CASE REPORT

Therapeutic neuroscience education via e-mail: a case report

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Abstract

Therapeutic neuroscience education (TNE) aims to alter a patient's thoughts and beliefs about pain and has shown efficacy in treating chronic pain. To date, TNE sessions mainly consist of one-on-one verbal communication. This approach limits availability of TNE to pain patients in remote areas. A 32-year-old patient with chronic low back pain (CLBP) who underwent surgery for thoracic outlet syndrome (TOS) attended a single clinic one-on-one TNE session followed by TNE via electronic mail (e-mail), pacing and graded exposure over a 4-month period. A physical examination, Numeric Rating Scale (NRS), Oswestry Disability Index (ODI), the Disabilities of Arm, Shoulder and Hand (DASH), and Fear-Avoidance Beliefs Questionnaire (FABQ) were assessed during her initial physical therapy visit as well as 1 and 4 months later. Pre-TNE, the patient reported: NRS (arm) = 7/10; NRS (leg) = 4/10; ODI = 10.0%; DASH = 36.7%; FABQ-W = 25; and FABQ-PA = 17. After 5 e-mail sessions all outcome measures improved, most noticeably NRS (arm) = 2/10; NRS (leg) = 0/10; DASH = 16.7%; FABQ-W = 8; and FABQ-PA = 7. TNE can potentially be delivered to suffering pain patients in remote areas or to individuals who have time and financial constraints, and likely at a significant reduced cost via e-mail.

Keywords

Education, neuroscience, pain, therapeutic neuroscience education (TNE)

Introduction

Research into educational strategies for patients with chronic musculoskeletal pain shows an increased use of therapeutic neuroscience education (TNE) (Louw, Diener, Butler, and Puentedura, 2011; Moseley, 2003a, 2004, 2005; Moseley, Nicholas, and Hodges, 2004). TNE is an education intervention used by physiotherapists (Louw, Diener, Butler, and Puentedura, 2011) aiming to help patients gain an increased understanding of the biological process underpinning their pain state (neuroscience) (Ryan, Gray, Newton, and Granat, 2010) with the ultimate goal of achieving a therapeutic effect such as decreased pain and improved movement and function. This case report and newer studies utilizing TNE suggest the standardization and utilization of the term TNE (Zimney, Louw, and Puentedura, 2014). TNE differs from traditional education strategies such as back school and biomechanical models by not focusing on anatomical or biomechanical explanations for pain, but rather on neurophysiology, neurobiology and the processing and representation of pain (Meeus et al, 2010; Moseley, 2005; Ryan, Gray, Newton, and Granat, 2010). Patients in pain are interested in knowing more about pain (Bender et al, 2008; Louw, Louw, and Crous, 2009; McDonald, Freeland, Thomas, and Moore, 2001) and it has been demonstrated that patients are capable of understanding the neurophysiology of pain, while professionals underestimated patients’ ability to understand the “complex” issues related to pain (Moseley, 2003b).

