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Reflections on the career of Janet Carr - a physiotherapy trailblazer

This editorial is being co-published in the Journal of Physiotherapy

Upon the death of Janet Carr in 2014 – one of the profession's leading lights with a life-long passion for advancing physiotherapy – it is timely to reflect not only on her life and contribution, but also on our profession's origins, directions and future.

In the last 50 years, the period in which Janet treated, taught, thought and wrote, the physiotherapy profession has faced significant challenges, resulting in unprecedented changes in our professional role. In particular, these years encompass the period when physiotherapists developed independence both in reasoning and professional practice. For the first time, physiotherapists were developing career paths in scholarship and learning as well as in the clinic. Entry programs were increasingly located in universities, such that academic pathways became possible, leading to the growth of higher degrees and research within the profession. The move from hospital-based to university-based education coincided with a shift in the profession towards scientific rigour. There was strong recognition of the importance of deriving clinical implications from the literature, particularly the related sciences, and of conducting research on human function. In addition, there was a rapid development of interventions based on a wider and sounder theoretical basis, the development of reliable measurement tools and the vigorous testing of outcomes.

Janet Carr, along with her close colleague Roberta Shepherd, has been at the forefront of many of these changes over the decades. The drive for change in the conceptual basis for professional practice is particularly evident in their scholarly work and academic leadership. This scholarship is evidenced in the progression of their writing over time which is mirrored in the scientific evolution of our profession. A marker of the early stage of their influence was the publication in 1980 of their first internationally available textbook - *Physiotherapy in Disorders of the Brain* – a book that was specifically published to clarify the changing role of physiotherapy in the treatment of adults with brain damage. Unlike previous physiotherapy texts, this book was extensively referenced to support their arguments, a feature that was particularly unusual at that time. By providing detailed reference lists, and giving, where possible, reasons for the treatments described, they provided a basis for further investigation into treatment effectiveness. The three main themes of this early text illustrates the beginning of the paradigm shift towards the need for a problem-oriented approach to assessment and treatment, the need for an understanding of the processes involved in motor skill relearning and the need to understand the pathological and psychological reasons underlying problem.

The next textbook, *The Motor Relearning Programme for Stroke*, published in 1982 also illustrates the change from inductive thinking to scientific rigour. In it, Janet and Roberta wrote: "We are aware of the need to research thoroughly the effectiveness of any new developments in physiotherapy, particularly since the therapeutic measures at present employed in stroke rehabilitation are carried out despite there having been little or no investigation of their effectiveness". They emphasized the need to describe physiotherapy intervention in detail and to develop tools to measure outcomes so that the effect of intervention could be tested. These ideas, which are taken for granted now, were in advance of the time.

By 1998, in their text *Neurological Rehabilitation: Optimizing Motor Performance*, Janet and Roberta were aiming to: "assist clinicians to become more informed and effective practitioners and to stimulate clinical and laboratory research which will in turn lead to dynamic and effective methodologies. Throughout the book, we have provided references in order to illustrate the process of utilizing theoretical and data-based information in clinical practice. Where these are available, we have included reference to outcomes studies because it is such evidence-based material which is a powerful determinator of theory and direction, enabling the development and testing of protocols (or strictly observed guidelines) as a means of establishing best practice." This quote illustrates that the profession had by then advanced to the stage of testing interventions, and coincides with the exponential increase in randomized controlled trials in physiotherapy (http://www.pedro.org.au/english/downloads/pedro-statistics/ accessed 3rd February 2015).

In the preface of the second edition of *Neurological Rehabilitation: Optimizing Motor Performance,* published in 2010, Janet and Roberta reflect on the progress of the profession and their optimism for the future. "Physiotherapists are making a major change away from methodologies developed in an earlier time for which there is no evidenciary support, and increasingly using methods that are congruent with current knowledge and for which there is encouraging evidence. The results of suitably rigorous clinical trials eventually contribute to evidence-based practice. The current interest in rehabilitation research and the quality of that research are grounds for optimism."

Janet felt that bridging the gap between science and practice was an overwhelming task for the clinician and was therefore a critical driver in writing textbooks throughout her career. Collaboratively with Roberta, Janet authored/edited 13 books from 1976 to 2010 which have inspired generations of physiotherapists. These books have been translated into most European languages and many Asian languages including

Korean, Chinese, Japanese, Arabic and Farsi. The books stimulated passionate debate and the development of ideas within the broad physiotherapy community, and between physiotherapy and other professions. To engage in this debate, Janet travelled, collaborated with international scientists, taught and presented conference papers in over 30 different countries. Janet and Roberta worked, discussed, argued and conducted their own research and scholarly work, while encouraging and mentoring young researchers and clinicians. Although Janet's major contribution was in neurological rehabilitation, the way she conceptualised the profession and moved it forward applied to other areas of rehabilitation. The breadth of her influence and mentorship is exemplified by the Foundations for Physiotherapy Practice Series, commissioned by Janet and Roberta, and published in the early 1990's: *Key Issues in Cardiopulmonary Physiotherapy* edited by Elizabeth Ellis and Jenny Alison; *Key Issues in Musculoskeletal Physiotherapy* edited by Jack Crosbie and Jenny McConnell; and *Key Issues in Neurological Physiotherapy* edited by Louise Ada and Colleen Canning. The editors of each of these volumes were, at the time, all Janet's junior colleagues who were inspired by her mentorship and guidance.

It is important for us to acknowledge our debt to those who inspire and lead us. Janet will be remembered as a tirelessly inquiring academic who was a trailblazer, and her legacy will be a lasting one. She cared about patients' outcomes before patient-centred care was articulated. Her contribution was ahead of its time in that it was in line with the contemporary view of healthcare systems which are now best conceptualized as learning systems where healthcare delivery, education and research coexist to improve patient outcomes at individual and societal levels. Janet entered the physiotherapy profession in 1954, at a time when the average working life of a physiotherapist was 5 years, and went on to devote close to 60 highly productive years to her profession. Janet never retired – until her death she held an honorary position of Associate Professor in the Faculty of Health Sciences, The University of Sydney. On hearing of Janet's illness, the physiotherapy staff at the University sent Janet flowers and promptly received a response from Janet: "I have fond memories of working at the School of Physiotherapy, The University of Sydney in its golden years – we thought we could change the world". Janet did change the world, she made it a better place, and she will be greatly missed. She inspired and empowered generations of physiotherapists.

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A critical review of the psychometric properties of the Nijmegen Questionnaire for hyperventilation syndrome

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ABSTRACT

The Nijmegen Questionnaire is commonly used by physiotherapists and other health professionals in clinical and research settings. This outcome measure was developed by researchers at the Nijmegen University in the Netherlands as a screening tool for the hyperventilation syndrome in the 1980s. However, the literature that supports the efficacy of its use is scarce. This paper examines the evidence in relation to the conceptual basis, validity, and reliability of the Nijmegen Questionnaire. A systematic review of the literature was carried out to identify studies that are related to the above measurement properties for the questionnaire. Studies identified were evaluated for their methodological qualities using the COSMIN checklist. The clinical utility of this instrument is also discussed. Issues associated with the development and validating process of this outcome measure are identified. There is also a lack of evidence in cultural validation given that the Nijmegen Questionnaire was developed in the Netherlands. While this is the only questionnaire currently available that is designed specifically for the screening of hyperventilation syndrome, administrators need to be aware of the issues identified in relation to validity and reliability when interpreting the results. Applying more robust validating processes to establish the efficacy of the Nijmegen Questionnaire appears to be a priority for researchers to improve the quality of health services for individuals suffering from hyperventilation syndrome.

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Key words: Nijmegen questionnaire, Hyperventilation, Outcome measurement, Reliability, Validity

INTRODUCTION

Hyperventilation syndrome (HVS) is a breathing pattern disorder which is often undiagnosed due to its multi-systemic and apparently unrelated symptoms (Mooney and Candy 2008, van Doorn et al 1983). HVS sufferers are regarded as high healthcare users due to the involvement of various medical or surgical services and array of investigations (Chaitow et al 2002, Lum 1975). Mooney and Candy (2008) have demonstrated that the financial implications are significant for both the patients with HVS and their healthcare providers.

Early diagnosis and implementation of individualised physiotherapy education and treatment are proposed as cost effective management approaches for patients with HVS (Mooney and Candy 2008). Diagnostic and screening tools for HVS include the hyperventilation provocation test (HVPT) and formulated questionnaires (Vansteenkiste et al 1991). HVPT is criterion for diagnosis and requires an individual to hyperventilate for few minutes to reproduce presenting symptoms of HVS (Hornsveld et al 1996). Outcome measures that assess hyperventilation and dysfunctional breathing include the Nijmegen Questionnaire, 33-item Hyperventilation Questionnaire (HVQ), and the Self Evaluation of Breathing Questionnaire (SEBQ) (Rapee and Medoro 1994, Courtney and Greenwood 2009, Vansteenkiste et al 1991). However, only the Nijmegen Questionnaire is suggested in the literature to be suitable for screening of HVS in adults (van Dixhoorn and Duivenvoorden 1985). Another questionnaire, the Rowley Breathing Self-Efficacy scale (RoBE scale) (Rowley and Nicholls 2006) is associated with the assessment of people with breathing pattern disorders but its focus is on investigating the individual's ability to control their symptoms in relation to breathing pattern disorders. This leaves the Nijmegen Questionnaire, which is widely used for the detection and diagnosis of HVS (van Dixhoorn and Duivenvoorden 1985).

The Nijmegen Questionnaire (see Appendix) is a short, self-administered patient reported outcome measure consisting 16 HVS related complaints. The frequency of occurrence can be rated on a five-point ordinal scale (0: never, 4: very often) (van Dixhoorn and Duivenvoorden 1985, van Doorn et al 1982). A score above 23/64 is a positive screening of HVS (Garssen et al 1984, van Doorn et al 1983, Vansteenkiste et al 1991). This questionnaire is non-invasive in nature compared to the HVPT. It is considered to be an accurate indicator for hyperventilation within the multidisciplinary setting (Chaitow et al 2002). Routine application of this tool is common in New Zealand physiotherapy practice of patients with breathing pattern disorders including HVS. However, data on the validity and reliability of the tool have not been synthesised to date.

In this paper, we report findings from a systematic review of the evidence for the validity and reliability of the Nijmegen Questionnaire. The conceptual basis of the Nijmegen Questionnaire is also explored using the criteria compiled by the Scientific Advisory Committee of the Medical Outcomes Trust (2002). The mechanism and difficulties surrounding the integration of this outcome measure in relation to its clinical utility within the physiotherapy outpatient setting are also explored.

A brief definition of all measurement properties relating to our evaluation are outlined in the following paragraphs for the purpose of this review.

Validity

The examination of validity is paramount in the process of test development and it involves a number of sequential steps before the final goal of creating a valid outcome measure is achieved (Laver Fawcett 2007, Pallant 2001). The basic definition of validity in the subject field of outcome measurement is the degree to which a scale is measuring what it is designed to measure (Hambleton and Jones 1993, McDowell 2006, Streiner and Norman 2008). Streiner and Norman (2008) further define the process of validating a test as a means to establish the level of confidence we can assume when inferences are made about individuals based on their scores from that outcome measure. Validity can be grouped into three types, namely content, construct, and criterion validity, with the latter looking at specificity and sensitivity specifically (Bowling 1997, McDowell 2006, Pallant 2001, Streiner and Norman 2008).

Content validity

In the literature, it is suggested that the content validity of a scale relates to whether the items or questions included are representative of all the attributes to be evaluated within the specified conceptual basis while meeting the objectives identified for the given instrument (Bowling 1997, McDowell 2006). Additionally, Streiner and Norman (2008) suggest the inclusion of a representative sample in the process of test development can lead to more accurate inferences of individuals being evaluated that are applicable to variety of circumstances, hence increasing the content validity of the instrument developed.

A sound conceptual basis is essential in the development of a health related outcome measure (McDowell 2006). The various aspects of a specified conceptual model articulate the concepts and populations that a measuring tool intends to evaluate and the relationships between the concepts (Scientific Advisory Committee of the Medical Outcomes Trust 2002). McDowell (2006) explains that a defined conceptual basis of a measure supports its content and allows the results obtained to be interpreted alongside a broader body of theory that is associated with the conceptual definition.

Construct validity

The presence of HVS is recognised through the identification of a variety of physical and psychological symptoms (Grossman and de Swart 1984). Such constellations of symptoms of HVS are considered by Streiner and Norman (2008) as hypothetical constructs. The process of construct validation of an outcome measure is complex because there is no one single test or criterion standard to follow (McDowell 2006). Construct validity of an instrument can only be established through an on-going process of learning, understanding, and testing of the constructs (McDowell 2006, Streiner and Norman 2008). Test developers need to look for a cumulative pattern of evidence to ascertain whether the emerging outcome measure relates to the theoretical constructs proposed when assessing the construct validity (Laver Fawcett 2007).

Criterion validity

Criterion validity is defined traditionally as the correlation of an instrument with another measuring tool that is considered the 'gold standard' in the same field (Bowling 1997, McDowell 2006, Streiner and Norman 2008). The comparison could be used formatively when developing a new tool to guide the items selection process by recognising the elements that correlate optimally with the criterion/'gold standard' (McDowell 2006). When assessing concurrent validity (a form of criterion validity), the researchers correlate a new measure with a measure that has been validated, i.e. both measures are administrated concurrently (Streiner and Norman 2008).

Cultural validity

The cultural background of the individual being evaluated can affect test administration and data interpretation (Laver Fawcett 2007). Health professionals need to select a valid and reliable assessment tool that is also culturally relevant to the people being assessed (Høegh and Høegh 2009). There are existing cross-cultural adaptation guidelines and processes in the literature that can help enhance the level of cultural validity or adaptability of a measurement tool (Beaton et al 2000, Høegh and Høegh 2009). Cultural validation process is not simply having the outcome measure translated to a different language; it is also to ensure the conceptual foundation of the outcome remains unchanged after the necessary adaptation of individual items (Beaton et al 2000).

Reliability

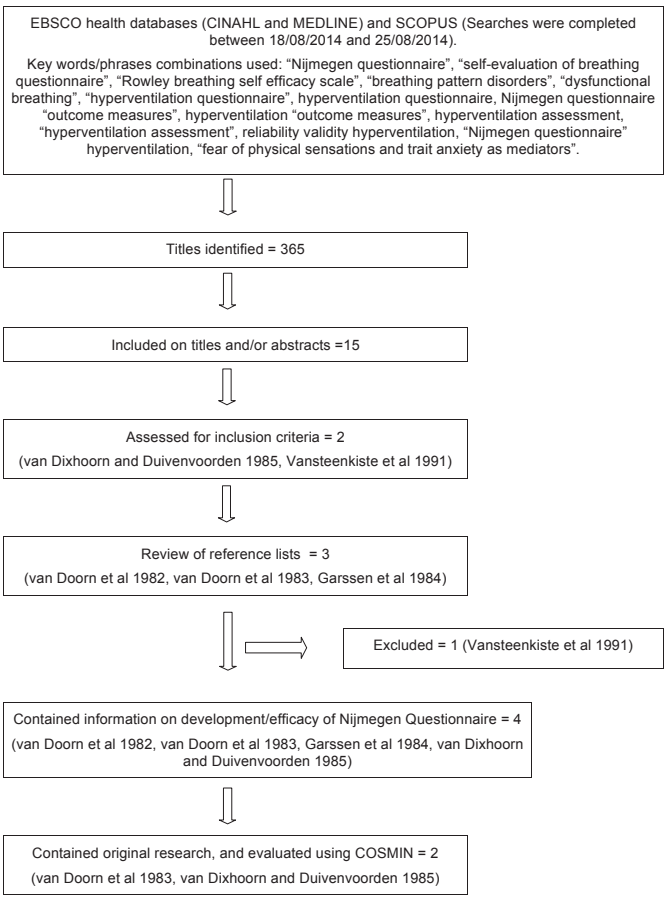
The various types of reliability in relation to patient reported outcome measurement are internal consistency and test-retest reliability (Bowling 2001). Internal reliability is the degree of the interrelatedness among the items, whereas test-retest reliablity is the extent to which scores on the same version of questionnaire for people who have not changed are the same for repeated measurement over time (Mokkink et al 2010).

