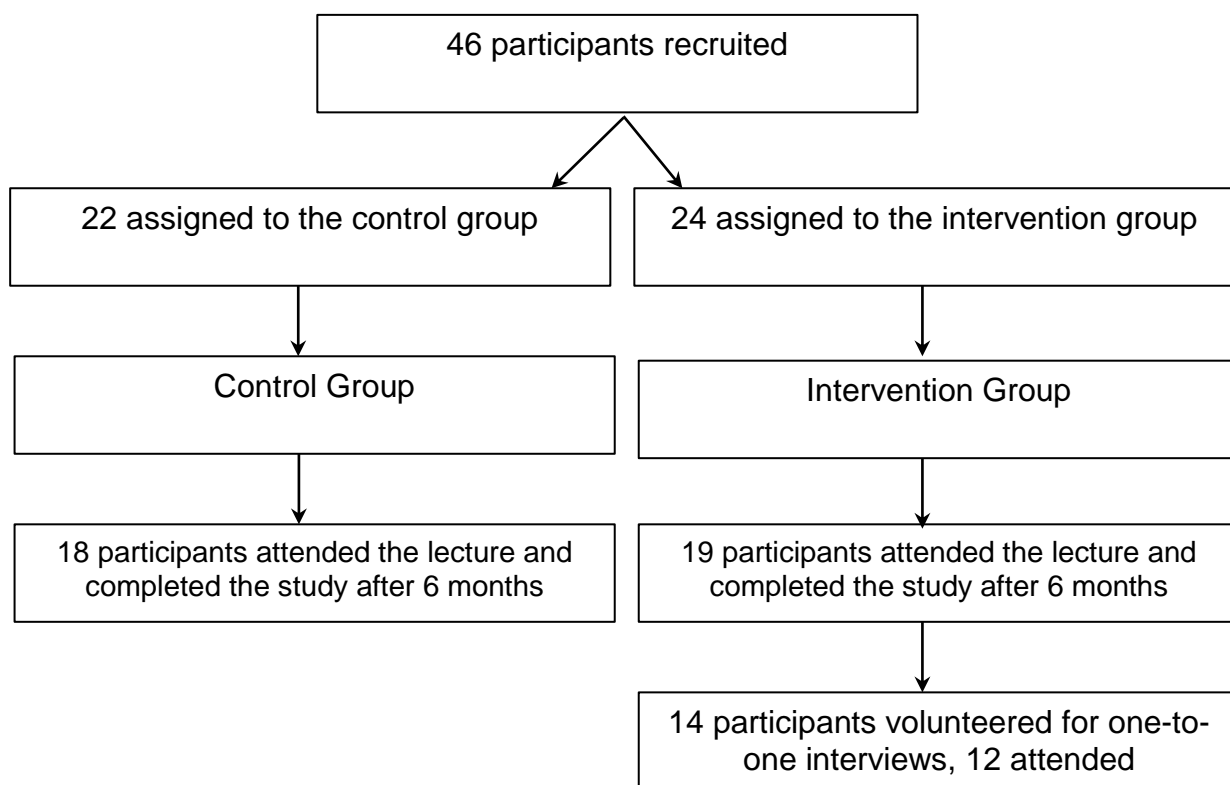
**Case Vignette Scoring**

Question	Response option on questionnaire	Classification of response
<b>Work</b>	Return to normal work	appropriate recommendation
	Return to part-time or light duties	
	Be off work for a further.... weeks (stating number of weeks)	inappropriate recommendation
	Be off work until pain has improved	
Be off work until pain has completely disappeared		
<b>Exercise</b>	Return to normal exercise classes	appropriate recommendation
	Return to light class participation	
	Refrain from participating for a further ... weeks (Stating number of weeks)	inappropriate recommendation
	Refrain from participating until pain has improved	
Refrain from participating until pain has completely disappeared		
<b>Activity</b>	Perform usual activities	appropriate recommendation
	Perform activities within the patient's tolerance	
	Perform only pain free activities	inappropriate recommendation
Limit all physical activities until pain disappears		
<b>Bed rest</b>	Avoid resting in bed entirely	appropriate recommendation
	Avoid resting in bed as much as possible	
	Rest in bed only when pain is severe	inappropriate recommendation
	Rest in bed until pain improves substantially	
Rest in bed until pain disappears		

