Development of a New Technology-based Learning Tool to Promote the Uptake of Clinical Practice Guidelines on the Management of Neck Pain in Chiropractic Teaching Faculty

by

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An oral defense of this thesis took place on November 20, 2018 in front of the following examining committee:

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The above committee determined that the thesis is acceptable in form and content and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate during an oral examination. A signed copy of the Certificate of Approval is available from the School of Graduate and Postdoctoral Studies.

Abstract

Background

Ensuring teaching faculty are well-informed of evidence-based clinical practice guidelines may help to ensure chiropractic students are educated accordingly throughout their training. This is imperative for maintaining high-quality education and developing competent chiropractic graduates.

Objective

To develop a pedagogically-sound, technology-based learning tool aimed at improving knowledge of an evidence-based clinical practice guideline for teaching and clinical faculty at the Canadian Memorial Chiropractic College.

Methods

I developed an online, module-based learning tool using an integrated knowledge translation approach informed by a systematic review and pedagogical theory. I conducted a cross-sectional evaluation of the user-centred constructs in a sample of teaching and clinical faculty.

Results

The constructs of the learning tool were evaluated favourably. Participant feedback informed the development of pedagogically-focused recommendations for future development of the learning tool.

Conclusions

My research can inform the development of pedagogically-sound, educational tools aimed to improve knowledge of clinical practice guidelines for chiropractic educators.

Key Words: Knowledge Translation; Technology-based Learning; Chiropractic; Education; Clinical Practice Guidelines

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Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter One Background

Thesis Introduction

My thesis includes two complementary studies designed to explore pedagogical components of a technology-based learning tool for teaching clinical practice guidelines to chiropractic teaching and clinical faculty at the Canadian Memorial Chiropractic College (CMCC). First, I conducted a systematic review to assess the literature describing the studies on the effectiveness of technology-based learning tools designed to improve knowledge of clinical practice guidelines for healthcare professionals. Second, I designed and evaluated a technology-based learning tool in a sample of teaching and clinical faculty at CMCC. These studies were designed and conducted in collaboration with clinical, education and methodological experts.

Purpose

The purpose of this section is to: 1) provide a conceptual understanding of knowledge translation and more specifically the integrated knowledge translation strategy; 2) provide an overview of technology-based learning tools; 3) provide an understanding of evidence-based practice; 4) provide an understanding of the chiropractic profession and chiropractic education; 5) describe the barriers that exist influencing the uptake and use of clinical practice guidelines within the chiropractic profession; and 6) describe how an integrated knowledge translation research approach could help increase the use of clinical practice guidelines in the chiropractic profession.

Knowledge Translation

Knowledge translation is an essential component of health research. Broadly, the goal of knowledge translation is to reduce the gap between knowledge and action [1]. Effective knowledge translation is imperative for integrating knowledge into clinical decision-making [1, 2]. Knowledge translation strategies can also work to promote a cultural shift within an organization to enhance the use of evidence in practice and to encourage collaboration between researchers and knowledge users [1, 2].

Knowledge translation is complex and includes many varying approaches which are often context-specific and, therefore, may not be appropriate for all knowledge translation

initiatives [3, 4]. Further, there is limited literature on how to best select the most appropriate knowledge translation approach [5-7]. However, the selection of a knowledge translation approach involves considering the target population (barriers and facilitators to current knowledge use and uptake of new knowledge), degree of interaction with the end-user or stakeholders (two-way movement of information), planned level of outreach (diffusion – "let it happen", dissemination – "help it happen", and application – "make it happen") and the complexity of the content [1, 3, 8].

For my thesis, I used an integrated knowledge translation (iKT) as described by the Canadian Institutes of Health Research (CIHR). The prominent component of integrated iKT is the involvement of a knowledge user group regarded as equal partners alongside the researchers [1, 8]. iKT is one of two approaches used in conducting knowledge translation [1]. This approach consists of knowledge exchange and dissemination strategies beginning prior to conducting the research and lasts beyond the life of the research project [1, 8]. The objective of iKT is to promote research that is relevant and useful to knowledge users by promoting the exchange of knowledge resulting in mutual learning [1, 8]. In contrast, an alternative approach is end-of-grant knowledge translation. This approach consists of knowledge exchange and dissemination following the conduct of the research. The objective of end-of-grant KT is to raise awareness of the research as well as to promote research-informed action [1, 8].

Successful iKT approaches bring together knowledge users from a variety of backgrounds and involve them in the decision-making processes of the research project and dissemination plans [1, 8]. The relationships developed between the research team and the knowledge users may vary depending on the nature of the research; however, they should extend past the life of the initial research project [1, 8].

