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The ROI of Preoperative Pain Neuroscience Education

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Introduction

Orthopedic surgery is one of the most common medical procedures in the United States, and its prevalence is only increasing. It is estimated that over 2 million spine surgeries are performed in the US annually, while over 1.5 million total knee arthroplasties (TKA) are performed.[1-3] What makes these numbers even more significant is that since 2010, TKAs have doubled.[4] Because of the increasing numbers of orthopedic surgeries in the US, these procedures have come under new scrutiny due to their ever-increasing costs and associated patient outcomes.

One in three patients still experience significant pain and disability following lumbar surgery, while one in five patients experience persistent pain and disability following TKA.[5-7] To address this pain, patients are sometimes sent to physical therapy for treatment after lumbar surgery and TKA. Recent research specific to postoperative rehabilitation, however, has highlighted issues with this assumption. First, postoperative rehabilitation following TKA or lumbar surgery has shown limited efficacy in reducing postoperative pain and disability.[8,9] Second, the exact content, frequency, duration, and timing of optimal postoperative rehabilitation is not known.[8] Third, and finally, it is now known that many patients are not readily sent to physical therapy following lumbar surgery and TKA, despite the presence of pain and disability.[10]

Given the increasing number of surgeries, high percentage of patients with ongoing pain and disability, limited efficacy, and referral to physical therapy, large numbers of patients report a poor surgical experience, which further fuels ongoing pain and disability.[5-7]

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Is preoperative rehabilitation the answer?

To address this issue, research started focusing on preoperative interventions.[11,12] Hospitals and surgery centers started offering preoperative classes and rehabilitation started offering prehabilitation sessions—strengthening and conditioning preoperatively as a means to prevent postoperative pain and disability.[13] Current best evidence, however, questions both these strategies. A series of systematic reviews of preoperative education in orthopedic surgery has found no postoperative benefit in terms of pain, disability, and length of hospital stay.[12,14] The only positive effect was some decreased anxiety prior to surgery. Similarly, no evidence has been found that shows that prehabilitation has positively influenced a patient undergoing orthopedic surgery.[13]

The net result for hospitals, surgery centers, surgeons, and healthcare systems is that approximately one in four patients have a poor surgical experience. Not only does this reflect poorly on the hospital, but it adds to the overall healthcare burden when these patients undergo further tests (i.e., imaging) and treatment to address their ongoing pain and disability.

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If preoperative rehabilitation is not working, what can be done to mitigate these postoperative effects?

Preoperative Pain Neuroscience Education for Lumbar Surgery

Developing the Program

In 2012, a pain neuroscience team started looking into this exact issue and decided to focus on lumbar surgery, given its high rate of one in three patients experiencing ongoing pain and disability after surgery.

In order to develop a strategy, the scientist started with a series of questions. Over the course of four years, the research team then set out to develop studies to answer these questions. Overall, it yielded a series of high-level, peer reviewed studies published in a variety of pain, surgery, and physical therapy journals. These studies yielded the following answers to these important questions:

What do patients undergoing lumbar surgery want from healthcare providers, surgeons, and the hospital?

In order to truly impact the problem, a patient-centered approach was needed. Previous studies have alluded to the fact that patients have unrealistic expectations of surgery and surgeons underestimate patient needs when it comes to preoperative education.

Patients one month after lumbar surgery were interviewed and surveyed about their surgical experience, including their needs.[15] Although 97 percent of patients thought their preoperative education was beneficial, more than one in three felt they did not get enough education on pain, especially pain experienced in the immediate postoperative period. Additionally, 50 percent of patients surveyed at four weeks postoperative were afraid their pain would get worse in the ensuing months.

> **50 percent of patients surveyed at 4 weeks postoperative were afraid their pain would get worse in the ensuing months.[15]**

What constitutes "usual" preoperative lumbar surgery education?

In order to truly assess why the current programs are not successful, it was decided to investigate what surgeons, surgery centers, and hospitals do for typical preoperative care.