METHODS

A literature search of the electronic databases (EBSCO Health databases, including CINAHL and MEDLINE) and health related citation index (SCOPUS) was undertaken to identify all articles that examined the validity and reliability of the Nijmegen Questionnaire for hyperventilation syndrome in adults, in addition to articles that were relevant to the development of the tool. Specific key words/phrases combinations were used for the electronic searches (see Figure 1). There was no limitation set on publication date. Papers published up until 25th August 2014 were included. The titles and abstracts of each paper form the initial searches and were reviewed for relevance after removal of duplicates. The full text was read if information provided in the abstract was insufficient. The reference lists of the articles identified from the initial searches were hand-searched to identify potential relevant titles. Studies were included if: (1) the aim of the study was to examine the *psychometric properties* (e.g. validity, reliability, sensitivity, or responsiveness) of the Nijmegen Questionnaire for hyperventilation syndrome in adults; (2) the study contained information relevant to the *development* of the Nijmegen Questionnaire for hyperventilation syndrome in adults. Studies were excluded if: (a) the study was puplished in languages other than English or Dutch (although there were none); (b) participants of the study were younger than 18 years of age; (c) participants of the study were diagnosed with any organic cardiac, neruological, or respiratory disease.

Critical evaluation of the studies that met our review criteria was guided by the COSMIN checklist (Consensus-based

Figure 1: Flow diagram showing the selection process of articles



Standards for the selection of health status Measurement INstruments), a standardised tool recommended for evaluating the methodological quality of studies concerning measurement properties (Mokkink 2010, Terwee et al 2012).

RESULTS

An overview of the paper selection process is shown in Figure 1. A total of 365 articles were generated electronically after discarding duplicates. Fifteen were identified as potentially relevant to this review based on their study titles and/or abstracts. Thirteen of these were rejected based on our exclusion criteria. The two remaining articles were read in their entirety and reference list checking led the researchers to three more titles. Upon further inspections, four of the five articles provided information about the development of the Nijmegen Questionnaire and its validity and reliability data (see Table 1 for a summary of studies included in this review) of the tool. Translation of Dutch papers was provided by one of the authors of this paper, whose first language is Dutch. Only two of the four articles contained original research. These two research studies were led by van Doorn (1983) and van Dixhoorn (1985) respectively. A critical evaluation of these two studies was guided by the COSMIN checklist (see Table 2 for a summary of the evaluation).

Content validity

The conceptual and empirical basis for the inclusion of the 16 items was published over three decades ago (van Doorn et al 1982). The researchers stated that the items were chosen out of a list of 45 complaints that were regarded as associated with HVS for their clinical relevance by a group of specialists from various disciplines. These items were tested in two other studies with 40 and over 200 participants respectively, to assess the Nijmegen Questionnaire's effectiveness in differentiating between individuals with and without HVS (van Doorn et al 1982). This approach is considered by McDowell (2006) as an idiographic approach in item selection, which employs empirical methods to select questions that best illustrate the eventual outcome after testing a larger number of items. The professional background of these specialists (physiology, psychology, and psychiatry) was published in a different paper in the following year (van Doorn et al 1983). However, van Doorn and colleagues (1982) did not offer further details regarding the item selection process and there was no evidence to suggest the involvement of the target population in the process of content derivation, implying that their perspective is not encompassed by the measure. The Scientific Advisory Committee of the Medical Outcome Trust (2002) suggests that to meet criteria of content validity both expert and lay panels should judge the clarity, comprehensiveness, and redundancy of the items included in a measuring tool. This was only partially fulfilled by the developers of the Nijmegen Questionnaire. Considering the unavailability of this information, the level of adequacy regarding the selected items in relation to the conceptual basis of the Nijmegen Questionnaire warrants further investigation.

Furthermore, the title of the questionnaire appeared to only reflect its geographical origin (the city of Nijmegen in the Netherlands). The absence of association between the name and content of the questionnaire potentially reduced the face validity of the Nijmegen Questionnaire, which is related to its acceptability for individuals being assessed (Bowling 1997, Laver Fawcett 2007). Thus, based on the COSMIN evidence, content validity was rated as poor (Mokkink 2010, Terwee et al 2012).

Construct validity

In the 1985 publication by van Dixhoorn and Duivenvoorden (1985), non-metric principal components analysis (NMPCA) was employed to assess the complexity of the Nijmegen Questionnaire for HVS complaints. This was the first easily identifiable step in relation to the construct validating process for the Nijmegen Questionnaire. The NMPCA was utilised to establish the dimensional structure of items included in the questionnaire and hence the structural validity (a form of construct validity) of the instrument (Tabachnick and Fidell 1996, van Dixhoorn and Duivenvoorden 1985). Three components (respiratory, central tetany, and peripheral tetany) were identified by the application of factor analysis and these followed the classic triad of HVS related complaints (Lum 1975). A key limitation of the study was an inadequate sample size to examine the structural validity of the Nijmegen Questionnaire; 75 patients were included, compared to sample size recommendations ranging between five to 10 people per item in the questionnaire (Thompson 2004).

The construct validity of the Nijmegen Questionnaire was also examined using linear analysis of discriminance (van Dixhoorn and Duivenvoorden 1985). The authors performed the analysis to establish whether the question items were able to discriminate optimally between individuals with and without

Table 1: Summary of studies in relation to the critical review of the Nijmegen Questionnaire

Authors	Year	Study title	Purpose of the study	Results
van Doorn, Folgering, and Colla.	1982	Control of the end-tidal PCO2 in the hyperventilation syndrome: Effects of biofeedback and breathing instructions compared	To evaluate the efficacy of a behavioural management of HVS	Behavioural management supplemented with explanations about the mechanisms of HVS and coping strategies are useful.
van Doorn, Colla, and Folgering.	1983	Een vragenlijst voor hyperventilatieklachten [A questionnaire for hyperventilation symptoms]	To investigate if a short questionnaire in which patients are asked to report the frequency of 16 common hyperventilation symptoms is useful	The questionnaire is useful in patient screening and the provocation test can be used to rule out false positives.
Garssen, Colla, van Dixhoorn, van Doorn, Folgering, Stoop, and de Swart.	1984	Het herkennen van het hyperventilatiesyndroom [Recognising the hyperventilation syndrome]	To assess and review the NQ	*The NQ is able to discriminate (23 as the cut-off score) between individuals with and without HVS.
van Dixhoorm, and Duivenvoorden	1985	Efficacy of Nijmegen Questionnaire in recognition of the hyperventilation syndrome	To establish the differentiating ability of the NQ by comparing individuals with and without HVS	The NQ is a suitable screening tool for early detection of HVS and an aid in diagnosis and therapy planning.

Note: HVS = hyperventilation syndrome; NQ = Nijmegen Questionnaire. *This study result was adapted from the study by van Doorn and colleague (1983).

HVS, hence assessment of discriminative validity (Streiner and Norman 2008). The researchers found significant differences in the scores between the individuals with HVS and those without across all components (van Dixhoorn and Duivenvoorden 1985). In other words, participants with HVS scored distinctly higher in all three groups of complaints in the Nijmegen Questionnaire compared to those without the syndrome. Despite the appropriate application of statistical methods throughout the testing process, the quality rating on the COSMIN checklist (Mokkink 2010, Terwee et al 2012) was reduced by the inadequate sample size, omission of clear hypotheses regarding the correlations, and how missing data were managed.

Criterion validity

Some evidence to support the criterion validity of the Nijmegen Questionnaire was presented in 1983 (van Doorn et al 1983). Participants with HVS previously diagnosed by the hyperventilation provocation test (criterion/'gold standard') and those without the disease were asked to complete the Nijmegen Questionnaire and discriminant analysis was employed through the validating process. The authors summarised that the total scores of Nijmegen Questionnaire correlated strongly with the hyperventilation provocation test (van Doorn et al 1983). In addition to the inadequate sample size, the study did not provide sufficient information regarding the percentage of missing data and how this was managed, thus the evidence for the criterion validity of the questionnaire was deemed fair instead of excellent (Mokkink 2010, Terwee et al 2012). In the 1985 study, the researchers demonstrated that the Nijmegen Questionnaire possessed a greater degree of specificity (94%) than sensitivity (89%) (van Dixhoorn and Duivenvoorden 1985). This suggested that the number of false alarms or false positives (i.e. people without HVS who were identified as having HVS) was less than the number of false negatives (i.e. HVS sufferers who were incorrectly identified as healthy). The authors concluded that the Nijmegen Questionnaire was a suitable screening tool for HVS (Bowling 2001, van Dixhoorn and Duivenvoorden 1985). It was suggested that results acquired by a screening tool (e.g. Nijmegen Questionnaire) should be subjected to a diagnostic test (e.g. Hyperventilation Provocation Test) to rule out false positives (van Doorn et al 1983).

Decisions around the cut-off point for a screening tool need to be considered in relation to specificity and sensitivity (Laver Fawcett 2007). McDowell (2006) proposed that 'if the goal is to rule out a diagnosis, a cut-off point will be chosen that enhances sensitivity, whereas if the clinical goal is to rule in a disease the cut-off point will be chosen to enhance specificity' (p 32). Although the cut-off score of 23/64 for the Nijmegen Questionnaire is documented (Garssen et al 1984, van Doorn et al 1983, Vansteenkiste et al 1991) and applied in the multidisciplinary health settings (Chaitow et al 2002), the empirical evidence that supports this is unclear in the literature. Van Doorn and colleagues (1983) was the only research team that supported their recommendation with original research. The authors suggested 22 as the cut-off score and recommended that patients who were identified with HVS to undergo the hyperventilation provocation test to rule out false positives. In the following year, Garssen and colleague (1984) suggested the currently accepted cut-off score (23/64) based on the summary of the research paper published by van Doorn and colleague (1983) without carrying out their own evaluation of patients. Although Garssen and colleague (1984) recommended how the Nijmegen Questionnaire should be administered, the credibility of this publication was diminished due to the lack of raw research data.

Table 2: Summary of study evaluation using the COSMIN checklist in relation to the Nijmegen Questionnaire

Evaluated measurement properties	Studies with original research		Overall quality scores	Questions for each property													
	Van Doorn, Colla, Folgering (1983)	Van Dixhoorn, Duivenvoorden (1985)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Reliability	✓		Poor	Good	Fair	Excellent	Poor	Excellent	Excellent	Good	Excellent	Good	Excellent	Poor	Poor	Poor	Excellent
Content validity	✓		Poor	Fair	Poor	Good	Fair	Poor									
Structural validity		✓	Poor		Good	Fair	Poor	Excellent	Excellent	Poor							
Hypotheses testing		✓	Fair	Good	Fair	Excellent	Fair	Good	Excellent	N/A	N/A	N/A	Excellent				
Criterion validity	✓		Fair	Good	Fair	Excellent	Excellent	Excellent	N/A	Excellent							

Note. Only the measurement properties that are included in the two studies are presented here. Excluded properties are internal consistency, measurement error, cross-cultural validity, and responsiveness. ✓ denotes the study that tested the specified measurement property. Each property has different number of questions within the COSMIN checklist as shown in the table. N/A indicates a lack of information from the study to answer the question listed. Adapted from *Rating the methodological quality in systematic reviews of studies on measurement properties: a scoring system for the COSMIN checklist* by CB Terwee, LB Mokkink, DL Knol, R Ostelo, LM Boutex, and H de Vet (2012).

Cultural validity

The Nijmegen Questionnaire was developed in the Netherlands. While this questionnaire has been widely used in the field of clinical practice and health research (Chaitow et al 2002), there was no literature available for critique in terms of its cultural validity. Without subjecting this questionnaire to a recognised cultural-adaptation process, the utilisation of this tool by health professionals working in different cultural contexts could significantly impact on clinical and research outcomes.

Reliability

The test-retest reliabilty of the Nijmegen Questionnaire was investigated by van Doorn and researchers (1983). They concluded that the questionnaire was relatively stable given the coefficient of 0.87 but, they did not state what correlation coefficient they used prior to data testing. The authors made the decision to retain all 16 items from the Nijmegen Questionnaire based on the range of bi-serial correlations obtained (.30 to .65) indicating that all items associated with presentation of HVS. The researchers stated that the similarity between the retained symptoms of HVS was minimal based on the inter-correlations between all of the items (0.03 to 0.52) (all items captured different aspects of HVS). Evidence for the reliability of the tool was rated as fair because the authors did not report how missing data were managed and Kappa statistics were not presented (Mokkink 2010, Terwee et al 2012). Internal consistency of the tool has not been investigated to date.

Clinical utility

Clinical utility is an important factor when evaluating the quality of an assessment (Laver Fawcett 2007). An empirically validated and standardised instrument does not automatically warrant relevance and usefulness of the tool in practice (Chaitow et al 2002). The clinical utility of an assessment tool can generally be judged in five categories: cost, time, energy and effort, portability, and acceptability (Laver Fawcett 2007).

Cost

The Nijmegen Questionnaire was published in the 1980s and it remains free for anyone to access. The ease of accessibility is

evident as the content of the questionnaire was found in our literature search (van Doorn et al 1982). There is cost involved when producing copies of the test in practice but no costly specialised training is required to administer the test.

Time

The time required for a patient to complete the Nijmegen Questionnaire is approximately five minutes (Garssen et al 1984). More time will be needed if an interpreter is required. Poor mental state and stamina resulting from an extended assessment can affect the validity and reliability of a test (Laver Fawcett 2007). In physiotherapy practice, the Nijmegen Questionnaire allows quick screening of HVS symptoms. It requires minimal preparation and results can be calculated and interpreted immediately.

Energy and effort

The energy and effort associated with the administration of an instrument is related to both the test administrator and the patient (Laver Fawcett 2007) and can influence the use of the test in health services (Chaitow et al 2002). Tests usually require less energy with repeated use (Laver Fawcett 2007). The Nijmegen Questionnaire comprises 16 short questions and is easily administered.

Portability

The portability of an assessment tool reflects the ease of carrying or transporting an instrument (Laver Fawcett 2007). A measure that is bulky or heavy has a low portability. The Nijmegen Questionnaire can be completed as a pen and paper exercise which is highly portable.