*Legend: Case vignette options for clinical recommendations regarding work, exercise, activity and bed rest. The first two responses are appropriate recommendations, the last remaining options are considered inappropriate. Adapted from Bishop et al (2008).*

**Figure 1**

**Flow diagram for recruitment and participants**



**Table 2**

**Baseline participant characteristics**

	<b>PNE</b>	<b>Control</b>
<b>N</b>	19	18
<b>Age</b>	31 (8)	30 (11)
<b>Gender</b>	17♀ 2♂	13♀ 5♂
<b>Disciplines</b>		
<i>PT (n)</i>	2	2
<i>OT (n)</i>	8	5
<i>Paramedic (n)</i>	3	3

<i>Radiography (n)</i>	1	2
<i>Midwifery (n)</i>	1	3
<i>Nursing (n)</i>	4	3
<b>RNPQ (0-12)</b>	5.7 (2.1)	6.6 (2.1)
<b>HC-PAIRS (13-91)</b>	54.6 (9.6)	53.6 (8.7)
<b>Red-flags quiz</b>	5.9 (3)	4.8 (2.1)
<b>Appropriate clinical recommendations</b>		
<i>Daily activities (n, %)</i>	18 (95)	13 (72)
<i>Exercise (n, %)</i>	13 (68)	13 (72)
<i>Work (n, %)</i>	15 (79)	13(72)
<i>Bed rest (n, %)</i>	13 (68)	12 (67)

*Legend: Data are presented as mean (standard deviation) except gender, discipline and clinical recommendations.*

**Table 3**

**Change in knowledge and attitudes after the education session.**

<i>Data collection point</i>	<i>Group</i>		<i>Between Group Mean difference</i>	<i>P-value</i>
	<i>PNE Mean (SD)</i>	<i>Control Mean (SD)</i>	<i>(95% CI)</i>	
<b><i>Change from Baseline to Immediately post-lecture</i></b>				
RPNQ	3.7 (0.4)	-0.01 (0.4)	3.69 (2.4 - 5.0)	0.001

HC-PAIRS	-17.1 (11.5)	-6.7 (8.8)	-10.4 (-16.3 , -4.6)	0.001
Red-Flags	1.0 (1.4)	1.7 (1.4)	-0.7 (-1.7 , 0.3)	0.143
<b><i>Change from Baseline to 6-months post-lecture</i></b>				
RPNQ	2.1 (0.4)	2.0 (0.4)	0.1 (-1.1 , 1.3)	0.860
HC-PAIRS	-8.0 (8.1)	-2.2 (9.5)	-5.8 (-11.5 , -0.2)	0.044

*Legend: RPNQ – Revised Pain Neurophysiology Quiz, HC-PAIRS - Health Care*

*Providers’ Pain and Impairment Relationship Scale collected immediately post-intervention and 6 months after intervention. Red-flag responses were not collected at 6-months, due to human error this questionnaire was not added to the online survey.*

**Table 4**

**Evidence-based clinical recommendations after the education session**

Recommendation	Appropriate recommendation, n, (%)		P-value
	PNE	Control	
Daily activity			
Baseline	18 (95)	13 (72)	0.090
Immediately post	16 (100)	16 (94.1)	1.00
6/12	18 (94.7)	15 (83.3)	0.340
Exercise			
Baseline	13 (68)	13 (72)	1.00
Immediately post	15 (93.8)	16 (100)	1.00

6-months post	18 (94.7)	16 (88.9)	0.604
Work			
Baseline	15 (79)	13(72)	0.714
Immediately post	15 (93.8)	16 (100)	1.00
6-months post	19 (100)	17 (94.4)	0.486
Bed rest			
Baseline	13 (68)	12 (67)	1.00
Immediately post	16 (94.1)	12 (70.6)	0.175
6-months post	15 (78.9)	14 (77.8)	1.00

*Legend: Data are presented as number of responses (%). A number of questions were not answered at all three time points as indicated by the variation in number of responses.*