A survey study of spine surgeons in the US revealed that the majority of the preoperative education delivered by surgeons consists of a biomedical model focusing purely on anatomy and little time spent on psychosocial issues such as fear, anxiety, and poor beliefs and expectations regarding the impending surgery.[16]

What does the general population think about lumbar surgery?

Patient beliefs and expectations are powerful drivers when it comes to a patient's pain experience. It was hypothesized that with the large number of people experiencing persistent pain and disability after surgery, the population at large may already be skewed towards a negative experience, which may influence the outcomes of surgery.

A survey study was developed to assess the general population's beliefs about lumbar surgery. Results from the study showed that the general population was unsure about lumbar surgery and harbor negative views when it comes to picking surgery over non-surgical approaches for their back pain.[17]

Is there any effective preoperative strategy that can be borrowed?

Amid the various systematic reviews and meta-analyses of preoperative education, some individual studies have shown some postoperative benefit. In-depth analysis of these may show some potential strategies that can be further explored to build a new comprehensive program to potentially influence postoperative outcomes.

One study, specific to lumbar surgery, showed a positive effect on postoperative pain on the day of surgery, and the two days following surgery. In this nurse-led study, patients were deliberately taught more about pain.[18]

Are there any other effective strategies that can be borrowed for patients with complex back pain?

Persistent (non-surgical) low back pain, interlaced with similarly high levels of fear-avoidance, pain catastrophization and faulty beliefs about pain, resembles postoperative persistent pain and disability seen in lumbar surgery. Is there a successful strategy for this population that can be adapted and applied for lumbar surgery?

Emerging pain science research has shown that teaching people more about the neurophysiology and neurobiology of pain, referred to as pain neuroscience education (PNE), has significant benefits for patients with persistent low back pain.[19] Various systematic reviews and meta-analyses show its positive effect on reducing self-reported pain, disability, fear-avoidance, and pain catastrophization, and also improve movement.[20]

Can we develop a lumbar surgery program using all this information?

Can the various aforementioned information be collected, synthesized, and used to help build a more comprehensive preoperative program for lumbar surgery? And if such a program is built, will it result in superior results compared to current programs and strategies?

With the program developed, a series of studies were designed to test the newly formed preoperative PNE program for lumbar surgery, and the results from these studies were used to develop a preoperative PNE program from lumbar surgery.[21]