Acceptability

The philosophy, theoretical frameworks, and interventions within a health service are to be considered when assessing the acceptability of a measure (Laver Fawcett 2007). Practitioners are encouraged to ascertain if the outcome measure is tolerated by the individuals being evaluated (Chaitow et al 2002). If a test is prone to cause distress, it might not be easily accepted by patients or their families. Patients from the lead author's clinic report that the questionnaire allows them to make sense of the symptoms of HVS and provides a baseline for progress monitoring.

DISCUSSION

The current review identified a small number of studies concerning the validity, reliability, and the development of the Nijmegen Questionnaire, of which only two studies contained original research. Considering the limited evidence presented over three decades, it is remarkable that the questionnaire is still widely used in clinical and research practice. The methodological flaws that were identified in the two original research studies using the COSMIN tool include the lack of target population involvement and missing items reporting, insufficient participants and statistical testing. Other measurement properties that are part of the COSMIN checklist such as internal consistency, measurment error, responsiveness, and cultural validity are not researched to date. Some of the methodolgoical flaws can be addressed by designing and carrying out studies with more participants, with the application of more robust statistical tests to generate results that can be used to better evaluate the validity and reliablity of the Nijmegen Questionnaire.

While the COSMIN checklist is a very detailed and comprehensive evaluation tool, it requires that the lowest rating to be taken as the final methodological quality score per category, i.e. the worse score counts. It means that a measurement property of the Nijmegen Questionnaire can be rated poor overall (Table 2) despite having other questions in the same category rated higher (e.g. fair, good, or excellent). Consequently it is is important to review each COSMIN domain prior to future research so that researchers can specifically design studies that meet all the criteria for a robust study design.

While the existing evidence on validity and reliability of the measuring tool is scant, the Nijemegen Questionnaire is the only outcome measure that is suggested to be suitable for screening of hyperventilation syndrome in adults. Further research studies are required to investigate its measurement properties, including a review of its cultural validity and clinical utility.

CONCLUSION

This paper provides a critical summary of the validity, reliability, and clinical utility of the Nijmegen Questionnaire. The number of existing journal articles on validity and reliability of this outcome measure is minimal. The research studies that were identified have fair to poor methodological properties. In particular, the evidence for the content validity, structural validity, and reliability was poorly represented in the studies reviewed and no research has been carried out on the cultural validity of the Nijmegen Questionnaire.

Nevertheless, the Nijmegen Questionnaire is used by health professionals as a diagnostic or screening tool for HVS (Chaitow et al 2002, Vansteenkiste et al 1991). While there is no evidence in the literature that specifically investigates the questionnaire's ability to measure change, the Nijmegen Questionnaire is often used as an outcome measure in clinical research (Agache et al 2012, Humphriss et al 2004, Thomas et al 2003). The lack of empirical evidence on the conceptual framework in relation to this instrument places doubt on the validating processes thus far. Physiotherapists who are considering or are already using this outcome measure need to be aware of the issues raised in this article when interpreting the scores. It is recommended that results gathered using the Nijmegen Questionnaire should be interpreted in conjunction with other clinical assessments when diagnosing patients with hyperventilation. Going forward, researchers can explore and re-establish the content and conceptual basis of the Nijmegen Questionnaire by involving individuals with HVS, examine the test-retest reliability, as well as the structural and internal validity more robustly with appropriate sample sizes and statistical techniques. Until such time, there is limited evidence for the use of the only questionnaire for hyperventilation screening or diagnostic testing.

KEY POINTS

- The Nijmegen Questionnaire is widely used in the screening of hyperventilation syndrome in health settings.
- There is a limited number of fair to poor quality studies evaluating the psychometric properties of the Nijmegen Questionnaire.

- Physiotherapists and other health professionals need to be aware of the limited evidence base for this tool.
- Further research that involves more robust statistical analysis is required to establish the validity, reliability, and sensitivity of the Nijmegen Questionnaire.

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APPENDIX: Example of the Nijmegen Questionnaire

	Not at all	Rare	Sometimes	Often	Very often
Symptoms	0	1	2	3	4
Chest pain					
Feeling tense					
Blurred vision					
Dizzy spells					
Feeling confused					
Faster or deeper breathing					
Short of breath					
Tight feelings in chest					
Bloated feeling in stomach					
Tingling fingers					
Unable to breathe deeply					
Stiff fingers or arms					
Tight feelings around mouth					
Cold hands or feet					
Palpitations					
Feelings of anxiety					
					Total:

Note: The questionnaire is completed by marking how often an individual suffers from the symptoms listed. The item scores are added up to give a total score out of 64 as an indication for the presence of hyperventilation syndrome.

Differences in student and clinician perceptions of clinical competency in undergraduate physiotherapy

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ABSTRACT

The ability of healthcare students to accurately self-reflect is crucial to the attainment of clinical competency; however limited research has been conducted in the physiotherapy profession. This study sought to determine a) whether ratings of clinical performance on a nationally standardised tool differ between students and their clinical educators; and b) whether the magnitude of agreement differs between ratings of clinical performance measured at two different time-points during clinical placements. From January 2012 until June 2013 undergraduate physiotherapy students and clinicians independently assessed students' clinical competency via the Assessment of Physiotherapy Practice (APP) at midway and final assessments across all clinical placements. The mean degree of agreement was compared using the Bland-Altman method. Statistical analysis revealed a mean APP% score difference (student minus clinical educator) of -7.5% (95% limits of agreement 13.7 to -28.8%) at midway and -9.7% (95% limits of agreement 7.9 to -27.4%) at final assessment. This represents student 'underestimation' of their clinical competency. Considerable within-subject variability was evident from midway to final assessment. Further examination of student and clinical educator agreement in the evaluation of student performance during health professional clinical placements is indicated in light of recent research.

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Keywords: Agreement; Clinical competence; Clinical education; Competency; Health professional education; Physiotherapy

INTRODUCTION

Effective learning in clinical healthcare practice requires an intricate partnership between the supervising clinical educator and the health professional student in order to establish the required clinical skills, graduate attributes, and professionalism required for safe and effective practice (Dean et al 2009, Wass et al 2001). The partnership between student and clinical educator carries many shared responsibilities. Effective communication and feedback between both parties is important to maintain a focus and direction of learning. These processes help to identify differences between students' current and expected levels of clinical skills and behaviours, and facilitate the development of strategies to address deficits (Boud 2000). Educators are responsible for the assessment and development of clinical performance (Molloy and Keating 2011) and if required, have a duty to prevent students' academic progression if public safety or professional standards are significantly threatened (Parker and Wilkinson 2008).

Disagreement between students and clinical educators regarding the level of clinical competency may be problematic. It may reduce the potential for learning, decrease the accuracy of critical reflection, and reduce learning outcomes (Boud et al 2013). A breakdown in the clinical educator-student relationship may result in lost clinical opportunities that could impose a burden on all stakeholders, including decreased health service provision (McMeeken 2008). Negative clinical experiences have also been shown to affect the workforce with poor morale and reduced career longevity (McAllister and McKinnon 2009). Differences in the perception of performance between educators and students may exist in clinical practice. For example, perception of performance is likely to be influenced by self-serving biases, knowledge of performance during previous clinical or campus-based experiences, and personal challenges or attributes such as anxieties and/or perception of self (Delany and Molloy 2009). Kruger and Dunning (1999) demonstrated that, in a non-clinical context, individual underperformers are more likely to overestimate their performance. If these findings translate to the clinical education setting, underperforming students may lack the ability to objectively appraise their capabilities. This could potentially adversely impact upon patient care or safety and is likely to impose greater responsibilities upon educators of such students. Poor agreement may demonstrate the need for intervention with either party and could assist with identifying students at risk of future poor performance due to a lack of insight into personal performance.

Despite the importance and limitations of existing literature regarding agreement between clinician and student perceptions of performance, such methods remain the predominant basis for evaluating the attainment of clinical skill competencies (and therefore progression through undergraduate training) in the physiotherapy profession across Australia. This occurs despite a parallel emergence of a strong reflective practice culture and yearning for proactive student support paradigms. Minimal research has been conducted in the physiotherapy profession to support this practice. One review of self-assessment (Miller 2008) yielded three articles involving physiotherapy students. Only one (Palmer et al 1985) made a direct comparison between student and clinician assessments of a simple clinical skill (manual muscle testing involving goniometry), revealing a moderate correlation. Whilst clinician assessment is used to determine clinical competency, the role of student self-assessment in physiotherapy remains relatively unknown.

The primary aim of this study was to determine whether ratings of clinical performance differ between undergraduate physiotherapy students and their clinical educators. The secondary aim was to determine whether the degree of agreement between students and clinical educators differed between midway and final measures of clinical performance.

METHOD

Procedure

This study was conducted between January 2012 and June 2013 with ethics approval from Monash University (reference CF10/1321 - 2010000703). Undergraduate physiotherapy students completing their third or fourth year of the Bachelor of Physiotherapy programme at Monash University attended clinical placements of either four or five-week duration over an 18-month period. Clinical performance was measured using the Assessment of Physiotherapy Practice (APP). This instrument was validated to assess physiotherapy competence across both New Zealand and Australia (Dalton et al 2011, Dalton et al 2012). The APP rates clinical performance relative to entry-level physiotherapists against 20 items (where applicable) using standardised 5-point Likert scales (score range 0-4, with 2 indicating competence of an entry level standard). A total score (maximum 80) is derived and converted into a percentage score, to account for items unable to be assessed.

The APP was electronically transposed to a web-based platform (the 'eAPP'), designed and developed specifically for the Monash University physiotherapy programme. To enable the study data to be collected, a parallel system was created to allow students to complete self-evaluations of their performance using the same eAPP. Student entries were independent of ratings from clinical educators. The eAPP was accessed via a secure online portal that allowed both parties to independently enter data blindly. The eAPP was completed at the end of the middle and final week of each clinical placement. For this study, the clinical educators were the individuals responsible for the student's supervision whilst on clinical placement. In Australia, these clinicians are typically employees of the healthcare providers.

Analysis

Midway and final student and clinician eAPP data were extracted from all clinical placements during the data collection period and pooled across the two enrolment cohorts. Raw eAPP scores were converted into percentages. Instances of data that were not available for both student and clinician at any given time-point were deleted. Individual placement percentages were then averaged across the total number of placements to derive overall mean ratings of midway and final student and clinical educator assessments of clinical performance. The degree of agreement was analysed using the Bland-Altman (BA) method (Martin Bland and Altman 1986). This involves visual inspection of a scatter plot where the mean difference of the observation (student eAPP % minus clinical educator eAPP %; Y axis) is plotted against the mean observed score (student eAPP % plus clinical educator eAPP % divided by two; X axis). The overall mean difference and upper and lower 95% limits of agreement are indicated by central, upper and lower horizontal lines corresponding to their respective Y-axis value. Ideal agreement without systemic bias is represented by a mean difference approximating zero with narrow 95% limits and an even distribution of data across the range of possible instrument scores (X-axis). This method allows for visual comparison of data over the full dependent variable scale at both the individual and group level. This offers advantages over alternative methods such as correlation coefficients or t-tests, as it reduces the risk of erroneous interpretation that may occur when group data are summarised down to single statistical significance values. This analysis was considered representative of the extent of student and clinical educator agreement of clinical performance across the undergraduate physiotherapy programme, and constituted the principal endpoint of analysis for the primary study aim. The secondary aim was addressed via exploratory comparison of BA plots from both the midway and final assessments and inspection of box and whisker and paired co-ordinate scatter plots. All data were analysed using Stata® Data Analysis and Statistical Software version 12.

RESULTS

Corresponding data from student and clinical educator ratings of eAPP were available from 101 and 102 students who completed a mean (standard deviation) of 3.3 (1.2) midway and 3.8 (1.0) final placement assessments, respectively.

Inspection of the BA plot corresponding to midway assessments (Figure 1) revealed a mean difference (student minus clinical educator) in eAPP % score of -7.5% and 95% limits of agreement 13.7 to -28.8%. This represents 'underestimation' of clinical competency on students' behalf. Mean eAPP % scores ranged from 31.9 to 78.4, with most being less than 65%.

Inspection of the BA plot relating to final assessments (Figure 2) revealed a mean difference (student minus clinical educator) in eAPP % score of -9.7% and 95% limits of agreement 7.9 to -27.4%. This, again, represents student 'underestimation' of clinical competency, to a slightly greater extent than at midway assessment. The limits of agreement were slightly narrower than at midway assessment. Mean eAPP % scores ranged from 45.7 to 89.2, with most being greater than 55%.

The difference in the mean degree of agreement between midway and final assessments was small (2.2%; Figure 3). Closer inspection of the magnitude of change from midway to final assessment showed that, despite a small mean increase in the magnitude of student 'underestimation' of clinical competency from midway to final assessment (from -7.5% to -9.7%), there was significant variability in the direction and magnitude of within-subject change (Figure 4).

Figure 1: Bland-Altman plot of agreement at midway assessments. S = student; C = clinical educator; eAPP = electronic version of the Assessment of Physiotherapy Practice.

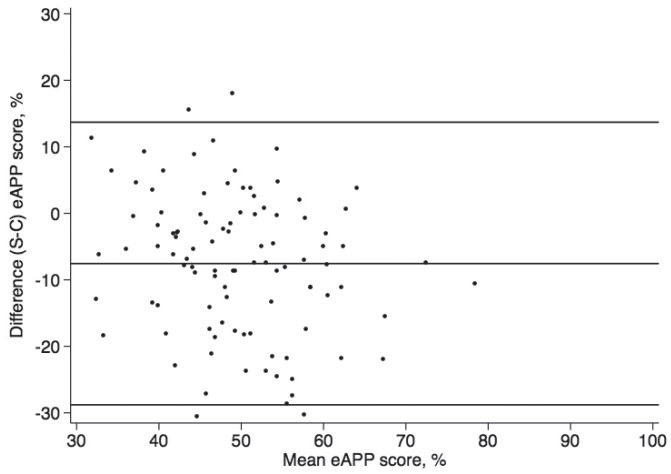
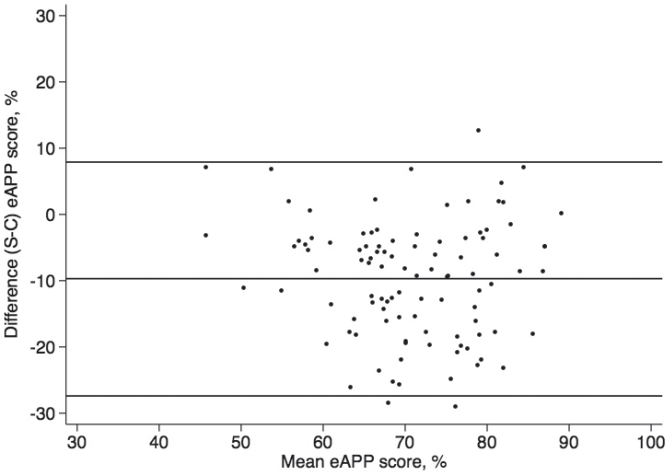


Figure 2: Bland-Altman plot of agreement at final assessments. S = student; C = clinical educator; eAPP = electronic version of the Assessment of Physiotherapy Practice.



DISCUSSION

To our knowledge, this is the first investigation to quantify the degree of agreement in ratings of skill competencies between students and clinical educators measured on a nationally standardised tool during physiotherapy clinical placements. Examination of student - clinician collaboration to ensure competency is crucial, given the heavy reliance placed upon clinical educators to assess competency in the medical, nursing and health science professions.