A recent systematic review reported that for chronic musculoskeletal pain disorders, there is compelling evidence that an educational strategy addressing neurophysiology and neurobiology of pain can have a positive effect on pain, disability, catastrophization, and physical performance (Louw, Diener, Butler, and Puentedura, 2011). Randomized controlled trials which utilized TNE have been shown to decrease fear and change a patient’s perception of their pain (Moseley, 2003c) and have an immediate effect on improvements in patients’ attitudes about pain. This education intervention also resulted in: improvements in pain, cognition and physical performance (Moseley, 2004); increased pain thresholds during physical tasks (Moseley, Nicholas, and Hodges, 2004); improved outcomes of therapeutic exercises (Moseley, 2002); and significant reduction in widespread brain activity characteristic of a pain experience (Moseley, 2005). Additionally, with the increased utilization of TNE, more information has become available on the content, delivery methods, frequency and place of TNE in relation to physical treatments such as spinal stabilization and manual therapy (Louw, Diener, Butler, and Puentedura, 2011; Louw, Puentedura, and Mintken, 2012). To date, TNE has demonstrated greater benefit in one-on-one verbal situations with a physiotherapist compared to group sessions. Individual sessions may last anywhere from 30min to 4h (Louw, Diener, Butler, and Puentedura, 2011; Moseley, 2003c). This optimized delivery method of TNE provides concerns regarding healthcare cost and availability of such specialized education to patients in remote regions or patients with limited time and financial resources. Recent research utilizing TNE has established the clinical benefit of 30-min TNE sessions, which fit into typical daily physiotherapy practice patterns and a series of weekly or bi-weekly sessions have been recommended (Louw, Butler, Diener, and Puentedura, 2013; Nijs et al, 2011). These shorter sessions may provide an answer to the challenge of time constraints with each patient visit in the clinic, faced by clinicians, along with likely being less expensive compared to longer, extensive TNE sessions. Patients in remote...
areas with limited access to such specialized one-on-one TNE, however face the challenge of accessing similar care that can be received in larger urban areas. Similar “in-clinic” attendance issues arise for patients with time and financial constraints. Using a single case design, we aimed to demonstrate how, after a single, one-on-one TNE session; a patient with chronic neck, arm and leg pain was followed, educated, paced, progressed and ultimately discharged via the electronic mail (E-mail). This educational model utilizing electronic media that is proposed in this report concurs with various studies utilizing increased use of electronic media to educate patients (Hailey, Roine, Ohinmaa, and Dennett, 2011; Hurling et al, 2007; Oshodi, 2007).

Case description

History

The patient is a 32-year-old mother of a toddler who lives 3h away from the clinical site for the delivery of the initial one-on-one TNE session. The patient presented with a long-standing history of right neck and upper extremity (UE) pain (constant 8 years) as well as right leg pain (intermittent 13 years). The patient started developing bilateral UE numbness, especially with overhead movements of the UE 10 years ago, denying any specific injury or accident. With progressive numbness, pins and needles and pain in the UE, she underwent a series of tests including neck X-rays, magnetic resonance imaging of the neck, computerized tomography of the neck and brain, subsequently revealing a medical diagnosis of thoracic outlet syndrome (TOS). The patient underwent extensive physiotherapy treatment for TOS focusing on posture, exercise, stretches and manual therapy. With no reduction of her symptoms, the patient underwent surgery 3 years prior to this episode of care, removing the first rib on the right as well as part of the scalene muscle. The patient reported immediate relief of her neurovascular symptoms (numbness, pins and needles and temperature changes), but pain in the UE remained, mainly in the ulnar distribution down the forearm, wrist and hand. The patient also reported developing increased sensitivity at the surgery site and cervical spine. With the increased sensitivity and pain after the TOS surgery, the patient started noticing increased right lateral and posterior leg pain from the buttock to the top and outside of the right foot. The patient had a chronic history of right-sided radiculopathy, stemming back to an acute onset 13 years prior to this evaluation. She reported periodic sensitivity of the right leg, but significantly more since the TOS surgery.

Pain, disability and fear self-report measures

Prior to therapy, the patient completed a series of self-reported measures in regards to function, fear and pain ratings. These questionnaires were chosen based on her history, presenting symptoms, ease of clinical use and prior use in TNE studies (Louw, Diener, Butler, and Puentedura, 2011; Zimney, Louw, and Puentedura, 2014). Self-report measures included: Oswestry Disability Index (ODI) (Deyo et al, 1998) (10.0%); Disabilities of the Arm, Shoulder and Hand (DASH) (Mintken, Glynn, and Cleland, 2009) (36.7%); Fear Avoidance Beliefs Questionnaire (Waddell et al, 1993) Physical Activity sub-scale (FABQ-PA) (17) and Fear Avoidance Beliefs Questionnaire Work sub-scale (FABQ-W) (24); and pain rating for arm 7/10 (NRS) and leg pain 4/10 (NRS) (Cleland, Childs, and Whitman, 2008).