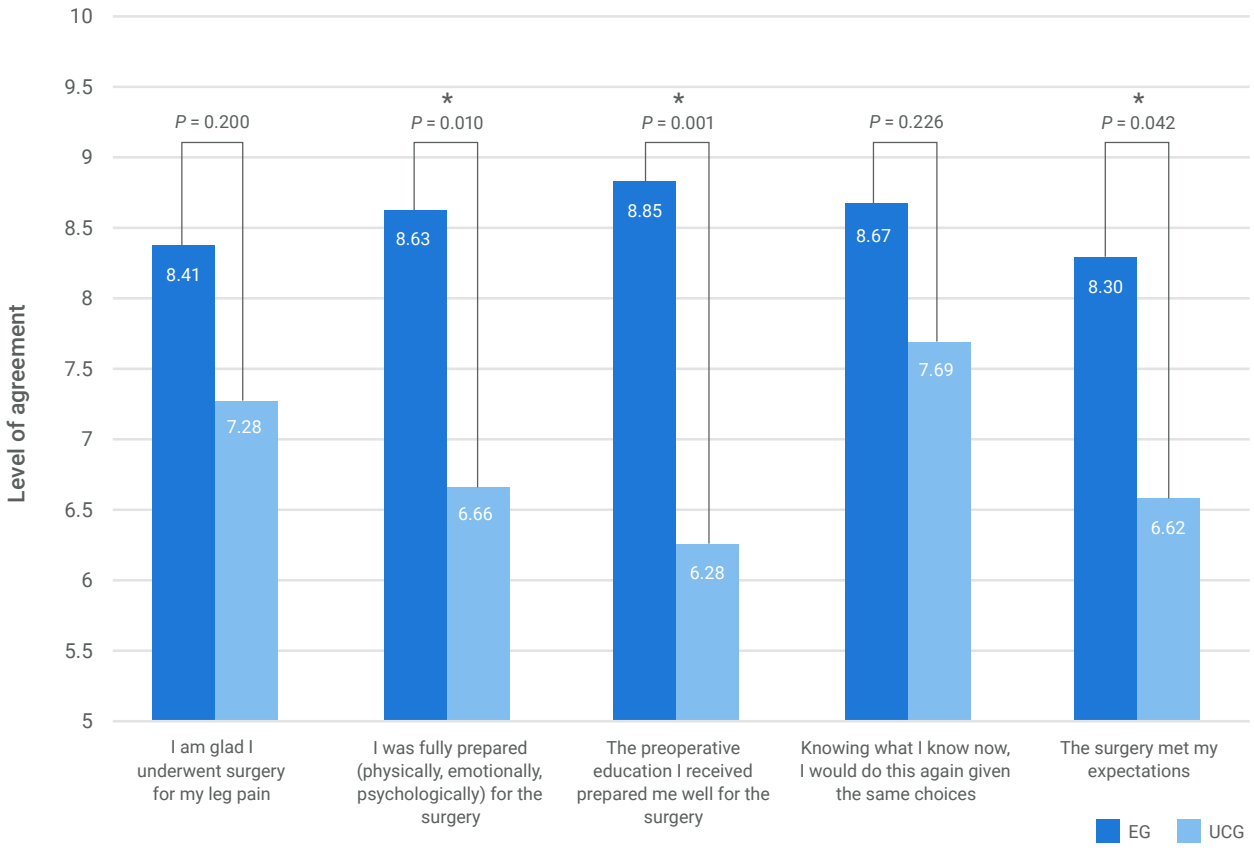
Results of the Program

The program was designed to be delivered as a one-on-one, clinician-led session, lasting 30 minutes. The session taught patients about their decision to undergo surgery, how a sensitized nervous system is part of the pain and surgical experience, and how pain after surgery is to be expected, given the heightened sensitivity of the nervous system. Finally, patients were given strategies to help calm down their sensitized nervous system (and pain) with simple-to-follow post-operative advice and strategies.

Early testing of the program showed that clinicians, in this case physical therapists, can be trained in the program, allowing it to be scaled and used in clinical trials and clinical practice.[22] The program showed that PNE shifted patients getting ready for lumbar surgery towards more realistic expectations after surgery, i.e., back and leg pain to some extent is expected and normal, versus expectations to be "pain free" post op.[23] Additionally, in line with non-operative complex low back pain, a functional magnetic resonance imaging study showed that the program decreased widespread brain activity correlating to reduced fear, anxiety, and catastrophization prior to lumbar surgery.[24]