Our data demonstrates that, on average, physiotherapy students rate their performance 7.5% lower than their clinical educators at the midway clinical assessment. This difference increases slightly to 9.7% by the end of the placement. These mean estimates were associated with a moderate, but consistent degree of variability in the order of +/-20%. Kruger and Dunning (1999) propose that individual underperformers are more likely to overestimate their performance while high performers are more likely to underestimate. We found minimal

Figure 3: Comparison of midway and final agreement. S = student; C = clinical educator; eAPP = electronic version of the Assessment of Physiotherapy Practice.

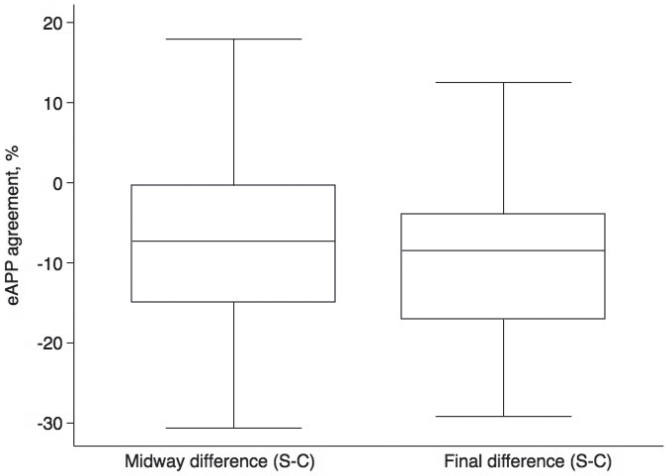
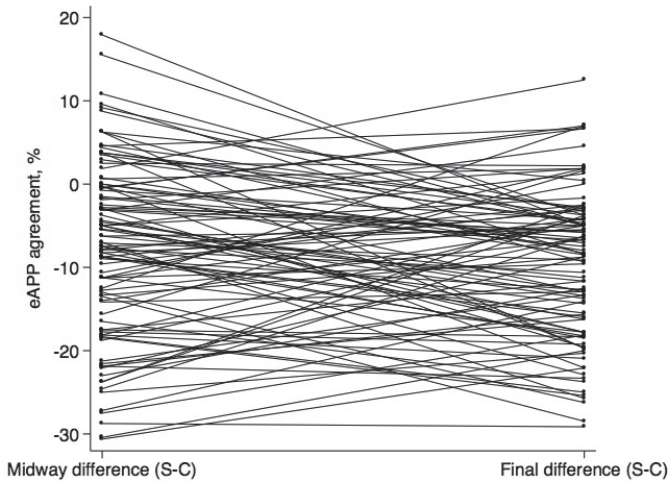


Figure 4: Within subject agreement change from midway to final assessment. S = student; C = clinical educator; eAPP = electronic version of the Assessment of Physiotherapy Practice.



evidence of student overestimation (indicated by aggregation of data well above the zero Y-axis value) at any measure of mean eAPP scores (X-axis) at either time-point (Figures 3 and 4). By contrast, these data suggest that, on average, students tend to mildly underestimate their clinical performance, particularly those who obtain higher final placement scores. This is consistent with findings from Boud et al (1989). These findings have clinical significance, highlighting a potential area for student support given the consequences of burnout and perfectionism in tertiary students in the literature (Dyrbye et al 2010, Gibbons 2010, Schweitzer and Hamilton 2002).

The precise reason(s) for the observed discrepancy in ratings of clinical performance between students and clinical educators was not clear, and beyond the scope of the present study. Hypothesised factors, attributable to either the students or clinical educators (or both), may include:

- Student underestimation. This could relate to a lack of clinical experience or understanding of new graduate competency levels

(upon which the APP is based). It may also reflect students' intrinsic ideals of the clinical supervisory relationship – one where their performance *should* be lower than that perceived by their clinical educators. Recent literature suggests that student underestimation may be associated with personality traits common to the health profession such as perfectionism (Schweitzer and Hamilton 2002).

- Clinician overestimation. Evidence suggests students may have greater awareness of their tacit knowledge than educators (Boud and Falchikov 1989), yet are non-homogeneous in their response to self-reflection (Harrington et al 1997). The reliability of clinical assessment scores is also known to vary according to clinician experience, assessment criteria clarity, task complexity, and assessment setting and duration (Blanch-Hartigan 2011, Harrington et al 1997). Alternatively, this overestimation may represent the 'failure to fail' phenomenon reported by Dudek and colleagues (2005).

The potential implications of student and clinician agreement regarding clinical performance are inexplicit. Two significant questions arise. First, does agreement relate to the attainment of clinical competencies? This may be contextually dependent but is of high importance to investigate. Second, what constitutes optimal agreement and a clinically important change in agreement? We expected the APP to demonstrate a high degree of agreement due to its robust design incorporating a five point Likert scale to rate key competency-based skill descriptor items (Boud and Falchikov 1989).

The importance of the observed difference in agreement reported in this study is yet to be determined. In the absence of an accepted definition regarding a 'significant difference', it is possibly the consistency of agreement across one or multiple clinical placements that could prove useful to monitor. Research using the earlier (midway) time-point may prove beneficial due to the opportunities that may be afforded for early detection and early intervention to address concerning behaviours. As discussed by Mattheos, clinicians may use these discrepancies as a point of discussion as it is "important to clarify that the deviation itself does not constitute a judgement of any kind" (Mattheos et al 2004).

A limitation of the approach used to measure insight in this study was the need for 'representative' data for individual students. As each student undertakes a number of clinical placements across a diverse range of clinical settings, we used the average of all available data across the number of clinical placements undertaken during the third and fourth undergraduate year of the physiotherapy programme. This enabled each dot to be representative of each student. We acknowledge this approach may omit important trends that could emerge over time. For example, students and clinicians may agree closely for the first four placements, yet strongly disagree on the fifth.

Clinician-based assessments were used as the reference standard, despite their known limitations (Ward et al 2002). Strategies to improve data reliability, such as multiple expert raters or student peer review, and consideration of inevitable differences between students' ability to accurately self-reflect, as recommended by Ward (2002), were not implemented as these were not practical within the constraints of the current clinical environment. It is crucial to note such 'uncontrolled' methods of evaluation accurately replicate the evaluation methods routinely used in undergraduate physiotherapy clinical practice across Australia.

Despite these limitations, the nature of enquiry reported in this study is important. The APP is the benchmark, validated instrument for assessing physiotherapy clinical competency in New Zealand and Australia. It has a statistically rigorous foundation and incorporates explicit marking criteria to enhance its accuracy. Furthermore, peer standard setting and familiarisation with the tool are embedded throughout the Monash University undergraduate curriculum to ensure consistency in its application.

There remains a dearth of literature regarding development of self-assessment skills within the physiotherapy profession. Current methods of evaluating student clinical competencies are unlikely to significantly change in the present fiscal academic and healthcare climate. Significant scope therefore remains to address some of these limitations and further explore these important concepts for the physiotherapy profession. For example, analysis of individual student data over time may determine the impact of clinical placement experience on student/clinician agreement and attainment of clinical competency. In particular, we support the findings of Eva and Regehr (2005) that self-assessment is "a complicated, multifaceted, multipurpose phenomenon that involves a number of cognitive processes". It is a skill which changes over time depending on content, context and expertise and we must consider this larger perspective. Further enquiries into the methods of student self-assessment used in physiotherapy appear indicated.

CONCLUSIONS

This study highlights the potential importance of examining student and clinical educator agreement in the evaluation of student performance during health professional clinical placements. On average, the degree of agreement and variability between midway and final assessments is consistent, however the precise reasons explaining student 'underestimation' are not clear. The considerable degree of within-subject variability from midway to final potentially limits the applicability of these data at an individual level. The relationship between agreement discrepancies and important clinical outcomes has not yet been established. A significant relationship may highlight significant opportunity to intervene early and optimise outcomes for students, educational institutions and healthcare providers alike. This study sets a foundation upon which such future research can be based.

KEY POINTS

- Progression through Australasian undergraduate physiotherapy clinical placements is almost exclusively determined via clinical educator ratings of student performance, despite known limitations of this 'expert vs novice' model.
- In our cohort, undergraduate physiotherapy students demonstrated reasonable insight (mild under-estimation) of their clinical performance in comparison to their clinical educators.

- The degree of agreement between student and clinical educator ratings of clinical performance conducted at midway or end of placements appears consistent.
- Identification of differences between student and clinical educator ratings of clinical performance at a midway assessment may offer a timely opportunity to implement early student support strategies to improve final placement outcomes. Its potential significance warrants further investigation.

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PERMISSIONS

This study was approved by Monash University Human Research Ethics Committee (reference CF10/1321 - 2010000703). Informed consent was gained as per the above ethics approval.

DISCLOSURES

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Pulsed electromagnetic energy as an adjunct to physiotherapy for the treatment of acute low back pain: a randomised controlled trial

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ABSTRACT

The intention of this study was to investigate any additional benefits of pulsed electromagnetic energy used as an adjunct to routine physiotherapy for the treatment of acute non-specific low back pain. To address this aim, a single centre, double blinded, placebo controlled randomised control trial was conducted. Forty participants presenting to the University of Otago, School of Physiotherapy Clinic with acute non-specific low back pain (<6 weeks) were recruited. The Oswestry Disability Index was employed as the primary outcome measure. Secondary outcomes included the Patient Specific Functional Scale and the Numeric Pain Rating Scale. Outcomes were collected at baseline, one week and four weeks (or discharge). Baseline characteristics exhibited no differences between groups. The group treated with active pulsed electromagnetic energy failed to demonstrate any significant additional improvements in Oswestry Disability Index, Patient Specific Functional Scale or Numeric Pain Rating Scale scores ($p>0.05$). Irrespective of group allocation, all participants experienced significant improvements in Oswestry Disability Index, Patient Specific Functional Scale and Numeric Pain Rating Scale scores over both follow-up periods ($p<0.05$). Concisely, pulsed electromagnetic energy provides no significant additional benefit to physiotherapy in the treatment of acute non-specific low back pain.

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INTRODUCTION

Low back pain (LBP) is a costly and disabling disorder that plagues the modern world, creating substantial personal, societal and financial burden (Hoy et al 2010). The global lifetime prevalence of LBP is estimated at 60-80 percent of people (Airaksinen et al 2006, Walker 2000, WHO 2003), with up to 65% suffering from recurrent, long lasting episodes (Itz et al 2013). Globally, LBP is the second leading cause of sick leave (Lidgren 2003). In New Zealand, the prevalence of reduced activities attributable to LBP is estimated at 18% and work absenteeism at 9% (Widanarko et al 2012). There is therefore a pressing need within the healthcare system to identify and commence time and resource efficient treatment strategies for LBP.

The multifaceted nature of LBP constitutes a considerable challenge for primary health professionals and researchers alike. Despite a myriad of treatment options available for LBP, there is not yet one modality or therapeutic approach that stands out as a definitive solution. Currently, there is consensus with recommendations to stay active, provide education, use manipulative therapy and discourage bed rest (Airaksinen et al 2006, Arnau et al 2006, Savigny et al 2009, van Tulder et al 2006). Additionally, almost every clinical guideline available for LBP advocates the provision of analgesia and non-steroidal anti-inflammatory drugs (NSAIDs) for relief of activity limiting symptoms (Roelofs et al 2008).

Each class of medication is associated with unique and important adverse effects. In particular, NSAIDs are associated with serious gastrointestinal (Hawkey 2000, Hernandez-Diaz and Rodriguez 2000), renovascular (Ejaz et al 2004), cardiovascular (Amer et al 2010, Bresalier et al 2005, Juni et al 2004, Kearney et al 2006), bone (van Esch et al 2013) and connective tissue (Mishra et al 1995, Proto and Huard 2013, Shen et al 2008) adverse effects. While back pain sufferers may benefit in terms of analgesia, research suggests that long-term NSAID use may be detrimental to the healing process and serious complications may occasionally occur with brief exposure to these drugs (Mishra et al 1995, Proto and Huard 2013, Shen et al 2008). A drug free pain relief alternative is pulsed electromagnetic energy (PEME), a non-thermal, risk-free option that works to enhance cellular activity healing and repair. PEME has been used in various forms for decades, as a means of treating injury and disease (Mourino 1991). Now, with advances in technology it is possible to deliver non-thermal PEME from small, lightweight, wearable devices.

A number of laboratory experiments have demonstrated the healing and analgesic effects of PEME at the level of cellular and animal studies (Li et al 2011, Shupak et al 2004a, Shupak et al 2004b). Research suggests that the mechanism by which PEME mediates its healing effects is by way of induction of ionic currents within target tissue. These currents in turn stimulate changes in cellular calcium and cyclic adenosine monophosphate

levels (Thumm et al 1999), along with increased synthesis of collagen, proteoglycans, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) (Goodman et al 1989, Pezzetti et al 1999). PEME has also been shown to increase levels of reactive oxygen species (ROS) and nitric oxide (NO) production (Kim et al 2002), all essential for the healing and remodelling of damaged tissue. While the exact mechanism by which PEME generates its analgesic effects is unclear, a number of experiments have suggested that exposure to PEME may stimulate endogenous and exogenous opiate pathways (Moffett et al 2012).

When the direct effects of PEME are measureable, as in cellular and animal studies, it is difficult to dispute that PEME has an effect on the healing process. Clinically, research suggests that PEME may have benefit for ankle injury (Pennington et al 1993), neck pain or acute whiplash (Foley-Nolan et al 1990, Foley-Nolan et al 1992), osteoarthritis (Ay and Evcik 2009, Pipitone and Scott 2001, Trock et al 1994), LBP (Harden et al 2007) and lumbar radiculopathy (Omar et al 2012). However, when it comes to human clinical trials where the outcome measures are mostly indirect measures of effects, the evidence is at best mixed (Bachl et al 2008). This is due to a number of confounding factors such as application technique, treatment regime and dose/response relationship resulting in conflicting and heterogeneous results.

This project aimed to explore the putative additional benefits of a novel PEME device, delivering a much lower flux density over a longer period than traditional machines, used as an adjunct to routine physiotherapy treatment in an acute non-specific LBP population. The experimental hypothesis was that the use of PEME as an adjunct to normal physiotherapy techniques would be effective in reducing pain and disability in patients suffering from LBP.

METHOD

Design

The study was a double blind, placebo controlled randomised controlled trial (RCT). Ethical approval was provided by the Health and Disability Ethics Committee (Ref No 13/NTA/30). This trial was also registered with the Australia New Zealand Clinical Trials Registry (ACTRN 1261 3000 328 774).

Recruitment

A total of 40 participants presenting with acute non-specific LBP were recruited from the University of Otago, School of Physiotherapy Clinic and provided with treatment. Participants were assessed against the inclusion/exclusion criteria during a routine physiotherapy examination. Eligible patients were invited to participate and provided with the relevant information and consent forms. Informed consent was obtained from all participants before commencing the trial.

Inclusion criteria

Patients over the age of 18 suffering from acute non-specific LBP with or without leg pain that has been present for six weeks or less.