The second major component of iKT is the need to develop a clear dissemination plan. Dissemination refers to the sharing of research results using a format and message appropriately tailored to the intended audience [8]. Dissemination aims to raise awareness and promote action by demonstrating practical applications for the research [1, 2, 8].

Knowledge users can guide the development of effective dissemination strategies that target specific audiences as they represent the broader community compared to the research team alone [1, 8]. Developing appropriate dissemination plans is critical to the potential impact and benefit of the research findings [7, 8]. Appropriate methods include but are not limited to: peer-reviewed publications, workshops, conferences, and tool development.

Technology-based Learning Tools

Technology-based learning tools are digital resources intended to deliver content and instruction in order to support learning [9-11]. Technology-based learning tools can be presented through numerous digital platforms such as computers, smart-phones, or tablets, and can be used for synchronous as well as asynchronous learning [9, 10]. A well-developed technology-based learning tool provides advantages to learners such as: overcoming barriers of distance and time by increasing accessibility, diffusing knowledge regardless of geographical location, and personalizing instructions to meet the needs of specific audiences [9, 10, 12, 13].

Technology-based learning tools deliver information resulting in learning similar to a classroom or a textbook format [9]. Although it can be argued that not all forms of delivery are equally effective, they all rely on the appropriateness of their methods of delivery of information and their level of engagement with the learners [9, 14-16].

Technology-based learning tools are flexible delivery vehicles of information because they are easily customizable to include features such as text, still and animated graphics, and audio [10, 13]. They also allow for more complex features such as immersive simulated environments [10, 13]. The flexibility of delivery options allows developers to tailor the learning tool depending on the previous knowledge of the learner and the complexity of its content [13].

There is a need to harness the benefits of technology in education to build the capacity for lifelong, continuous learning [10, 17]. Understanding the audience for which the learning tool will be tailored provides insight as to how to more effectively reduce their specific barriers

and improve engagement [18-20]. Technology-based learning tools have the potential to be customized to the unique learning needs of their intended audiences leading them to be a favoured resource for knowledge dissemination strategies [9, 21-24].

Technology-based learning tools have been implemented in various healthcare settings. The use of technology-based learning is used in healthcare to increase knowledge, change behaviours, improve patient care, as well as to improve administrative efficiencies [22-24]. However, knowledge translation influencing the use of evidence in clinical practice has had limited success [5, 17, 25]. Despite the growing body of literature in the area of knowledge translation, clarity about definitive strategies to enhance knowledge translation is lacking, and strategies that have been found effective are often situation/context specific [5-7].

Evidence-based Practice

Evidence-based practice is a term coined by Sackett et al. and is defined as "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients" [26]. The use of evidence-based practice can improve quality of care, reduce healthcare expenditure, as well as increase patient safety [17, 27]. One method for implementing evidence-based practice is the use of clinical practice guidelines. Clinical practice guidelines include clinical recommendations developed following an evaluation of the scientific literature [28]. Clinical practice guidelines optimize patient care by allowing healthcare providers and patients to select the best evidence-based care consistent with patients' unique needs and preferences [28]. Clinical practice guidelines aim to promote a shared understanding of current evidence as well as key research gaps when it comes to patient care [12].

Guideline compliance among healthcare professionals continues to be a challenge [12, 17, 29]. Technology-based tools provide a convenient method for accessing and distributing clinical practice guidelines while allowing for review and updates in accordance with emerging evidence [12, 13, 17]. However, there is limited evidence of the efficacy of technology-based learning tools for improving knowledge of clinical practice guidelines in healthcare professionals [17]. Further, few studies have investigated technology-based

learning knowledge translation strategies in healthcare professionals [17, 30], and to my knowledge, none have focused on the chiropractic profession.

Using an integrated knowledge translation approach to develop pedagogically-sound technology-based learning tools may be an appropriate approach to reducing the gap between knowledge and action.

The Chiropractic Profession

Chiropractic was first introduced in Canada in the early 1900s [31].Today, the profession is governed by colleges guiding the standards of care delivered by approximately 8400 chiropractors nationwide [32]. In Canada, chiropractors are the most accessed Complementary or Alternative Medicine (CAM) providers and are visited by over 4 million patients yearly [33].