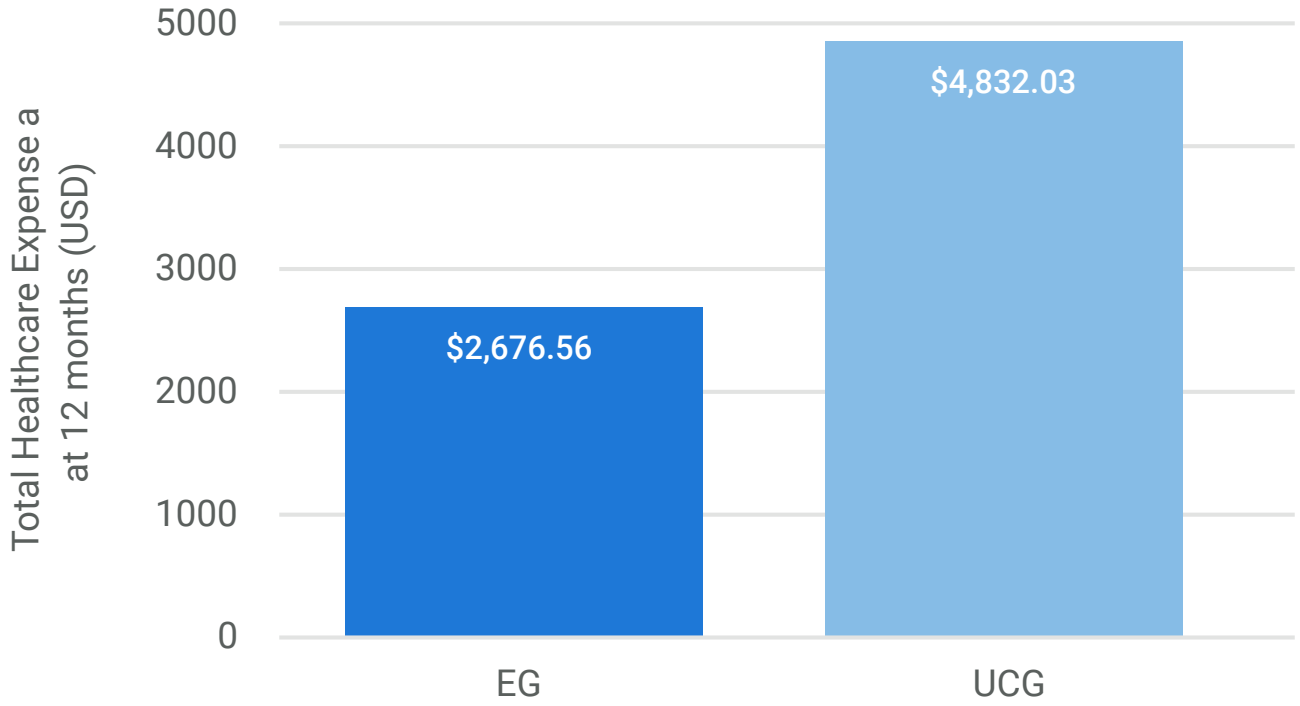
With the program developed, tested, and validated, it was ready for large-scale testing. A multi-center randomized clinical trial was developed with half of the patients getting ready for lumbar surgery receiving preoperative PNE and the other half not.[25] Patients then underwent lumbar surgery and were tracked for three years post-op.[26] At one year after lumbar surgery, there was no difference between the two groups for back pain, leg pain, and disability, however:

- The PNE group, despite having similar pain and disability, rated their surgical experience far superior, including willingness to undergo another surgery, and rated the surgical experience as positive, versus the non-PNE patients.



Results of the Program Continued

Healthcare savings



- The big result, however, was that those patients in the one year after surgery (same pain and disability) who received preoperative PNE spent 45 percent less on healthcare (tests, imaging, treatment) compared to those who didn't receive preoperative PNE. Savings exceeded $2,000 per patient in the one-year postoperative period. With 600,000 laminectomies/discectomies in the US annually, this program would amount to a $1.2 billion annual savings.
- The same patients were tracked for three years, and the same results to patient satisfaction and cost savings remained intact. **In fact, the cost savings grew to a 60 percent difference in favor of the PNE-group.**
- Recently, a Belgium-led team replicated these studies and showed similar results in cost savings, but also favorable superior results for preoperative PNE for fear-avoidance, function, and catastrophization (Huysman, et al., submitted for publication). Additionally, the preoperative PNE program patients returned more frequently than non-PNE patients.

Applying the Program to Total Knee Arthroplasty

With the positive results from the lumbar surgery studies, attention shifted to the development, testing and validation of a preoperative PNE program for total knee arthroplasty (TKA). The content was adapted to pertain to TKA, including the decision to undergo TKA, sensitization of the nervous system with knee osteoarthritis over time, pain and sensitization of the nervous system following surgery, as well as strategies to calm down the sensitized nervous system, and pain, after TKA. The TKA program was designed to be done in group format using visual aids and a lecture, and able to be added to any surgery center or hospital preoperative education classes.