Exclusion criteria

Exclusion criteria were as follows: cauda equina symptoms or known presence of tumour, metabolic disease, rheumatoid arthritis, osteoporosis, prolonged history of steroid use, signs consistent with nerve root compression, spinal fracture, history of lumbar spine surgery, current pregnancy, cardiac pacemaker, cardioverter defibrillator, neuro-stimulator or any active medical device or metallic implant within the area of the lower back.

Randomisation

Block randomisation was used to achieve balance in the allocation of participants to the two treatment arms (PEME or placebo). Four blocks of 10 were formulated using a computer generated random block list. For each block list, the clinic receptionist assigned participants to one of the two groups by asking them to select any one of 10 identical opaque sealed envelopes. Each envelope contained the letter A or B. Each letter corresponded to either an active or placebo PEME device. The investigator, treating physiotherapist and participant were blinded to group allocation. Randomisation codes identifying allocation were held by the research administrator until after the data were analysed.

Intervention

According to group allocation, participants were distributed either a placebo or active PEME device. Participants were asked to wear the PEME device continuously for the first seven days, after which use was discontinued. The device antenna was placed over the site of LBP and kept in place by a comfortable elastic Velcro wrap worn around the waist. All participants were educated on the use of the device by their physiotherapist and received typical physiotherapy treatment as deemed necessary. The treating clinician was responsible for determining the content of each session (typically manipulation, mobilisation, advice and exercise; singularly or in any combination). Participants received physiotherapy treatment twice per week for up to four weeks. If further treatment was deemed necessary after four weeks, it was continued, however no further measures were used during study analysis. Any participant that failed to attend three consecutive treatments or comply with the PEME user guidelines was removed from the trial. In all such cases, the relevant reason for non-attendance/compliance was ascertained, and relevant outcome measures were performed as far as possible.

Pulsed Electromagnetic Energy Device

Active

The device used in this study was a PEME device (RecoveryRx, BioElectronics Corp) that emits a safe form of non-ionizing electromagnetic radiation. The carrier frequency of this device is 27.12 MHz, the assigned Federal Communications Commission (FCC) medical frequency. It has a pulse rate of 1,000 pulses per second and a 100 µs burst width. The magnetic flux density or field strength of the device is 0.03 milliTesla (mT). The peak burst output power of the 12 cm antenna is approximately 9.8mW covering a surface area of approximately 100 cm^2.

Placebo

The placebo device did not emit a radiofrequency electromagnetic field but was otherwise identical to the active device. The energy from the active device did not produce any sensation, thus it could not be distinguished from the placebo device.

Outcome measures

The primary outcome measure was the Oswestry Disability Index (ODI) (Fairbank et al 1980, Roland and Fairbank 2000). The ODI is an internationally recognised, well-validated tool for measuring the impact of LBP across five domains. It provides

a score between 0 and 50. Standard practice is to double the score and report it as a percentage (0% indicating no disability and 100%, representing a patient that is completely disabled or bed bound by their symptoms).

Secondary outcome measures included the Numeric Pain Rating Scale (NPRS) (Childs et al 2005, Jensen et al 1999, Stratford and Spadoni 2001) and the Patient Specific Functional Scale (PSFS) (Cleland et al 2006, Stewart et al 2007, Stratford 1995). The NPRS quantifies pain using an 11 point visual analogue scale (VAS). Zero indicates no pain while 10 represents the worst pain imaginable. The PSFS is a questionnaire that can be used to quantify activity limitations and functional outcomes for patients with musculoskeletal injuries or conditions. During the initial assessment, patients were asked to identify three everyday activities that they were experiencing difficulty with or unable to complete as a result of their LBP. Using a zero to 10 VAS (zero, the patient is unable to complete the task; 10, the patient is able to perform activity at the same level as before the injury) participants recorded their level of function for the three identified tasks. The average of the three scores was recorded.

For each outcome measure the change in score from baseline to four weeks (or discharge) was compared to the minimal clinically important difference (MCID). The MCID can be defined as the minimal change in an outcome score that is meaningful for patients. The MCID has been established as change between 6-10 points (12-20 percent) for the ODI (Ostelo et al 2008), 2.3 points for the PSFS (Maughan and Lewis 2010) and 2 points for the NPRS (Childs et al 2005).

Data collection

During the initial assessment, baseline characteristics and demographics were recorded. Outcome measures were performed at baseline, seven days and four weeks (or earlier if discharged). Participants were required to discontinue use of NSAIDs because of their possible detrimental effect on the healing process, but were able to continue with simple analgesics such as paracetamol.

Sample size

To detect a difference between groups of 8 points on a 50-point scale (ODI), with alpha set to 0.05 and power of 80%, 20 participants per group, allowing for up to 20% drop out, were required.

Statistical analysis

Statistical analysis was performed using the statistical package for the social sciences software (SPSS). On a per protocol basis (alpha set to 0.05) normal descriptive statistics of the two groups such as means and standard deviations were calculated. ANCOVA was used to analyse the outcome data at initial and follow-up time points.

RESULTS

The first 40 participants meeting inclusion criteria were included in the study. No participants withdrew from the study or were lost to follow-up. In addition, PEME appeared to be well tolerated with no adverse reactions reported. Figure 1 outlines participant flow through the study. Demographic and baseline data are presented in Table 1. No statistical differences in baseline data were observed between groups (p>0.05).

Figure 1: Participant flow through the study.

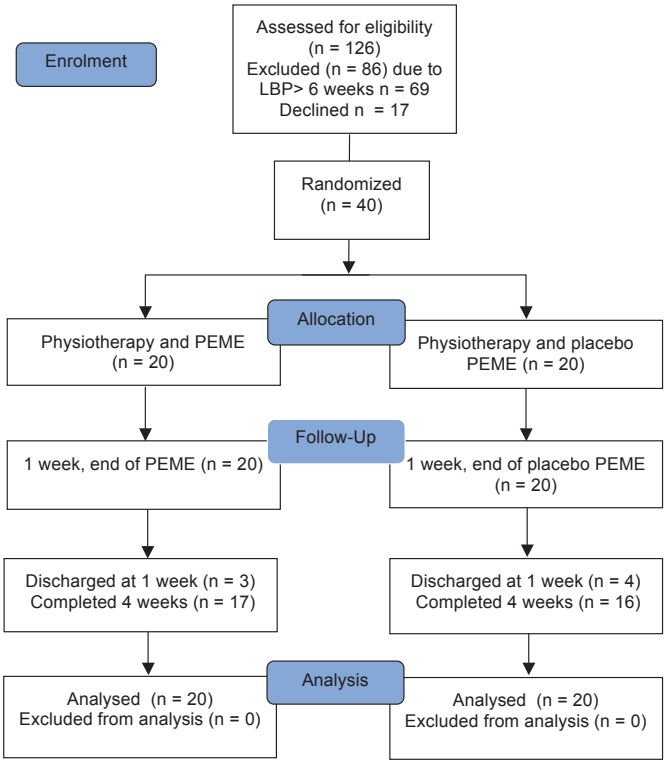


Table 1: Participants mean demographic and baseline data.

Characteristics	PEME group (n=20)	Placebo group (n=20)	p
Age (y)	35.7	30.2	>0.05
Sex (F/M)	9/11	11/9	>0.05
Disability (ODI)	35.60 (SD 15.39)	35.20 (SD 20.82)	>0.05
Function (PSFS)	4.10 (SD1.21)	3.99 (SD 1.75)	>0.05
Pain (NPRS)	5.00 (SD 1.39)	4.91 (SD 1.92)	>0.05

PEME – Pulsed Electromagnetic Energy; y – years; F – Female; M – Male; ODI – Oswestry Disability Index; PSFS – Patient Specific Functional Scale; NPRS – Numeric Pain Rating Scale.

†ODI, PSFS, and NPRS scores expressed as Mean±SD

Table 2 displays the results of ANCOVA analysis for each of the outcome measures (ODI, PSFS, NPRS). Results show that although group allocation was not determinative of results, there was a significant time effect for all outcome scores. Group/time interactions indicated that there were no significant differences in outcome measure scores between groups at any of the follow-up periods (p>0.05). Effect sizes are also displayed.

While there were no significant differences in pain, disability and function outcome measure scores between groups (figures 2-4), the results of within group analysis indicate that all ODI, NPRS and PSFS scores improved significantly from baseline to week one, baseline to week four and week one to week four

Table 2: Results of ANCOVA analysis for Oswestry Disability Index (ODI), Patient Specific Functional (PSFS) and Numeric Pain Rating Scale (NPRS).

	DF	F	p	Effect Size
ODI				
Group	1	0.03	0.85	0.00
Time	2	43.16	0.00	0.43
Group/time	2	0.02	0.97	0.00
PSFS				
Group	1	0.21	0.65	0.02
Time	2	81.4	0.00	0.58
Group/time	2	0.015	0.99	0.00
NPRS				
Group	1	.044	0.83	0.00
Time	2	77.11	0.00	0.57
Group/time	2	0.07	0.93	0.00

ANCOVA – Analysis of Covariance; DF – Degrees of Freedom; F – F test; ODI – Oswestry Disability Index; PSFS – Patient Specific Functional Scale; NPRS – Numeric Pain Rating Scale.

($p<0.05$). Changes for both pain and function exceeded the MCID for each outcome measure, indicating a meaningful improvement in both pain and function by all participants during the treatment period.

The mean and standard deviation of number of treatments for the placebo and treatment groups were 5.8 (2.3) and 4.6 (1.8) respectively, although this was not significantly different ($p = 0.82$). Post hoc analysis of study results revealed that three out of 20 participants in the PEME group were discharged after one week, while four out of 20 from placebo group were discharged at one week. In the PEME group, 18 out of 20 participants did not require all 8 treatments, and in the placebo group, 13 did not require all treatments.

DISCUSSION

This study investigated the potential additional benefits of a novel PEME device used as an adjunct to physiotherapy for treatment of acute non-specific LBP. Results suggest that PEME provides no additional benefit to routine physiotherapy in the treatment of acute non-specific LBP. The group treated with active PEME failed to demonstrate any significant additional improvements in ODI, PSFS or NPRS scores. However, all participants, irrespective of group allocation demonstrated significant improvements in ODI, NPRS and PSFS scores from baseline to week one, baseline to week four and week one to week four (or discharge) ($p<0.05$).

Figure 2: Between group mean differences in Oswestry Disability Index (ODI) scores over all of the follow-up periods (baseline, week one and week four/discharge).

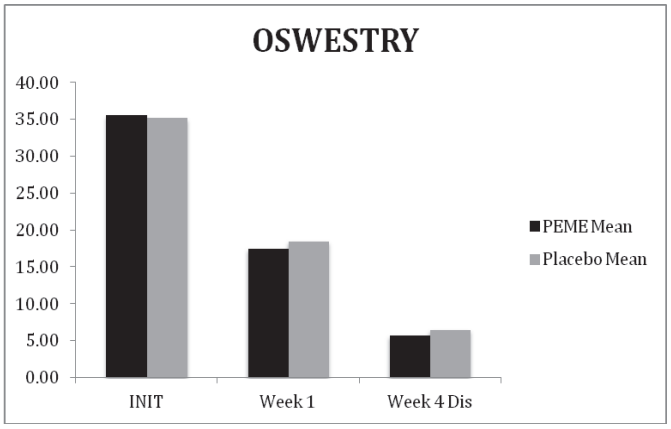


Figure 3: Between group mean differences in Patient Specific Functional Scale (PSFS) scores over all of the follow-up periods (baseline, week one and week four/discharge).

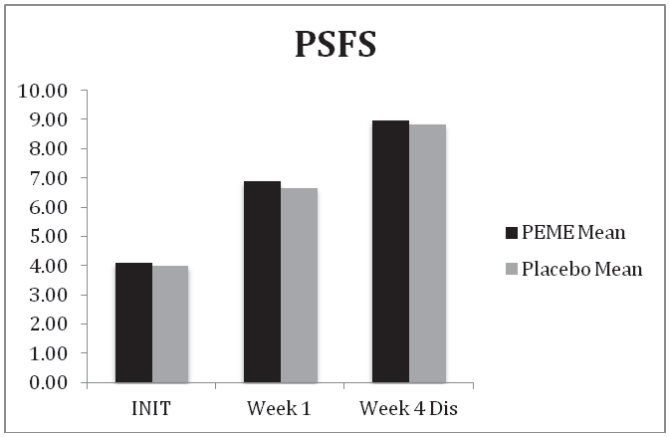
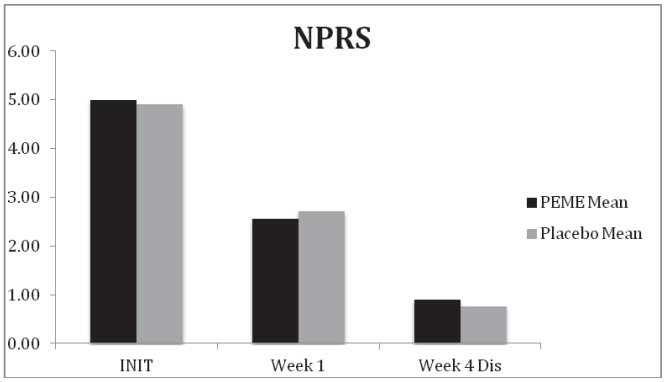


Figure 4: Between group mean differences in Numeric Pain Rating Scale (NPRS) scores over all of the follow-up periods (baseline, week one and week four/discharge).



Given the results of the present study, it may be suggested that PEME is ineffective in a clinical setting and fails to produce statistically significant results. The results of clinical trials are inconsistent and conflicting on this issue (Bachl et al 2008). Some studies have demonstrated positive, clear and measurable effects for PEME at the level of cellular and animal studies (Li et al 2011, Shupak et al 2004a, Shupak et al 2004b) and a recent meta-analysis found PEME to be associated with statistically significant improvements for pain, edema and healing in non-postoperative, postoperative and wound healing applications (Guo et al 2012). However, only eight out of the 14 studies focusing on non-postoperative PEME applications reported positive effects for pain and function following soft tissue injuries such as ankle sprains, neck pain, whiplash, lacerations, algoneurodystrophy and heel neuromas (Guo et al 2012). Whilst it may appear that PEME is effective in soft tissue, non-postoperative applications, numerous studies report neutral or insignificant results.

To the best of our knowledge, no other study has investigated the therapeutic effects of PEME for acute non-specific LBP. However, PEME has been researched in both chronic LBP (Harden et al 2007) and lumbar radiculopathy populations (Omar et al 2012). Harden et al (2007) conducted a randomised, placebo controlled pilot study to investigate the efficacy of PEME for chronic LBP. In contrast to the present study, Harden et al (2007) reported statistically significant improvements in pain using the McGill pain questionnaire and the VAS. Additionally, another recent trial conducted by Omar et al (2012) demonstrated PEME to be associated with significant improvements in both pain and disability for participants suffering with lumbar radiculopathy.

Between studies, there is much methodological and clinical heterogeneity, making comparisons difficult. Studies differ in terms of device technology, physical parameters, treatment duration and frequency, outcome measures, study periods and participant inclusion/exclusion criteria. Unlike the present study, both Harden et al (2007) and Omar et al (2012) utilised non-portable PEME devices with larger magnetic flux densities. The device employed by Harden et al (2007) had a magnetic flux density of 15 mT, a pulse rate of 120 pulses per second and covered surface area of 747 cm2. The device used by Omar et al (2012) was also non-portable and had a field strength that ranged from 0.5 to 1.5 mT and a frequency that varied between 7 Hz and 4 kHz. In contrast, the device used in the present study was small, portable and wearable. It delivered a low-dose (0.03 mT), pulsating electromagnetic field continuously over a time span of seven days. It had a frequency of 27.12 MHz, pulse rate of 1000 pulses per second and covered a surface area of 100 cm2.