Physical examination

Prior to the evaluation, the patient completed a medical screening questionnaire, which was reviewed by the physiotherapist. The screening did not reveal any “red flags” that would prevent any physical examination or the need for medical referral. Observation of the neck and UE revealed a scar over the right clavicle insertion without any significant swelling, while observation of her lumbar spine revealed no lateral shift. Cervical spine active range of motion (AROM) revealed normal pain-free ROM for flexion, side flexion left and right as well as rotation left and right. Cervical extension was most limited (15 degrees) with visible apprehension. Active, followed by passive neurodynamic tests were used to examine the movement and sensitivity issues of the upper limbs: (left and right) median, ulnar and radial nerves; lower limbs (left and right) straight leg raise (SLR); and the trunk slump test (Butler, 2000). Neurodynamically the patient had a positive upper limb neurodynamic test (ulnar) at 45 degrees abduction for pain reproduction in the upper arm, elbow and hand, which was altered with side flexion of the cervical spine (Butler, 2000). Lumbar physical examination showed increased right leg pain with 45 degrees forward flexion and leg pain intensifying with adding neck flexion, while slump testing revealed increased right leg and foot pain with the addition of neck flexion at end-ROM (Butler, 2000). SLR was limited at 70 degrees bilaterally, with no significant increase in leg pain on the right. Neurologically (strength, sensation and reflex) the patient’s UE’s and lower extremities (LE’s) were intact bilaterally (Butler, 2000). Palpation examination revealed a positive Tinel test (Monsivais and Sun, 1997) over the right ulnar and radial nerves at the elbow and right tibial nerve behind the knee and posterior tarsal tunnel produced a heightened pain response compared to the uninvolved (left) side (Walsh and Hall, 2009).

Diagnosis and prognosis

The patient’s history, subjective and objective examinations presented with signs and symptoms associated with central sensitization are provided in Table 1 (Nijs, Van Houdenhove, and Oostendorp, 2010; Smart, Blake, Staines, and Doody, 2009). Furthermore, the patient presented with several bio-psycho-social yellow flags which may have been influencing her cognitions regarding her pain (Table 1) (Kendall, Linton, and Main, 1997; Kendall and Watson, 2000; Watson and Kendall, 2000). Both central sensitization and yellow flags have been recommended as indicators for the use of TNE (Nijs et al, 2011; Nijs, Meeus, and De Meirleir, 2006). Furthermore, based on the sensitivity of the nervous system, fear of physical activity and the patient’s interest in TNE, it was decided to start with TNE as a primary treatment, followed by a graded exposure of movement and exercise. The patient expressed two very definite goals with the TNE: (1) developing a greater understanding of her pain and sensitivity; and (2) regaining her ability to get back to exercising, specifically exercise for her arm, trunk and general conditioning. Aerobic exercise has shown considerable evidence for patients with central sensitization as well as neuropathic pain (Busch et al, 2007; Kuphal, Fibuch, and Taylor, 2007). Considering the patient’s educational level (doctoral degree), mild disability for her LBP, no significant treatments since TOS surgery and her affinity for exercise it was established she would likely have a favorable prognosis with the TNE and exercise program and likely see significant improvements in 4–6 weeks.

Interventions

Therapeutic neuroscience education

TNE involved a 1.5-h one-on-one verbal session, covering neurophysiology, neurobiology and pain processing (Louw, Puentedura, and Mintken, 2012). Metaphors, examples, pictures and drawing were used during the verbal sessions (Louw, 2013; Louw, Diener, Butler, and Puentedura, 2011). A detailed
description of TNE has been described previously (Louw, Puentedura, and Mintken, 2012). Upon completion of the TNE session, the patient was given specific instructions to complete related to improving her understanding of her pain, pacing of physical exercise and goal setting.