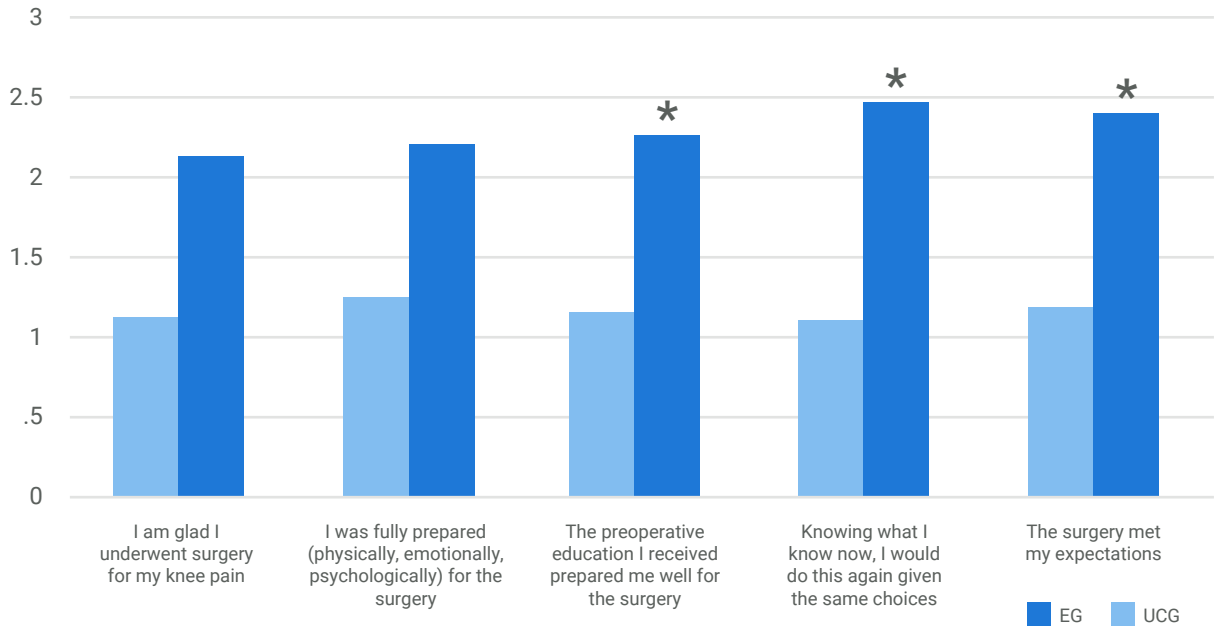
Results of the Program

Prior to testing the preoperative PNE program for TKA on a large scale, a smaller scale study was undertaken to test the program. Patients scheduled for TKA were taught PNE prior to TKA and results showed that the nervous system of the TKA knee preoperatively calmed down 20 percent—which is similar in effect size as what is currently being reported with membrane-stabilizers given to patients prior to TKA, without the side effects of the medication.[27]

Following testing, a randomized clinical trial tested the newly designed TKA program by alternating TKA patients to receive PNE or not prior to surgery. Patients were followed for six months following TKA. At the six-month follow-up, patients receiving PNE or not were equal in terms of knee pain and disability—similar to lumbar surgery. Once again, however, despite having similar pain and disability, the PNE-group had superior surgical and hospital experiences compared to the non-PNE group, including willingness to undergo another TKA.[28] Cost analysis was not part of the TKA study since postoperative management for TKA is more structured and predetermined compared to lumbar surgery.

> **Patients scheduled for TKA were taught PNE prior to TKA, and results showed that the nervous system of the TKA knee preoperatively calmed down 20 percent.**

Patient Experience



Conclusion

With the establishment of the preoperative PNE programs for lumbar surgery and TKA, which have since spawned various additional studies, attention shifted to other orthopedic surgeries. The preoperative PNE program has since been adapted and tested for shoulder surgery in preparation for larger, more comprehensive clinical trials. The immediate post-PNE session for shoulder surgery has shown promise, with the sensitivity of the nervous system on the surgical shoulder decreasing 26 percent prior to surgery.[29] Future studies will explore larger clinical trials for shoulder surgery and expansion of the TKA program for total hip arthroplasties.