Dosage is a complex but critical aspect of PEME therapy. The degree to which an electromagnetic field elicits a biological or clinical effect is dependent upon exogenous (field strength, energy exposure, mode of delivery) and endogenous (anatomical and pathological) variables (Guo et al 2012). Like pharmacotherapy, different dosages and dose regimes will produce different effects in different target tissues under differing conditions of exposure (Markov 2007). There are vast combinations of PEME parameters, creating a wide range of treatment conditions and effects. Unfortunately, there are no set guidelines for PEME therapy. Small effect sizes and insignificant or conflicting results may be the outcome of insufficient dosages and a lack of standardisation around dose parameters.

Despite failing to generate significant results in the present study, the RecoveryRx anti-patch device has demonstrated positive and significant effects in several other studies. A recent RCT conducted by Brook et al (2012) used this device to investigate the effects of low-dose PEME on plantar fasciitis. Comparative to the present study, participants were instructed to wear the device over a period of seven days. Brooke et al (2012) reported PEME therapy to be associated with statistically significant reductions in self-reported morning pain.

In addition, three recent clinical trials, using similar devices, have demonstrated the pain relief potential of low-dose PEME post breast surgery (Hedén and Pilla 2008, Rawe et al 2012, Rohde et al 2010). The study by Rawe et al (2012) used an identical device to establish that low-dose PEME delivered continuously over a period of seven days is capable of producing significant improvements in pain and medication use.

Although the aforementioned studies utilised the same PEME device and treatment duration as the present study, the clinical conditions under which they were investigated differed. Colbert et al (2008) emphasise that the most important dosimetry parameter is the dose received by the target tissue. Target tissues will differ in both density and depth from the body surface (Colbert et al 2008). As such, while a specific dose may appear effective for one condition, it may be inappropriate or ineffective for others (Colbert et al 2008). Many studies, including the present, neglect to include estimations of the distance between the site of device application and the target tissue(s) (Colbert et al 2008). Without such measures, it is impossible to judge the strength at which the target tissue received the magnetic field (Colbert et al 2008).

Given the non-specific heterogeneous nature of LBP, the specific tissue responsible for the production of pain and symptoms in each patient, for whatever reason, isn't always identified. However, it could be suggested that the tissues targeted in this RCT were located at a level deeper to the body surface than that of the tissues targeted by Brooke et al (2012) and Rawe et al (2012) and the dosage may be insufficient or inadequate for LBP.

Many of the clinical trials investigated the effects of PEME in isolation, involving only one dependant and one independent variable. Such an approach may have enhanced study internal validity and possibly effect sizes. Notwithstanding, the present study chose to provide all participants, irrespective of group allocation, with individualised physiotherapy treatment two times a week for four weeks (or until discharge). It was noted that the participants in the PEME group received 1.2 treatments less than those in the placebo group, and 90% of them did not require all eight treatments; though statistically insignificant given the sample size. While the tailored approach to treatment may have introduced bias, reduced internal validity and influenced effect sizes, it is well recognised that the LBP population is extremely heterogeneous in nature (Foster et al 2011). The individually tailored approach utilised in the present study is reflective of a real world or clinical setting. Thus, although the internal validity of the study may have been weakened, the external validity was likely strengthened.

All participants, irrespective of group allocation, experienced significant improvements. Because the study examined the effects of PEME in conjunction with physiotherapy, it is impossible to determine the specific variable responsible for

such improvements. However, many studies have confirmed that a high proportion of acute LBP sufferers will experience rapid and significant improvements in pain and disability over the first four to six weeks of recovery (Costa et al 2012, Pengel et al 2003). Given that the present study spanned over a period of merely four weeks, it is plausible to suggest that the widespread and significant improvements observed across both groups may reflect the natural progression of LBP.

Due to time constraints, a long-term follow-up period was unable to be incorporated into the study; this lack of a long-term follow-up period following treatment may limit study findings. Lifetime recurrences of LBP are estimated at 85% of people with 65% experiencing at least one reoccurring episode within 12 months of initial symptom onset (Itz et al 2013). Data on participants' use of simple analgesics was not collected, so this may have been a confounding factor that could have influenced results.

CONCLUSION

The results of the present study suggest that PEME provides no additional benefit to routine physiotherapy for the treatment of acute non-specific LBP. Inconsistent and conflicting results across studies may be reflective of insufficient dosage and a lack of standardisation around parameters.

KEY POINTS

- PEME provided no significant additional benefit over routine physiotherapy treatment for NSLBP.
- All participants improved significantly over time, achieving greater than MCID scores for all outcome measures.

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CONFLICT OF INTEREST

I declare on behalf of myself and the other authors that we know of no competing interests (financial, professional or personal) which may be perceived to interfere with or bias any stage of the writing or publication process. This includes, but is not restricted to, any factors that may influence full and objective presentation of the article, peer review and editorial decisions.

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Home care: An opportunity for physiotherapy?

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ABSTRACT

Remaining physically active in later life is critical to maintaining independence in activities of daily living and is a major contributor to overall health status amongst older people. Traditionally a key focus of physiotherapy has been on maintaining functional capacity and mobility. However, the health and disability sector is a constantly evolving entity. Clinicians from a number of disciplines, including physiotherapy, need to be flexible, responsive and innovative and maximise cost benefit for the service funder. Nicholls et al (2009) highlighted the imperative need for physiotherapists to investigate innovative models that align with current and future policy and health care reforms. Over the past 15 years there has been an increased emphasis on supporting older people to remain living at home. This article describes New Zealand and international evidence relating to the optimisation of the potential role of physiotherapy in providing rehabilitation expertise into the provision of Home Care for older people.

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Key Words: Home Care; Physiotherapy; Rehabilitation; Aged

BACKGROUND

As in other countries, the older (ie 65+) population is increasing. Currently, in New Zealand this age group accounts for 475,000 (12%) of the population and is expected to number approximately 826,000 (19%) in 2025 and 1.2 million (25%) by 2050 (Statistics New Zealand 2006). Furthermore, the over-80-year-olds are the fastest-growing cohort (of any age group) and increasing at a rate of around 5% each year (Ministry of Social Policy 2001). It is evident the changing structure of the population along with the eventual doubling in the percentage of the population aged over-65 years is going to have an unprecedented and significant impact on all aspects of society.

Since health care expenditure increases with rising age, an ageing population will therefore place further pressure on health care demand and cost (Organisation for Economic Co-operation and Development 2006). A comparison of OECD nations examined age profiles of health expenditure and found, on average, per capita health expenditure for the older age group (65+) was three to five times than that for the 15 to 64 age group (Moise and Jacobzone 2003). New Zealand's statistics reveal similar results with a strong exponential relationship between per capita health expenditure and age. For the 65-69 age group, spending was almost double the all-age per capita average, whereas for the 85+ age group it was nearly eight times the all-age average (Ministry of Health 2004).

A SHIFTING OF FOCUS

New Zealand government policy developed in the early 2000s, such as The New Zealand Health Strategy (King 2000), The New Zealand Disability Strategy (Dalziel 2001a), The Positive Ageing Strategy (Dalziel 2001b), The Primary Health Care Strategy (Ministry of Health 2001) and The Health of Older Persons Strategy (Dyson 2002), provided a focus for providers of health services to ensure equitable, timely, affordable and accessible health services for older people. There was a clear theme of the need for significant change in the way these services were provided. Furthermore, there was identification of the requirement for improved co-ordination of health and support services around the needs of older people and a greater emphasis on health promotion and disease prevention to assist with positive ageing with a greater emphasis placed on community-level health care and support services. A final theme was that enhanced services needed to be available to enable older people to 'age-in-place' and remain at home with entry to residential care increasingly being for high-level care, usually towards the end of life.

More recent strategic directives from both central government (New Zealand Guidelines Group 2003, Ryall 2007) and work undertaken by District Health Boards (DHBs) tasked with implementation of the strategies (Auckland District Health Board 2006, Counties Manukau District Health Board 2004, Hutt Valley District Health Board 2010, Northland District Health Board 2008, South Island Alliance 2013), identified service developments necessary to improve the hospital and community interface for older people. Of particular relevance is that home care needed to have a rehabilitation and empowerment focus that supported specialist health services for older people and collaborative relationships needed to be developed between health and disability support services to ensure a co-ordinated approach and continuity of care for older people.

As a result of this ongoing emphasis on delivering services to allow older people to remain living in their own home there is evidence of a shift away from institutionalisation within New Zealand. Boyd et al (2009b) describe the findings of the Older Peoples Activity Level (OPAL) census. The study sought to determine the rate of institutionalisation of older people in the three Auckland DHBs over the preceding 20 years and to compare variations in resident demographics, length of stay and dependency levels over this time. The authors reported that Aged Residential Care (ARC) bed numbers had increased by only 3%, despite a 43% increase in the population over the age of 65 years. In addition, the proportion of the population over the age of 85 years living in ARC had declined from 40% to 27% and that the median age of residents had risen from 83 to 86 years. Further support for decreased use of ARC and increasing rates of older people remaining at home is provided by a survey of 389 facilities across New Zealand that report low rates of growth in ARC bed numbers despite the significant growth in the New Zealand population of those aged over 65 (Grant Thornton NZ 2010).

With the increased emphasis on ageing-in-place as both a national and local strategy and the reduced emphasis on ARC it is important to explore the options for supporting older people to remain in their own homes with increasing levels of disability. There is extensive support for the view that health services delivered in an older person's home are often delivered at a critical juncture in an individual's functional status. Primarily these services include primary care, community based service provision (funded through DHB or ACC contracts) and home care.

THE ROLE OF HOME CARE IN SUPPORTING OLDER PEOPLE

Until recently, there has been an implicit assumption that in-patient rehabilitation for older people is the gold standard for care through maximising the individual's potential for independence and arresting the functional decline that is prevalent in old age. However, as the number of older people increase, viable alternatives to hospitalisation become increasingly important as it is simply not possible to continue to match population growth with hospital beds. Furthermore, recent research highlights that hospital is not always the best location to provide rehabilitation and care for older people. Between 25% and 50% of older people who are hospitalised lose some of their functional abilities during their hospital stay (Inouye et al 1993). Furthermore, three months after a hospitalisation, 66% have not regained their previous level of functioning (Boyd et al 2009a, Sager et al 1996, Sager and Rudberg 1998).

It has long been recognised that functional capacity inside, and more importantly outside the home environment, is essential for independent living (Stanko 2001, Thorngreen et al 1990). Furthermore, mobility outside of the home has been shown to have a strong association with greater emotional support from social networks (Dwyer et al 2000, 1995), including the maintenance of cultural connections (Sheridan et al 2011). Although home care services have the potential to improve this situation, they have often focused in the past on treating disease and 'taking care' of the client rather than on helping clients to regain functioning and independence. Many researchers and clinicians describe the harm associated with 'wrapping older people in cotton wool' and the resultant deterioration linked to deconditioning and disuse (McMurdo 1999). This would appear to be supported by a study undertaken by Hansen et al (2009). Using regression analysis on a set of Danish longitudinal data featuring people aged 67–77 they estimated the effect of home care while controlling for initial health, including initial Activities of Daily Living (ADL) ability and well-being, along with demographic and socioeconomic conditions. They concluded that traditional models of home care either have no effect, or actually have a detrimental effect, on a person's functional ability and long term outcome. Further international support is provided by a cross-sectional observational study comprised 4,007 randomly selected older people receiving home care services in 11 European countries (Bos et al 2007). Quality indicators for home care were explored. The most common quality problems identified were: not adequately realising rehabilitation potential in ADLs; a lack of involvement of occupational therapy and physiotherapy in service delivery and poor control of pain.

The overarching goal of home care is to "provide high quality, appropriate and cost-effective care to individuals that will enable them to maintain their independence and the highest quality of life" (Havens 1999, p 40). Fundamentally, home care is viewed as having three key objectives:

1. To substitute for acute care hospitalisation;
2. To substitute for long-term care institutionalisation; or
3. To prevent the need for institutionalisation and maintain individuals in their own home and community (Havens 1999).

THE EVOLUTION OF HOME CARE

Traditionally, there has been considerable variation within New Zealand in the organisational structure of home care providers contracted by DHBs to deliver services to support older people in the community. A common feature of all is the presence of at least three levels of staff: managers, coordinators and support workers. Arguably, the most significant issue with home care has related to the workforce and specifically this has focused on the support worker and coordinator roles (King et al 2012, Ministry of Health 2006, Parsons 2004a, Parsons 2004b, Parsons 2004c).

Within Home Care, support workers are often untrained staff (Parsons 2004a, Parsons 2004b, Parsons 2004c, Parsons et al 2008). However, following extensive development, there is now a New Zealand Qualifications Authority (NZQA) accredited training programme for support workers to develop the fundamental skills necessary to deliver services to older people in their homes (Ministry of Health 2007) and completion of the programme by support workers is now a requirement for organisations delivering services under DHB contracts. Traditionally, the coordinator role was undertaken by non-health professionals with very large caseloads (Gundersen Reid et al 2008) however, a recognition of the complexity of the role and the need for proactive and responsive services has meant that registered health professionals (Registered Nurses and Allied Health) are now being employed in the role (Bryan et al 1994, Challis et al 2001, Crawley 1994, Gundersen Reid et al 2008, Ministry of Health 2006).

These two crucial developments in the workforce have been components of a model of quality improvement in home care service delivery within New Zealand over the past 15 years (King et al 2012, King et al 2011, Parsons et al 2012, Parsons and Parsons 2012, Parsons et al 2013). The model, called Restorative Home

Support (RHS), focuses on restoration and maintenance of older people's physical function, aiding compensation for impairments, so that the highest level of function is achieved. The model integrates principles from medicine, rehabilitation, goal facilitation and nursing to improve functional outcomes for older people.

The aim of RHS is to change the philosophy from one where delivery of care may create dependency to provision of services which maximise independence, improve self-esteem, self-image, quality of life and reduce the level of care required (Atchinson 1992, King et al 2012, Parsons et al 2014, Parsons et al 2012, Parsons et al 2013, Resnick et al 2007, Resnick et al 2006). Based on the evidence reported above and the developments across a number of DHBs within New Zealand (Gundersen Reid et al 2008, Gunderson-Reid 2006, Parsons et al 2008), Table 1 summarises the key elements of Restorative Home Support. These elements concur with the essential elements of the Re-ablement concept in the UK (Glendinning and Newbronner 2008, Patmore 2005, Pilkington 2008) and the concept of restorative support in the United States (Baker et al 2001, Nadash and Feldman 2003, Tinetti et al 2002).