**Increased understanding of her pain and sensitivity**

- The goal of any cognitive intervention is to obtain a deep learning experience, (Crabtree, Roeyen, and Mu, 2001) thus developing a deep, true understanding of the issues and applying it to the situation. To ensure a greater understanding, the patient was asked to spend time during the next week and think of questions she had about the TNE information or anything related to her condition and compile a list she could discuss with the clinician to gain clarity.

- The patient was provided with written TNE information to review. The clinician performing the TNE utilized parts of a preoperative neuroscience educational booklet for lumbar radiculopathy (Louw, Butler, Diener, and Puentedura, 2013) and relevant sections (i.e. nerve sensitivity, central sensitization, yellow flags, and strategies to calm the nervous system down) was highlighted and the patient was asked to read it at least twice in the next week and any questions should be added to the question list.

**Exercise**

**Aerobic exercise**

- Given the abundance of literature on the benefit of aerobic exercise for chronic pain (Busch et al, 2007; Ferreira et al, 2007; Hoffman, Shepanski, Mackenzie, and Clifford, 2005; Nathan et al, 2001) and the patient’s main goal to start exercising again without damage, the patient was asked to start a walking program of 5 min of brisk walking a day and adding 1–2 min every 2 d, for a goal of 30 min (Fulcher and White, 1997).

- Spinal stabilization exercises

  - Two basic spinal stabilization exercises were shown and reviewed with the patient, per her goals. The exercises were modified “planks” with knees bent and bridging exercises (Childs et al, 2004). Each exercise was to be performed 5 times × 10 second hold. One repetition was added every other day to reach 10 × 10 s, after which time increments would increase 5 s every 2–3 d to reach a goal of 10 × 30 s of each exercise (Puentedura, Brooksby, Wallmann, and Landers, 2009).

- UE exercises

  - The patient was given 3 exercises, to be performed with 2 lbs dumbbells: (1) bicep curls; (2) shoulder abduction (ABD) with elbows bent and no higher than 90 degrees abduction; and (3) triceps extensions. Exercises were to be performed on both arms, starting at twice a day (AM and PM). Given the arm sensitivity, the UE exercises started with 1 set of 30 s per exercise and if no increased or lingering pain ensued, a second set could be added 3–4 d later. The goal was to reach 4 × 30 s of each exercise, before weight would be increased.

**Goal setting**

The patient presented with very vague, ill-defined goals in therapy and she was thus instructed to develop a list of specific goals pertaining to various aspects of her life, including physical/exercise, home work (activities of daily living – ADL’s) and social life. No specific parameters were set regarding the goals (Gladwell, 2006).

**E-mail approach**

Given the patient’s distance from the clinical site of the initial TNE session and the patient’s ability to comprehend and recite the key aspects of TNE (nerve sensitization, nociception versus pain, and meaning of pain), it was decided to have the patient report on her progress related to her tasks, goal setting and increased understanding of TNE via e-mail communication with the clinician who delivered the TNE (Table 2). The initial plan was weekly e-mails by the patient to the therapist, with return e-mails back to the patient within 24 h. With progress regarding pain, function and exercise, weekly e-mails would be changed to e-mails every other week and eventually once a month, until discharge and all goals met (Figure 1).

**Outcomes**

The self-report outcome measures indicate a progressive decrease at 1 and 4 months post-TNE in arm and leg pain, DASH score, and fear avoidance (Table 3 and Figure 2). The patient’s outcomes followed close to the projected prognosis. The patient in this case report completed her assignments 100% of the time (reporting back via e-mail at designated intervals). Review of the e-mail log and self-reported progression of tasks and goals reveals high compliance to the instructions as well as positive behaviors associated with recovery (i.e. increased time walking, increased resistance with arm weights, increased repetitions of trunk exercises, and increased adherence to purposefully exercise the ability to explain her nerve sensitization to other individuals). Apart from outcome measures and written exercise logs, the patient remained active with her daily household tasks, caring for her toddler and working 30 + h per week.