	OLD APPROACH	NEW APPROACH
	Patient has low back and leg pain. Patient consults with spine surgeon and decides to undergo low-back surgery. Surgeon gives patient 10-15 minutes of preoperative education regarding the surgery, procedures, and recovery.	
Preoperative	Patient waits for surgery date.	Patient visits a physical therapist for preoperative education regarding pain science and a booklet to take home. • 1 Visit • 30 minutes • $3 booklet
Surgery	Patient undergoes low-back surgery.	
	Patient is tracked for one year after surgery	
Post-operative	Patient doesn't understand how pain works and worries about post-operative pain. Patient undergoes additional imaging, tests, and treatments.	Patient understands what pain is and how it works and has realistic expectations of post-operative pain. Patient undergoes standard follow-up.
	After one year, both patients have the same outcome regarding back pain, leg pain, fear of work, fear of physical activity, pain catastrophization, and function. Substantial differences are observed in average cost and level of satisfaction.	
Average Cost	Avg. cost for imaging, tests, and treatments: $4,833	Avg. cost for imaging, tests and treatments: **$2,678**

600,000 discectomies were performed in the US in 2012. If the cost of savings per patient were applied, it would account for an annual savings of **$1.2 billion.**

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ABOUT THE AUTHOR

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Adriaan earned his undergraduate, master's degree, and PhD in physiotherapy from the University of Stellenbosch in Cape Town, South Africa. He is an adjunct faculty member at St. Ambrose University and the University of Nevada Las Vegas, teaching pain science. Adriaan has taught throughout the US and internationally for 25 years at numerous national and international manual therapy, pain science, and medical conferences. He has authored and co-authored over 100 peer-reviewed articles related to spinal disorders and pain science. Adriaan completed his PhD on pain neuroscience education and is the Director of the Therapeutic Neuroscience Research Group—an independent collaborative initiative studying pain neuroscience. Adriaan is a senior faculty, pain science director, and vice-president of faculty experience for Evidence in Motion.

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References

1. Deyo RA, Mirza SK, Martin BI, Kreuter W, Goodman DC, Jarvik JG. Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. JAMA : the journal of the American Medical Association. 2010;303(13):1259-1265.

2. Zaina F, Tomkins-Lane C, Carragee E, Negrini S. Surgical versus non-surgical treatment for lumbar spinal stenosis. The Cochrane database of systematic reviews. 2016(1):CD010264.

3. Cross M, Smith E, Hoy D, et al. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. Annals of the rheumatic diseases. 2014;73(7):1323-1330.

4. Singh JA, Yu S, Chen L, Cleveland JD. Rates of Total Joint Replacement in the United States: Future Projections to 2020-2040 Using the National Inpatient Sample. J Rheumatol. 2019;46(9):1134-1140.

5. Oertel MF, Ryang YM, Korinth MC, Gilsbach JM, Rohde V. Long-term results of microsurgical treatment of lumbar spinal stenosis by unilateral laminotomy for bilateral decompression. Neurosurgery. 2006;59(6):1264-1269; discussion 1269-1270.

6. Deyo RA, Mirza SK. The case for restraint in spinal surgery: does quality management have a role to play? Eur Spine J. 2009;18 Suppl 3:331-337.

7. Hirschmann MT, Testa E, Amsler F, Friedrich NF. The unhappy total knee arthroplasty (TKA) patient: higher WOMAC and lower KSS in depressed patients prior and after TKA. Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA. 2013;21(10):2405-2411.

8. Oosterhuis T, Costa LO, Maher CG, de Vet HC, van Tulder MW, Ostelo RW. Rehabilitation after lumbar disc surgery. The Cochrane database of systematic reviews. 2014;3:CD003007.

9. Han AS, Nairn L, Harmer AR, et al. Early rehabilitation after total knee replacement surgery: a multicenter, noninferiority, randomized clinical trial comparing a home exercise program with usual outpatient care. Arthritis Care Res (Hoboken). 2015;67(2):196-202.

10. Louw A, Puentedura EJ, Diener I. A descriptive study of the utilization of physical therapy for postoperative rehabilitation in patients undergoing surgery for lumbar radiculopathy. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society. 2016;25(11):3550-3559.