PHYSIOTHERAPY AND HOME CARE

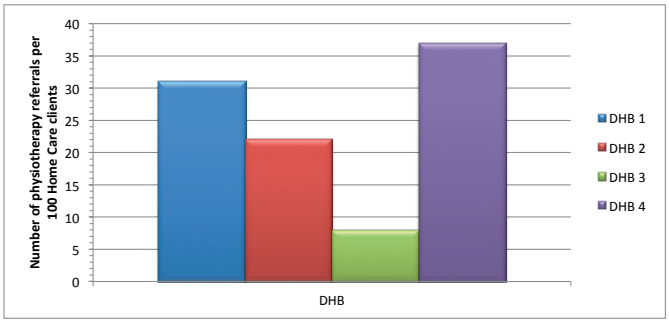
To date, models of RHS have been implemented in a number of District Health Boards in New Zealand. In addition, intensive and time limited supported discharge teams, that are based on the key principles shown in Table 1, have been formed in Waikato DHB (START) (Waikato District Health Board 2013) and in Canterbury DHB (CREST) (Canterbury Clinical Network 2012). There is considerable evidence to indicate the vital role of physiotherapy in the implementation of RHS (Baker et al 2001, Nadash and Feldman 2003, Parsons et al 2013, Tinetti et al 2012a). Allied health (physiotherapy and occupational therapy) can teach and implement plans of treatment in cooperation with coordinators to allow individuals to maintain the maximum amount of independence that their physical condition allows (Baker et al 2001, Nadash and Feldman 2003, Tinetti et al 2002, Tinetti et al 1997, Whitehead et al 2014). In addition, there is a role for physiotherapy within the model in the application of key competencies associated with goal facilitation, task analysis and breakdown, fitness and function, strength, balance / proprioception, motor control and adaptation and in the use of skills related to exercise prescription; maximisation of mobility; falls prevention advice and education for support workers, family, patient and home care coordinators. With the standardisation of training of support workers within home care there is considerable potential for the physiotherapist to identify the older persons functional issues, design a treatment plan to minimise these issues and then, through close communication and collaboration with the home care coordinator, for the treatment programme to be delivered as a key component of the home care episode.

Table 1: Key elements of restorative care

Restorative care element	Explanation	References
Goal facilitation	A key concept of restorative care is to base a support programme around the goals and aspirations of the older person This requires the identification of both a distal goal and the proximal goals required to attain the distal goal.	King et al 2011, Parsons et al 2012, Parsons et al 2014, Parsons and Parsons 2012
Functional and repetitive ADL exercises	Functional exercises involve working on muscle groups used in everyday activities and programmes are undertaken by the older person under the supervision of the support worker.	de Vreede 2004, de Vreede et al 2005, Duncan and Pozehl 2002, Krebs et al 2007, Manini et al 2007
Support worker training and enhanced supervision	Restorative home support relies on support workers to collaborate with older people to maximise their independence, which is a shift from the current home care model which focuses on providing care. In addition, restorative home support adopts enhanced health professional integrated supervision via coordinators.	Francis and Netten 2003, Harris-Kojectin et al 2004, Stone 2001, Stone and Wiener 2001
Health Professional training	The role and competencies of health professionals working in the coordinator role change greatly with the evolution of restorative home support. Roles and duties may include: delegation and supervision of non-regulated staff; comprehensive assessment; care management; goal activity analysis and grading, expertise surrounding community integration for older people.	Baker et al 2001, Nadash and Feldman 2003, Tinetti et al 2002, Parsons et al 2013
Care management	Restorative care utilises care management where the intensity varies according to the level of service input This includes regular reviews to enact required changes to service delivery; and developing management plans with the client.	Bryan et al 1994, Challis et al 2001, Crawley 1994, Doty 1998, Hallberg and Kristensson 2004, Hokenstad 2005, Lillis and Mackin 2001, Quinn 1995

However, the engagement and involvement of physiotherapists in the design and delivery of the model has been highly variable (Gundersen Reid et al 2008, Parsons et al 2013). This is highlighted in a study of four DHBs who implemented a model of RHS. The number of referrals from the home care organisation for physiotherapy input varied from 8 to 37 per 100 home care clients (see Figure 1).

Figure 1: Referral rates for physiotherapy input into restorative home care across four DHBs in New Zealand (Gundersen Reid 2008)



The potential effect of low rates of utilisation of physiotherapy is considerable. As shown in Table 1, one of the core components of restorative support is the optimisation of physical activity and the integration of functionally based exercises into the provision of home care, a key skill of physiotherapists. A study of 205 older people randomised to receive either a restorative model or standard home care showed a significant relationship between physiotherapy referral and improvements in physical function over time (*t* [72] =-2.12, p=0.04) (Parsons et al 2013).

There is compelling evidence to show the potential impact of aligning and integrating physiotherapy clinical input into the provision of home care services aligned to a restorative model. However it is important to consider the barriers that have prevented this integration before consideration of pragmatic solutions within the New Zealand context.

BARRIERS TO THE INTEGRATION OF PHYSIOTHERAPY AND HOME CARE

A review of the available literature suggest two main issues that have prevented maximisation of the potential gains from involvement of physiotherapy in home care. These are: resourcing of physiotherapy services and inter-organisational / inter-professional boundaries.

Resourcing of physiotherapy services

On present estimates, there is only one physiotherapist for every 27 people over the age of 80 and only one physiotherapist with a dedicated interest in gerontology for every 550 of people aged over 80 years (Copeland 2010, Nicholls et al 2009). Furthermore, the Health Workforce Annual Survey reports that only 4% (202 / 4,445) of physiotherapists work in a community setting (Ministry of Health 2011). This immediately indicates a major barrier to the provision of physiotherapy as a key component of a restorative model of home care within the context of a rapidly rising population of older people. It is not surprising then that a review of home care providers reported significant delays in accessing physiotherapy input of between 17 and 55 days (Parsons et al 2008). Closer examination of the reasons for the delay in providing input revealed the impact of prioritisation processes used within the local clinical area. Such pragmatic approaches for systematically triaging clients with the greatest need of physiotherapy input have been common across the world for many years. However these decisions are often made in isolation without consideration of the opportunities to contribute to an integrated model of rehabilitation involving the physiotherapist and home care. There is also evidence to show that a large proportion of those referred for physiotherapy input were already known to the service and so there was a risk of parallel services being implemented without close coordination and collaboration between home care and the physiotherapy service.

Inter-organisational / inter-professional boundaries

In New Zealand, home care occurs within a comprehensive community based primary care environment that includes DHB secondary and specialist services (including community based physiotherapy), primary care, pharmacy and non-governmental organisations. As a result the alignment of physiotherapy with home care service provision is dependent on working across a number of inter-organisational boundaries.

Work across organisational boundaries is often characterised by power relationships that are more contested and dispersed than is the case in traditional bureaucracies (Baker 2005). Trust has been shown to be of particular importance in determining that inter-organisational relationships are effective (Williams 2007) with attitudes of mistrust and suspicion a primary barrier to co-operation between organisations (Webb 1991). For home care coordinators and physiotherapists seeking to align physiotherapy with home care service delivery, there is often continued shifting in their responsibilities and the tasks involved in their roles as the service seeks to maximise outcomes for patients. This requires synergy between physiotherapists and those in less familiar roles such as unregulated support workers and nurses working as home care coordinators to develop a shared understanding of the scope and responsibilities of each of the roles in planning and delivering services to older people (Barber 1983, Burt et al 1996, Connell and Mannion 2006, Davies and Mannion 2000, Dyer et al 2014, Shapiro 1987).

The evidence for working across organisational and professional boundaries also suggests the need for a shared philosophy of care (Baker et al 2001, Barnes and Frock 2003, Nadash and Feldman 2003). This is highlighted in the implementation of a restorative model of home care in the United States where Barnes and Frock (2003) found occupational therapists and physiotherapists at cross-purposes with the support worker. Whereas the support worker provided ADL services for the client, the occupational therapists and physiotherapists were determined to have the client perform these tasks as independently as possible. The tendency has been for nurses and support workers to be nurturing and to 'do for' the client. This conflicts with the rehabilitation focus of maximising the client's independence. This often led to competition rather than cooperation between the disciplines, as well as confusion and frustration for the client and family. This view is supported by Nadesh (2003) and Baker (2001) who report the lack of a consistent belief system among the various members of the home care team. Without careful communication, providers can find themselves giving conflicting advice to older patients. This was identified as a widespread problem while working with clients in 27 home care agencies in a home-based rehabilitation

clinical trial designed to help participants gain independence in ADLs through behavioural or environmental changes (Tinetti et al 1999). For example, a nurse might assign a home support worker to bathe and dress an older woman post stroke at the same time as the rehabilitation therapists are encouraging her to build endurance and regain independence by performing those self-care tasks. It is suggested that experiences such as this lead to a lack of trust that the home care provider can deliver services with a focus on rehabilitation and an increased reluctance for physiotherapists to agree to interventions based on their assessment of the older person being delivered by support workers as part of Home Care.

As illustrated above there is considerable potential for physiotherapy to contribute to the integration of rehabilitation within home care. However there are considerable barriers in place in the current environment in New Zealand. It is not feasible using current models of service delivery for physiotherapists to provide high quality and evidence based interventions to maximise the functional ability and independence of the increasing number of older people without a significant increase in resources and staffing. Internationally, physiotherapy is facing major challenges within evolving health care systems where there is an increasing need for rehabilitation in both primary and inpatient settings and current health professional groupings may not be sustainable in their current form (Doyal and Cameron 2000). In addition, traditional assumptions about professional roles are currently being challenged (Smith et al 2000).

FINDING A WAY FORWARD

Dufour et al (2013) explored the place of physiotherapists within community based health teams in Canada and outlined five key roles: (1) manager; (2) evaluator; (3) collaborator; (4) educator; and (5) advocate. Such a model shows considerable synergy with the anticipated requirements for alignment of physiotherapy and home care. However it also necessitates the exploration of the role and required competency for physiotherapists providing rehabilitation expertise within this context. Such a model has a focus on a potential consultative role for physiotherapy where there is involvement in assessment and subsequent input into interdisciplinary service planning with the integration of defined interventions to maximise mobility, function and independence. Inherent in this approach is the need to provide education to home care team members to develop robust and responsive communication strategies to enable monitoring and adaptation of treatment plans based on client progress (Francis and Netten 2003, Harris-Kojectin et al 2004, Stone 2001, Stone and Wiener 2001). It is recognised that this has often occurred at a local level in an informal manner. However to formalise this process it is necessary to further clarify the role of physiotherapy within the delivery of RHS.

Sibbald et al (2004) describe three pertinent processes for developing role clarity and function amongst health professionals: (i) enhancement; (ii) substitution; (iii) delegation. Enhancement occurs when the role of a worker is extended by increasing the depth of the role in terms of increased skill in relation to specific tasks. In contrast, substitution is characterised by expanding the breadth of role; workers may operate across more than one group or undertake the work of another, therefore acting as a substitute. Delegation is defined as delegation as 'moving a task up or down a traditional uni-disciplinary ladder'. These processes in effect alter the boundaries between different health professional groups.

Within the context of RHS in New Zealand, Sibbald et al's model is important to consider when exploring the synergy between physiotherapists, home care coordinators and support workers. It is proposed that enhancement of the physiotherapy role is not feasible given the constraints on funding and the extremely limited resource of physiotherapists. However, there is increasing evidence of the process of substitution of traditional physiotherapy tasks and roles by the home care coordinator. An example of this is the provision of simple exercise programmes and mobility advice (de Vreede 2004, de Vreede et al 2005, Denton et al 2014, Duncan and Pozehl 2002, Krebs et al 2007, Manini et al 2007, Stevens and Vecchio 2009, Tinetti et al 2012b). This is a pragmatic solution to address the need for rehabilitation advice and expertise. However, such an expansion of the role of coordinators, who are mostly registered nurses, requires clarity and robust discussion at a local and national level to minimise confusion and ensure that the functional status and safety of the older person is maximised.

There is also considerable international evidence of delegation of physiotherapy and associated roles in models of restorative home care. Primarily this has focused on the rehabilitation interventions delivered by support workers following assessment and programme design by the physiotherapist (Denton et al 2014, Stevens and Vecchio 2009, Tinetti et al 2012a). Such delegation is dependent on having suitably trained support worker staff and a level of trust by the physiotherapist in the ability of the support worker to deliver the programme and respond effectively to changes in the client over time. Within the New Zealand context this is only possible as a component of a system wide quality improvement initiative that comprises robust communication between the support worker, coordinator and physiotherapist (King et al 2012, King et al 2011) to enable responsive communication of progress and the required adjustments to the intervention.

CONCLUSION

Within the context of the ageing population and the increased focus on services to support older people to remain at home there is an imperative need to develop integrated services to maximise function of older people. There has been considerable research, service development and quality improvement undertaken in New Zealand and internationally to emphasise the capacity of home care to contribute to significantly improving function and independence. The key skills of physiotherapists in assessment, design and delivery of rehabilitation interventions offer considerable potential opportunity to further enhance models of restorative home care. However there are identifiable barriers to the full realisation of this alignment. Physiotherapists need to engage in the development of the role of physiotherapy in these models to ensure that there is role clarity and that the scarce physiotherapy resource is maximised. The opportunities for delivering truly inter-disciplinary rehabilitation across organisational boundaries are considerable and there are a growing number of exemplars within New Zealand where this synergy is being realised.

KEY POINTS

- There has been a strong emphasis at an international, national and local level to enhance the quality of home care services for older people to support them to remain living at home.
- There needs to be development of the potential synergies between physiotherapy and home care to maximise the opportunities for rehabilitation for older people.
- This article presents some of the potential barriers and proposes solutions for the imperative need for more effective utilisation of physiotherapy in home care service delivery.

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One-week time course of the effects of Mulligan's Mobilisation with Movement and taping in painful shoulders

Teys P, Bisset L, Collins N, Coombes B, Vicenzino B (2013) One-week time course of the effects of Mulligan's Mobilisation with Movement and taping in painful shoulders. Manual Therapy 18:372-377. DOI: 10.1016/j.math.2013.01.001. (Abstract prepared by Erik Botnmark). DOI 10.15619/NZJP/43.1.05

Aim

The aim of this study was to compare the one week time course of range of motion (ROM), pain severity and pressure pain threshold (PPT) after one session of mobilisation with movement (MWM), with or without the addition of tape.

Methods

A repeated-measures, crossover, randomised trial. Twenty-five patients with unilateral antero-superior shoulder pain of more than four weeks duration, who responded positively to an initial MWM treatment session, were randomised to receive either a single glenohumeral MWM treatment (3 sets of 10 repetitions) or the same MWM with the addition of tape after treatment. The tape was applied with the aim of augmenting the effect of the MWM, and was removed 48 hours post-application. Outcome measures included pain free active abduction ROM in the plane of the scapula, pain severity (100 mm visual analogue scale) and PPT assessed using pressure algometry. Measurements were taken at baseline, immediately following treatment, at 30 mins, 24 hours and seven days post-intervention. After a seven day washout period all patients received the alternate treatment.

Results

No significant differences were observed regarding the order of which the patients received the two interventions. Both MWM alone and MWM with tape provided statistically significant reductions ($p < 0.05$) in pain immediately post-intervention and at 30 mins, but neither treatment demonstrated sustained effects at 24 hours or after 7 days. MWM with tape produced statistically significant ($p < 0.05$) improvements in pain free ROM at all intervals (26.8° post-intervention, 21.0° at 30 mins, 20.7° at 24 hours and 18.9° after 7 days), while improvements with MWM alone was statistically significant ($p < 0.05$) only immediately after intervention and at 30 mins (16.2° and 11.9° respectively). No statistically significant differences were observed for PPT for either treatment.