**Discussion**

To the best of our knowledge this is the first reported case of TNE delivered with the use of e-mail. Care should be taken in the findings of a single report and extrapolating a pure cause-and-effect relationship. Many factors may have influenced recovery, including tissue healing, social support, etc. The findings of this case report, however, provide a potential avenue
Making the patient understand the importance of pacing herself

Reinforcing the message of knowledge as a means to help modulate pain via descending inhibition.

Unexplained pain could be seen as a possible threat and thus enhance a pain experience (Moseley, 2003a). The patient is asked to identify a cause-and-effect relationship between the stimulus that is nerve irritated and the nerve irritation (Moseley, 2004). This is important: Why is today’s “not a good day”? You need to think. It usually relates to emotions or activities. If you can identify them and then either avoid it in the future or if you do a similar task/more emotions, know what to expect and it is normal. Nerves are barometers for the stresses in our life.

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### Table 2. TNE via E-mail description.

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<tr>
<th>Patient e-mail</th>
<th>Therapist reply</th>
<th>Rationale</th>
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| **E-mail session 1: 1 week later**
My first week went well with the walking and exercises. My leg usually felt better towards the end of the walk when it would feel warmer. My arm's of course had the hardest time with the exercise, but they felt fine after. I did not have any problems with the core exercises except feeling it in my arm the last couple of days. My walking is now up to 13 min and tomorrow I will start 14 min. I am using the 2lb weights for the arms including bicep curls, shoulder abduction to 90 degrees with elbow bent and triceps extensions. All have been for 30 x 2 sets. My core exercises included modified plank and bridges for 10 reps x 10 s.
I have felt good at work without flare ups, but started to feel a little more starting on Tuesday. Today I have not had a good day. My R leg is burning and aching and my arms are also aching with the nerve pain. The leg has been the worst though. My questions are about when to advance the arm weights, do I just keep advancing the walking 1 minute every 2d, and do I work through the flare ups or back off a little?
I did explain what I learned to many other people and I read the booklet 3 times. The booklet was excellent.

Very good. It is amazing when you back off a little, not irritate the nerves and then get the benefit of the exercise. On top of all of this is also a smart brain that understands what is going on and thus help control the pain you experience. This is important: Why is today’s “not a good day”? You need to think. It usually relates to emotions or activities. If you can identify them and then either avoid it in the future or if you do a similar task/more emotions, know what to expect and it is normal. Nerves are barometers for the stresses in our life.

Do not increase weights. Increase your repetitions, cut rest periods. High repetitions, low weights; think blood flow; think flushing blood through the body and around the nerves...

Very good. Now – more homework:
1. Report back in 1 week on reason for the “not so good day”
2. Keep logging and reporting on your exercise progression.
3. Ask any questions you want
4. Write me a paragraph on what is going on with your arm and leg – based on what we discussed and what you have been telling people.

You're doing great. I can see you steadily increasing your health, fitness and getting back to stuff you like to do. The sensitivity will ease.

Flare ups are minimal and when they occur, you know why and can either (i) prevent them next time or (ii) not freak out about them, thus calming the nervous system.

Way to go!!

1. Reason for “not so good day”: I cannot exactly remember why my leg bothered me during week one. I don’t recall any increased stress on that day. I can tell you that my leg flared up this past Friday. I had been sick all week and I am wondering if it flared up because of that. I have found that if I stay busy I don’t notice the leg as much. So on Friday night after putting my daughter to bed I went out shopping for 2 h. I did not notice my leg one time. By the time I got home and started to think about it again, it was back to its baseline.