11. Oshodi TO. The impact of preoperative education on postoperative pain. Part 1. Br J Nurs. 2007;16(12):706-710.

12. Johansson K, Nuutila L, Virtanen H, Katajisto J, Salantera S. Preoperative education for orthopaedic patients: systematic review. J Adv Nurs. 2005;50(2):212-223.

13. Janssen ERC, Punt IM, Clemens MJ, Staal BJ, Hoogeboom TJ, Willems PC. Current Prehabilitation Programs Do Not Improve the Postoperative Outcomes of Patients Scheduled for Lumbar Spine Surgery: A Systematic Review With Meta-analysis. J Orthop Sports Phys Ther. 2020:1-47.

14. Louw A, Diener I, Butler DS, Puentedura EJ. Preoperative education addressing postoperative pain in total joint arthroplasty: review of content and educational delivery methods. Physiotherapy theory and practice. 2013;29(3):175-194.

15. Louw A, Louw Q, Crous LCC. Preoperative Education for Lumbar Surgery for Radiculopathy. South African Journal of Physiotherapy. 2009;65(2):3-8.

16. Louw A, Butler DS, Diener I, Puentedura EJ. Preoperative education for lumbar radiculopathy: A Survey of US Spine Surgeons. International Journal of Spine Surgery. 2012;6:130-139.

17. Landers MR, Puentedura E, Louw A, McCauley A, Rasmussen Z, Bungum T. A population-based survey of lumbar surgery beliefs in the United States. Orthopaedic nursing / National Association of Orthopaedic Nurses. 2014;33(4):207-216.

18. McDonald S, Hetrick S, Green S. Pre-operative education for hip or knee replacement. Cochrane Database Syst Rev. 2004(1):CD003526.

19. Louw A, Diener I, Butler DS, Puentedura EJ. The effect of neuroscience education on pain, disability, anxiety, and stress in chronic musculoskeletal pain. Archives of physical medicine and rehabilitation. 2011;92(12):2041-2056.

20. Louw A, Zimney K, Puentedura EJ, Diener I. The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature. Physiotherapy Theory and Practice. 2016:1-24.

21. Louw A, Butler DS, Diener I, Puentedura EJ. Development of a preoperative neuroscience educational program for patients with lumbar radiculopathy. American journal of physical medicine & rehabilitation / Association of Academic Physiatrists. 2013;92(5):446-452.

22. Louw A, Puentedura EJ, Diener I, Zimney K, Cox T. Pain neuroscience education: Which pain neuroscience education metaphor works best? SA J Physio. 2019;75(1).

23. Louw A, Diener I, Puentedura EJ. The short term effects of preoperative neuroscience education for lumbar radiculopathy: A case series. International Journal of Spine Surgery. 2015;9:11.

24. Louw A, Puentedura EJ, Diener I, Peoples RR. Preoperative therapeutic neuroscience education for lumbar radiculopathy: a single-case fMRI report. Physiotherapy Theory and Practice. 2015;31(7):496-508.

25. Louw A, Diener I, Landers MR, Puentedura EJ. Preoperative pain neuroscience education for lumbar radiculopathy: a multicenter randomized controlled trial with 1-year follow-up. Spine. 2014;39(18):1449-1457.

26. Louw A, Diener I, Landers MR, Zimney K, Puentedura EJ. Three-year follow-up of a randomized controlled trial comparing preoperative neuroscience education for patients undergoing surgery for lumbar radiculopathy. J Spine Surg. 2016;2(4):289-298.

27 .Louw A, Zimney K, Reed J, Landers M, Puentedura EJ. Immediate preoperative outcomes of pain neuroscience education for patients undergoing total knee arthroplasty: A case series. Physiotherapy Theory and Practice. 2018:1-11.

28. Louw A, Puentedura EJ, Reed J, Zimney K, Grimm D, Landers MR. A controlled clinical trial of preoperative pain neuroscience education for patients about to undergo total knee arthroplasty. Clin Rehabil. 2019:269215519857782.

29. Louw A, Rico D, Langerwerf L, Maiers N, Diener I, Cox T. Preoperative pain neuroscience education for shoulder surgery: A case series. S Afr J Physiother. 2020;76(1):1417.