Musculoskeletal conditions, such as back and neck pain, are primary reasons for accessing chiropractic care [34]. Back and neck pain result in millions of days of sick leave and contribute to significant direct and indirect healthcare expenditures [29, 35]. Those who seek treatment for back and neck pain typically consult general practitioners, physiotherapists, and chiropractors [35]. The growing use of chiropractic care emphasizes the need to increase knowledge and use of evidence-based clinical practice guidelines for the management of chiropractic patients in order to optimize patient care and limit inefficiencies [29, 35]. However, current literature suggests that chiropractors' use of clinical practice guidelines in practice is sub-optimal [27, 29, 35-40]. This profession-wide limitation highlights the needs for future knowledge translation research, taking into account barriers to participation and uptake as well as favoured pedagogical approaches to learning in order to improve use, awareness, and knowledge of clinical practice guidelines.

Chiropractic Education

In Canada, there are two accredited academic chiropractic programs; the Canadian Memorial Chiropractic College in Toronto, Ontario and the Clinique Universitaire De Chiropractique in Trois-Rivières, Quebec. Together, these programs aim to train the next

generation of chiropractors using evidence-based practice [41, 42]. Students' classroom experiences using evidence have been found to be directly related to their use of evidence-based practice throughout their chiropractic careers [27, 43, 44]. Maintaining high-quality education, that emphasizes the use of evidence-based practice is essential for competent chiropractic graduates [27].

Evidence-based Chiropractic Practice

Barriers limit the uptake of evidence-based chiropractic practice. These barriers include limited awareness of knowledge translation initiatives and clinical practice guidelines, limited time, perceptions that resources lack clinical relevance, lack of incentives for completing continuing education, and limited skills in locating, interpreting and critically appraising research [20, 38, 45]. These barriers highlight the need for research to identify knowledge translation strategies developed specifically for the chiropractic profession as well as clarify which methods have been found effective in the hope to increase the use of clinical practice guidelines in clinical patient care. My research aims to contribute to addressing this need.

Methodological Approach

My research design is set within an iKT strategy. It incorporates the two main components of the strategy wherein knowledge users were made an integral part of the research team. It also incorporates the development and evaluation of a knowledge dissemination strategy in the form of a technology-based learning tool. This dissemination strategy includes a feedback mechanism to develop a knowledge translation intervention that is tailored to a specific audience; this is referred to as the Knowledge-to-Action cycle. My research focuses on the first four steps of the Knowledge-to-Action cycle which includes 1) identifying the problem; 2) adapt knowledge to the local context; 3) assess barriers to knowledge use; and 4) select, tailor, and implement interventions.

The development of a tailored technology-based learning tool could help increase the use and awareness of clinical practice guidelines in the chiropractic profession. Furthermore, the integrated knowledge translation approach will build a foundational understanding for

future knowledge translation research within this population which includes barriers to participation and uptake as well as favoured pedagogical approaches to learning.

Objectives

General Objective

The purpose of my thesis is to develop a pedagogically sound technology-based learning tool aimed at improving knowledge of an evidence-based clinical practice guideline in teaching and clinical faculty at the Canadian Memorial Chiropractic College.

Specific Objectives

1. To systematically review and synthesize the literature on the effectiveness of technology-based educational interventions designed to improve knowledge about the evidence-based management of health conditions using clinical practice guidelines by healthcare professionals.
2. To develop a technology-based learning tool to improve knowledge about the management of neck pain using an evidence-based clinical practice guideline in teaching and clinical faculty at the Canadian Memorial Chiropractic College.
3. To evaluate the learning, design, and engagement constructs toward the technology-based learning tool.

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Chapter Two Are Technology-based Educational Interventions Effective in Improving Knowledge about Clinical Practice Guidelines? A Systematic Review of the Literature

Abstract

Background

Rapid advances in evidence-based medicine prove difficult for healthcare professionals to remain current with new evidence. Although technology is increasingly used to transfer knowledge, little is known about the effectiveness of technology-based learning tools in healthcare professionals. We aimed to synthesize the evidence on the effectiveness of technology-based learning tools designed to improve the knowledge of evidence-based clinical practice guidelines by healthcare professionals.

Methods

We conducted a systematic review and searched MEDLINE, Embase, and CINAHL from inception to July 2018. We included studies investigating the effectiveness of technology-based learning tools developed to improve knowledge of evidence-based clinical practice guidelines for healthcare professionals. We critically appraised the literature and synthesized the evidence from internally valid studies using best-evidence synthesis.

Results

We retrieved 8,321 articles. Of those, 25 studies met our selection criteria and were critically appraised; six had a low risk of bias and were included in this review. Preliminary evidence suggests that spaced-education is associated with improvement in knowledge; however, its effectiveness relative to other interventions is unknown. Similarly, module-based online educational interventions are associated with improvement in knowledge of clinical practice guidelines, but they are not more effective than paper-based self-learning or in-person workshops.