2. Exercise program: I have been walking daily and lifting weights and have not missed a day. I am walking 19 min starting today. I am still walking outdoors and have different routes that I take. If my leg is bothering more I might choose a more flat route and

- Making the patient understand the importance of pacing herself during exercise and avoid flares, which is typical of a boom-bust cycle (Butler and Moseley, 2003).
- Reinforcing the message of knowledge as a means to help modulate pain via descending inhibition.
- Unexplained pain could be seen as a possible threat and thus enhance a pain experience (Moseley, 2003a). The patient is asked to identify a cause-and-effect relationship between possible factors and her pain “today” to help her understand possible triggers for her pain and thus alleviate potential hyper excitability of the nervous system. Encouraging patients to take an active self-help approach to their care is a cornerstone of cognitive behavioral therapy and empowers the patient.
- Aerobic exercise is beneficial for chronic pain (Busch et al, 2007) thus exercises focused on increased repetitions, shorter breaks and light weights.
- Aerobic exercise additionally affects adrenaline in blood (Kuphal et al, 2007), which has been correlated to increased nerve sensitivity.
- Report back on bad day – ability to identify potential stimuli that may provoke a pain experience and thus work on modifying the stimuli.
- Logbooks have been shown to increase compliance with exercise (Moseley, 2004).
- Ask question and paragraph – continued process of understanding pain and a deep learning process (Crabtree et al, 2004).
- Continued encouragement

### Logbooks have been shown to increase compliance with exercise (Moseley, 2004)

<table>
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<th><strong>E-mail session 2: 2 weeks later</strong></th>
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1. **Reason for “not so good day”:** I cannot exactly remember why my leg bothered me during week one. I don’t recall any increased stress on that day. I can tell you that my leg flared up this past Friday. I had been sick all week and I am wondering if it flared up because of that. I have found that if I stay busy I don’t notice the leg as much. So on Friday night after putting my daughter to bed I went out shopping for 2 h. I did not notice my leg one time. By the time I got home and started to think about it again, it was back to its baseline.

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### Logbooks have been shown to increase compliance with exercise (Moseley, 2004)

- Cytokines are known to increase nerve sensitivity. Providing a biological/physiological explanation of a pain experience is at the core of TNE and thus helps alleviate stress due to the unknown.
- Distraction is known to help alleviate pain experiences.
- Latent periods after nerve irritation is commonly described in clinical practice and poorly understood (Butler, 2000). By explaining the concept of latency it is aimed to alleviate the patient’s fears and have her understand her symptoms are familiar to the clinician and thus further calm her fears.
- The goal was to gain increased benefit from the exercises and not produce undue pain experiences. By avoiding hills, the patient could get the benefit of the exercise and avoid flare. It was
avoid the hills. Is this ok? I increased my arm exercises to 3 x 30 last week with the 2lb and it is going well. No flare ups. My arms have not had any flare ups. The abduction is very challenging by the 2nd and 3rd set for my R arm. Do I ever change arm exercises or stick to the same ones? I know that anything that involves my shoulder will be more challenging than my elbow.

3. I think I asked all the questions that I have above.

4. My arm is hurting because after my surgery my nerves did not come down out of alarm mode. They are now easily irritated with very minimal activity even though my body is no longer injured. My leg is reacting the same way, but it started after an event occurred in my neck that caused the immune system to check on my body to see how previously injured areas were doing. My previous right sciatic nerve injury was checked on and sent into alarm mode. Currently my brain is frequently sending messages out to check on by arm and leg and interpreting the response that there is injury still in my body. This is manifested in my feelings of numbness and pain/achiness.

E-mail session 3: 4 weeks later
I am doing well. I am walking 34 min now and using the 3lb hand weights. I do have a few questions though.

1. I understand how to advance the arm exercises as far as sets and weight, but I wasn’t sure if I should change up the exercises.

2. I have advanced my planks by adding in some on my feet without my knees on the floor and that is going well. I am still doing the bridges and they are easy.

3. As far as the walking goes, do I continue to walk daily and add 1 minute every other day? I can see how this will get difficult to fit into my day if I keep adding on a minute. Is it still effective if I don’t do it daily? When would I advance to other aerobic activities such as an elliptical or an exercise class?