Conclusion

Patients who responded positively to MWM of the shoulder experienced an additional duration of improvement in pain free active ROM for up to one week with the added application of tape.

Commentary

Shoulder pain is one of the most common musculoskeletal problems in the general population, and it is reported that approximately 20% of disability payments for musculoskeletal problems are due to shoulder disorders (Michener et al 2004). Patients regularly seek help from physiotherapists, but treatment outcomes are often poor (Sueki and Chaconas 2011). MWMs are frequently used to treat shoulder problems, but evidence is scarce and only relates to immediate effects (Teys et al 2013). Similarly use of tape to augment the effects of MWMs is often advocated (Mulligan 2010), but no previous studies have investigated the effects of this in patients with shoulder pain and/or dysfunction.

Teys et al (2013) have presented an article investigating whether the use of tape augments the effects of MWMs in shoulder patients. Fifty-three consecutive patients complaining of anterolateral shoulder pain were treated with an MWM technique were treated with a posterolateral translation of the humeral head in the glenoid fossa, as described by Mulligan (2010). Twenty-five patients (47%) responded positively, meaning that they had instant improvement of pain free active shoulder abduction in the scapular plane by at least 10° after one MWM treatment.

The results of this study are interesting as they indicate that initial effects on painfree ROM with MWMs to the shoulder can be prolonged by adding a simple strip of tape applied from the anterior shoulder, over the acromion and diagonally across the scapula to a point approximately level with the T7 spinal segment. In a clinical setting it would be interesting to see the results of using this period of increased ROM for exercises aimed at addressing any identified muscle dysfunctions or impairments.

The application of tape in this study provided no additional benefit with regard to reducing shoulder pain, but did improve shoulder function in the form of approximately 20° increased painfree active scapular plane abduction, which was sustained for one week. Functional limitations and the ability to work has been reported to be more important for patients than pain (Faber et al 2006). One might therefore argue that painfree ROM is a more clinically important outcome measure than pain for this patient group, as improvement of painfree active ROM most likely reflects improved shoulder function. However, because this study only measured ROM in one plane of movement it is difficult to estimate any global functional implications.

As stated by the authors themselves this is the first study aiming to investigate whether there is an added effect of adding tape to MWMs in painful shoulders, and consequently care must be taken not to overinterpret the results. The study sample is relatively small and it is not known whether the additional effects of tape provide benefit for longer than one week. However, as the application of tape seems to have few side effects or adverse events (Radford et al 2006), there are few contraindications to using this technique in clinical practice. The application of tape is quick and of little cost, and many physiotherapists have already experienced positive results with its use. This article provides preliminary evidence that treatment effects for patients with painfully restricted shoulder ROM, who respond positively to MWMs, can be augmented by the addition of taping.

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Middle and lower trapezius strengthening for the management of lateral epicondylalgia: a case report

Bhatt JB, Glaser R, Chavez A, Young E (2013) Middle and lower trapezius strengthening for the management of lateral epicondylalgia: a case report. Journal of Orthopaedic Sports Physical Therapy 43:841-847. DOI: 10.2519/jospt.2013.4659. (Abstract prepared by Ingunn Botnmark). DOI: 10.15619/NZJP/43.1.06

Background and Aims

This case report pertains to a 54 year-old woman who presented with a 5-month history of right lateral elbow pain. Her symptoms had not improved since onset, despite pain medication. The aim of this case study was to document the beneficial effects of a treatment program focusing only on scapular position and trapezius strengthening in the management of clinically diagnosed lateral epicondylalgia (LE).

Methods

The patient attended five physiotherapy sessions over 10 weeks. She was instructed to perform strengthening exercises targeting the middle and lower trapezius twice a day (3 x 10 repetitions). The exercises were progressed when quality and control were good. No intervention was directed at the elbow. The main outcome measures used to assess response to treatment were the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire and an 11-point numeric pain rating scale (NPRS). In addition, grip strength, middle and lower trapezius strength, and scapula resting position were measured during the first and last sessions.

Results

From an initial DASH score of 44.2 the patient reached 0 by her fifth visit. Self-reported pain during aggravating functional tasks at home changed from 7/10 to 0/10. Grip strength improved from 26.1 kg (with 7/10 pain) to 42.2 kg pain free. Trapezius muscle strength changed from 3+/5 and 4-/5 (middle and lower) to 5/5 in both. Scapula resting position was symmetrical on the left and right at the final assessment. The DASH and NRPS scores were reassessed and maintained at the two and six month follow-up sessions.

Conclusion

This case report highlights that addressing the function of scapular muscles might be of importance in the physiotherapy management of LE.

Commentary

Colloquially referred to as "tennis elbow", LE is reported to have an incidence of 1-3%, being prone to chronicity, and is considered a difficult condition to treat (Coombes et al 2009). It is proposed that in addition to a tendon pathology there are impairments in motor systems and pain processing, with variable presentations in subgroups of patients (Coombes et al 2009). A study on female tennis players found significantly reduced lower trapezius strength in those diagnosed with LE, compared to symptom-free players and controls (Lucado et al 2012). However, directing treatment towards the scapular muscles has gained little attention, and is why this case report is worthy of noting. Remarkably good results were achieved in only a few physiotherapy sessions when combined with a progressive home exercise programme. This is beneficial both from a patient and a socio-economic viewpoint.

The patient's onset of symptoms was after carrying heavy loads. A diagnosis was reached based on three positive special tests, reduced pain free grip strength and reproduction of symptoms with palpation of the common extensor tendon. On examination the woman had an abducted scapula position with relative internal rotation of the humerus. When manually normalising the position of her scapula, grip strength changed from 26.1 kg with 7/10 pain to 33.7 kg pain free. In addition to the clinical assessment, electromyography was used to gain further insight into levels of muscle activity. A marked reduction of activity in extensor carpi radialis brevis (44%) and biceps brachii (23%) was observed while the patient performed a gripping task with the scapula position actively corrected, compared to no correction. The improvements observed during the course of the treatment are suggested to be due to several factors; it is possible that motor learning, pain inhibition and neurophysiological effects all played a role.

This is a thorough and high quality case report. Possibly, differential diagnoses could have been addressed a bit more thoroughly, but the diagnostic criteria used are in line with what are currently advocated as best practice (Vicenzino 2011). Nonetheless, given that this is a case report there are several associated limitations that are acknowledged by the authors. With only one patient and no blinding, there is little control of what factors contributed to the outcome. It is plausible that this result could be one of a kind, although the authors emphasise they have had experience with several similar cases in their clinic. The fact that the patient's symptoms immediately improved when the position of the scapula was corrected supports the hypothesis that scapula position and possibly scapular muscle strength contributed to the positive outcome. More research is indicated and it would be interesting to see if the results are generalisable to a larger patient sample.

It is unknown whether impairments of scapular muscle function predispose to an elbow problem, or if they are a likely consequence of elbow tendon pathology. However, it is important to recognise that LE patients are a heterogeneous group (Coombes et al 2009). From a clinical perspective the most important consideration is how to help the patient regain pain-free function. This case is a reminder of how different parts of the body can influence each other, and that it is important to assess and address contributing factors that are not necessarily in the immediate area of the presenting symptoms.

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ESSA's Student Manual for Health, Exercise and Sport Assessment (2014)

Jeff Coombes, Tina Skinner (editors). Mosby Elsevier 446 pages, ISBN 978-0-7295-4142-8

Exercise prescription is increasingly important for physiotherapists for clients of all ages and conditions. Assessment of health, physical fitness and performance provides the baseline for prescribing safe and relevant programmes for individual clients. This text, written by Australian and New Zealand contributors in collaboration with Exercise and Sports Science Australia (ESSA), provides the basic theory and protocols for exercise testing. It includes tests that range from the use of a tape measure to sophisticated laboratory-based tests, such as lactate threshold and exercise electrocardiography. While most physiotherapists are less likely to be involved in the clinical procedures of the latter, they need a good understanding of the interpretation of results.

The cardiovascular health procedures include the basic assessment of auscultation, heart rate and blood pressure monitoring, the Framingham Risk Charts and the Australian Cardiovascular Disease Risk Charts. The chapter on Physical Activity describes the International Physical Activity Questionnaire, and use of commercially-available pedometers and accelerometers. Pre-exercise health screening and risk stratification, important for identifying potential 'red flags' for exercise prescription or indication for physician referral, are presented clearly. The chapters on neuromuscular strength, power, endurance and flexibility are applicable for clients ranging from sedentary to elite athletes. High intensity exercises that are not dependent on expensive laboratory equipment and interpretation of their results, including sub-maximal and VO_2max testing procedures are described. Finally, functional measures relevant for older adults are presented.

Throughout the book, step-by-step procedures are explained which can be used in clinics and practices to standardize these assessments. Detailed questionnaires and reporting forms are provided, including normative values and the reliability of the data are where these are available. The ring bound structure makes the book user-friendly as a guide.

Students and novice graduates will find the book extremely useful, in addition to those colleagues wishing to update and expand their skills. A code inside the book allows full text download, add notes and highlight sections. It is extremely user-friendly and informative, providing expert knowledge for working in this highly competitive field of health and exercise assessment.

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Neuromusculoskeletal examination and assessment. A handbook for therapists. 4th Edition

Edited by Petty, N. 2011 (Reprinted 2013) Churchill Livingston: Edinburgh. ISBN: 9780702055041. Soft cover; 447 pages

This text provides a systematic guide to the examination of patients presenting with neuromusculoskeletal dysfunction with a focus on the development of technical and clinical reasoning skills. It is designed for Physiotherapy students but could also be utilised as a resource for those in their first years of practice. I am quite familiar with this textbook from the UK (and its previous editions), as at AUT in the musculoskeletal programme we have recommended this text to our students as a useful resource to support their learning.

As with previous editions, this text provides a detailed description of the principles of the subjective and objective examination as introductory chapters. The chapter on subjective interview provides a very thorough description of the theoretical rationale underpinning the assessment process. Thereafter each chapter, written by a different author, is dedicated to a region of the body, providing detailed information on the clinical examination of spinal and peripheral joints (including the temporomandibular region). Throughout the text the information is presented in a systematic logical fashion and is accompanied by graphics that are clearly described within the text. There has been an attempt to present a variety of techniques or tests that are considered useful diagnostic tools whereby the sensitivity and specificity of these tests have been provided; however, presenting information such as this has the potential to conflict with recent evidence more readily available. With respect to some of the techniques described (e.g cervical spine chapter) there does seem to be a bias towards the Maitland style prone accessory joint assessment, which is not consistent with the combined physiotherapy-osteopathic approach currently taught at the AUT Department of Physiotherapy and NZMPA continuing education programme. However there are several techniques described that are consistent with our practice here in New Zealand.

New to the text is a chapter on the principles of assessment in particular developing a hypothesis, which obviously will help to strengthening the clinical reasoning process for a clinician requiring some assistance with this. Further to this additional photographs have been added to this edition, which support the various assessment techniques described in each of the regional chapters. Consistent with previous editions, presented at the end of each chapter is an extensive reference list should you wish to explore any of the supporting literature in more detail. Key authors and their theories and supporting evidence are threaded throughout the text for each relevant chapter including Jull, Bogduk, Maitland, McConnell, McKenzie, Mulligan, Butler, Hodges, Lee, Margarey, Sahrmann, Panjabi etc). Therefore the text has quite a well rounded approach with respect to its content.

There never seems to be the perfect text; however, it is my belief that this text has many positives. The highlight of the text is the introductory chapters including the new chapter on assessment. I see this text as a very good choice to assist with the clinical reasoning process as it simplifies what can be quite a complex process. For students, physiotherapists at the beginning of their career, or physiotherapist who might be involved in clinical education, this text would be a useful adjunct in establishing a strong foundation with which to build future learning.

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Mosby's Respiratory Care Equipment

JM Cairo. Elsevier 2014 (9th edition). ISBN: 978-0-323-09621-8. Soft cover. 657 pages.

With the ongoing advancement of technology and health care delivery, as health care workers we have to be up to date with our knowledge in continuing to provide a high standard of quality services to the population. This book has been edited and published in the last three decades and it is up to its ninth edition with recent information included in it. It was authored by a respiratory therapist in the United States of America and the purpose of the book is to provide respiratory therapists a comprehensive overview of the equipment and techniques and the rationale behind them, to treat cardiopulmonary dysfunction. Although the scope of a Respiratory Therapist in the States is different from a Cardiopulmonary Physiotherapist, nonetheless there are important basics and knowledge within the cardiopulmonary physiotherapy field that this book provides that can be applied in our daily clinical practice.

The book is divided into five sections with each chapter beginning with an outline, objectives and key terms, to aid the reader with navigating its contents. Each chapter is summarized in a bullet pointed format which makes it very easy to read. There are also clinical questions throughout the chapter to challenge readers to think whilst reading.

The first section provides a revision of basic respiratory science which is in-depth yet written clearly and simply, and well-illustrated with diagrams. This section also discusses the principles of infection control which includes how microorganisms transmit and how health care workers can assist in controlling infection transmission by adhering to isolation precautions.

The second section of the book provides information on medical gases including oxygen, carbon dioxide, nitric oxide among others and the various ways to store and transport them. However in this section the most relevant to cardiopulmonary physiotherapists is oxygen therapy and delivery devices and systems. The book explains the difference between high-flow versus low-flow oxygen therapy and r devices. It also includes the clinical practice guidelines of the American Association for Respiratory Care on Oxygen Therapy administration in various situations.

The third section discusses airway management, humidity and aerosol therapy. The author provides a comprehensive review of the various types of nebulizers and inhalers used at different settings and their technique. This section also discusses lung expansion therapy devices such as incentive spirometer, intermittent positive pressure breathing (IPPB) device and positive airway pressure (PAP) devices. It outlines the basic principles of other chest physiotherapy techniques of manual chest physiotherapy, pneumatically powered and electrically powered devices, and the mechanical insufflation-exsufflation device. High-frequency oscillation devices are also discussed such as intrapulmonary percussive ventilation, flutter valve therapy and the high-frequency chest wall oscillation device.

Section four discusses the various technique and devices in assessing pulmonary and cardiovascular functions. Although it is most relevant to respiratory therapists, the basic principles of these are still relevant to cardiopulmonary physiotherapists such as the lung function test standards in a spontaneously breathing person versus a mechanically ventilated person.

The last section describes devices used in a critical care setting and in extended care. It is primarily on mechanical ventilation both invasive and noninvasive. It outlines the basic principle of mechanical ventilation and different modes and settings. This also includes the mechanical ventilators used in infants and pediatric populations. Extending further, this book also describes the mechanical ventilators used at home with troubleshooting guidance.

This book definitely provides a very good basis for cardiopulmonary physiotherapists from an acute to a community setting. It outlines a very comprehensive scope and knowledge for respiratory therapists that can be applied to cardiopulmonary physiotherapy. It provides a broad range of devices that are relevant to our clinical practice that allows us to have a good understanding of them. In comparison to the previous editions the author has included some clinical practice guidelines and some clinical scenarios, the book is however still relatively machinery based. As physiotherapists, it is also important to look at research evidence to ensure the assessment and treatment used are valid and effective.

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