4. My nerves did not come down from “alarm mode” probably because I was afraid and did not understand the pain. Using my arm (especially right) hurt and I was afraid of the pain. Thanks a lot for all of your help. I really appreciate it. Not sure if there’s anything else I need from you at this time.

E-mail session 4: 8 weeks after initial TNE

Hi
Checking in on you. It has been 4 weeks.

- How are you doing?
- Give me an idea of your overall “pain experience”
- How are your exercises going?
- Any questions at this time?

1. This is impressive. Way to go. Stop for a second and think how far you have come.

2. Stabilization progression – very good.

3. Walking was originally chosen due to its simplicity – easy to do, little load on the body. As for time, it’s completely up to you. If patients can get to 4-5x/week 30 min, it is very good. Yes, you can use other forms of aerobic exercise, keeping the principles of pacing in place.

4. Good answer. Work it into your definition and explanation.

- You are progressing well. Please complete and send back the measurement sheets based on how you are doing today.
- Given your favorable response to therapy, I will send you a follow-up E-mail in 4 weeks. At any point, feel free to send me an E-mail regarding any questions you may have.

- I am doing really well. Thanks for the E-mail. It has been going so well, I have “forgotten” I am “in therapy”.

- My overall arm symptoms are much less – at least 50%, but it has the same “wave” of up and down depending on what I do.

- Followed-up with the patient to ensure she is following the TNE and pacing program.

- Constant positive feedback and encouragement

- Constant reinforcement of correctly analyzing pain from exercise and use of the UE. Given her history and sensitivity, pain is likely to be expected for weeks and months during recovery, pacing and graded exposure. This “knowing” is important in the down-regulation of the central and peripheral nervous system.

- Having the patient verbalize, write down and recite the core message of nerve sensitivity is seen as enhancing a deep learning experience and thus cognitive changes.

- Reinforcing the pacing and graded exposure approach along with the TNE understanding of pain.
### Table 2. Continued

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<thead>
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<th>Therapist reply</th>
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<tbody>
<tr>
<td>I kind-of expect it. Cannot remember any recent bad flare.</td>
<td>I think we are all good. I might as well copy and paste my E-mail session 5: 16 weeks later</td>
</tr>
<tr>
<td>4-month follow-up</td>
<td>E-mail from a month ago. All is well. No questions. Life is busy and I almost have to remind myself of my arm. Leg pain pretty much gone.</td>
</tr>
<tr>
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<td>I have started mixing the elliptical and walking. (More elliptical than walking to be honest) and no problems. I am doing step aerobics classes and do most of the arm exercises. I have not done many upper extremity exercises. No questions. All good.</td>
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For patients with persistent pain receiving up-to-date TNE in remote locations or due to time and financial constraints,

Over a 4-month period, a patient with a high level of arm pain (7 of 10), reoccurrence of past leg pain, high fear-avoidance for physical activity and moderate disability of the UE experienced a steady decrease in pain, disability and fear via a one-on-one TNE program, supplemented with continuous follow-up via E-mail. In 4 months the patient’s main complaint (arm pain) reduced by 5 of 10 on a NRS, while the functional change in the DASH yielded a reduction of 20%, thus producing a minimal detectable change in function for the UE (Beaton et al., 2001; Mintken, Glynn, and Cleland, 2009). Prior to the TNE, the patient’s FABQ-PA score of 17 was associated with a higher likelihood of not returning to work (Burton, Waddell, Tillotson, and Summerton, 1999; Fritz and George, 2002), which was subsequently reduced by more than 50%. The results from this case report concur with previous studies utilizing TNE in reducing pain, disability and fear (Louw, Diener, Butler, and Puentedura, 2011; Moseley, 2003c, 2004, 2005; Moseley, Nicholas, and Hodges, 2004).

Although it could be argued that the one and 4-month progress may have been due to the initial, intensive one-on-one educational session and the subsequent e-mails may not have contributed to the outcomes, a review of the e-mails would imply an incomplete understanding of the TNE and ability to progress exercise and function. It could be postulated that if the questions were left unanswered, fear may have increased, potentially resulting in reduction of activity and possible increase in pain. The delivery of the TNE with follow-up ability for questions and answers is based on the current recommendations for the use of TNE (Louw, Diener, Butler, and Puentedura, 2011; Nijs et al., 2011) and this case report followed said guidelines. Current evidence indicates that one-on-one verbal communication provides superior results for TNE, (Louw, Diener, Butler, and Puentedura, 2011) compared to more economical group sessions. It is postulated that one-on-one sessions are more advantageous due to the individual nature of pain (Melzack, 2001; Moseley, 2003b). Pain experiences are unique to the individual’s experiences (Moseley, 2003b). Although a general pain theme and education session may help patient’s understand pain better, applying the principles to the individual is limited in a group session due to personal and sensitive information being shared with other attendees, the limited ability of the clinician to personally apply the TNE to each person’s case and a likely inability of a clinician to memorize each patient’s personal information. Individual one-on-one sessions on the other hand are expensive and time consuming (Moseley, 2003c). This case, however, provided an opportunity for ongoing, personalization of the TNE to a patient’s specific condition without the problems highlighted in group sessions or the expense of one-on-one in-clinic sessions (Moseley, 2003c).

The significant advantage of providing TNE via e-mail is reaching patients in remote areas or patients with time or financial constraints (Brennan, Mawson, and Brownsell, 2009; Russell, 2009). Although the patient in this case attended a one-on-one session and the expense of traveling to and from the clinical site, subsequent sessions did not require additional travel. Pain is a universal phenomenon and thus also affects rural and remote populations (Merskey and Bogduk, 1994). With the increased use of and availability of the Internet (Saryeddine et al., 2008) the results of this case report provide patients with hope and it is further suggested that future studies investigate if continued dialogue via e-mail is superior to a single one-on-one session and ultimately if all sessions (initial and subsequent) can be delivered via electronic media (web-based learning). Furthermore, education is an active process in need of challenge, reflection and the ability to ask questions (Sharples and Moseley, 2010; Wittmann-Price and Godshall, 2009). In contrast to booklets and a passive
approach of gaining knowledge, e-mail may provide a more personalized ability to educate patients.

Various limitations, cautions and future study avenues are found in this case report. First, the issue of patient confidentiality and electronic e-mail should be considered and explored in future studies. Second, due to current reimbursement models of physical therapy in the United States, the patient in this report was not charged for the e-mail sessions (average 10 min per e-mail communication), which will need further investigation by scientists, policy makers and third party payers. This case report, however, also yielded a surprising and exciting finding in regards to the therapist providing TNE. The ability to read, think and carefully structure a response was easy and less demanding. In busy, pressure-filled clinical practice environments treatments, progressions and answers are often formulated with limited time availability and may in fact add stress to clinical practice. Therapists struggle treating patients with chronic pain (Latimer, Maher, and Refshauge, 2004; Moseley, 2003a) and this e-mail case report provided a surprising side effect allowing a clinician time to read, reflect, clinically reason and carefully carve out a treatment plan for a patient with central sensitization. It could be argued that the patient, feeling somewhat tethered to a helpline may have been part of the recovery process. In the end this case report achieved its goal of helping a patient presenting to physiotherapy with significant pain and disability, and creating exciting questions beckoning a series of studies associated with TNE.

Declaration of interest
The author reports no conflicts of interest.

References
Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C 2001 Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand

Table 3. Self-report outcomes measures at initial consult, 1 month post-TNE and 4 months after TNE.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>At time of evaluation</th>
<th>1 month</th>
<th>4 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm pain</td>
<td>7</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Leg pain</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Oswestry</td>
<td>10</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>DASH</td>
<td>36.7</td>
<td>25</td>
<td>16.7</td>
</tr>
<tr>
<td>FABQ-W</td>
<td>24</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>FABQ-PA</td>
<td>17</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>