Discussion

We found little evidence supporting the effectiveness of technology-based learning tools designed to improve knowledge about clinical practice guidelines. Future high-quality research is required to appropriately review these interventions to better understand their effectiveness.

Background

Healthcare professionals are expected to remain current with clinical evidence [1, 2]. One method available to clinicians to update their knowledge is evidence-based clinical practice guidelines (CPGs). CPGs include clinical recommendations developed following an evaluation of the scientific literature [3]. CPGs optimize patient care by allowing healthcare providers and patients to select the best evidence-based care consistent with patients' unique needs and preferences [3]. However, the use of evidence in clinical practice is sub-optimal as there are few practical ways to access relevant, evidence-based information [4-11]. There is a need for appropriate knowledge translation (KT) activities to facilitate the dissemination of evidence to healthcare professionals [12-18]. However, there is inconclusive evidence guiding the choice of KT strategies targeting healthcare professionals [19]. Therefore, improving our understanding of technology-based educational interventions that are effective in improving knowledge is necessary to develop KT strategies for these populations.

The growing use of technology challenges traditional methods of knowledge sharing in healthcare [20]. In this review, we define technology-based learning tools as instruments of learning that incorporate digital technology as a method for the delivery of information [21]. Examples include website, online courses/modules, and podcasts. Technology-based learning tools in healthcare education can improve access to information to meet the needs of healthcare professionals [22-25]. Moreover, they can be used to adapt information to the clinician's learning styles, as well as increase intrinsic motivation [23-26]. Terms such as web-based learning, e-learning, computer-assisted learning, and online learning have been used synonymously and refer to educational media delivered in an electronic form [5, 27, 28].

There is a need to understand the effectiveness of technology-based educational interventions for healthcare professional self-directed learning, [2, 29, 30] as well as strategies specific toward disseminating CPGs [27]. A previous systematic review aimed to report on the perceived usability and behaviour changes following the use of technologies disseminating CPGs [27]. This review provides preliminary evidence regarding a variety of technologies; however, their conclusions are based on studies of mixed quality [27]. The

purpose of our systematic review is to synthesize the best evidence on the effectiveness of technology-based learning tools designed to improve knowledge of evidence-based CPGs for healthcare professionals.

Methods

Registration

We registered our systematic review protocol with the International Prospective Register of Systematic Reviews (PROSPERO) on August 3, 2017 (CRD42017071308).

Target population

Our review targeted studies of practicing healthcare professionals, including, but not limited to, physicians, medical residents, nurses, chiropractors, occupational therapists, physical therapists, acupuncturists, and emergency responders. Studies were excluded if the population included students not yet in clinical practice.

Outcome

We restricted our review to studies that assessed knowledge following the use of a technology-based learning tool. We did not include studies assessing other measures, such as behavioural change and clinical outcomes. While we recognize that a change in knowledge does not in and of itself guarantee an eventual implementation of a new practice, a change in knowledge is an important antecedent of behaviour change and is typically needed if the implementation of a new practice is expected [31]. We did not use a specific definition of knowledge. Instead, we accepted the authors' definitions and/or means of assessing knowledge and commented on their justification.

Study Characteristics

We included studies that met the following inclusion criteria: 1) English language; 2) randomized controlled trials (RCTs), cohort studies, case-control studies, and pre-post-intervention trials; 3) use of a technology-based educational tool to enhance knowledge of an evidence-based CPG; and 4) measurement of knowledge. We excluded: 1) guidelines, letters, editorials, commentaries, reports, book chapters, conference proceedings/abstracts,

lectures, and consensus development statements; 2) case reports, case series, qualitative studies, literature reviews, biomechanical and laboratory studies, and studies not reporting a methodology; and 3) educational simulation design interventions.

Information Sources

We developed our search strategy in consultation with a health sciences librarian (Appendix A). We searched MEDLINE and Embase (through Ovid Technologies Inc.) and CINAHL Plus with Full Text (through EBSCOhost) from inception to July 2018. The search strategies were first developed for MEDLINE and subsequently adapted to the other databases. The search strategy combined Medical Subject Headings (MeSH), and text words (title and abstract) related to clinical practice guidelines and technology-based education. We used EndNote X7 to create a bibliographic database.

Screening and Critical Appraisal

We used a two-phase screening process to select eligible studies. In Phase I, pairs of independent reviewers screened citation titles and abstracts to determine eligibility. Citations were classified as either relevant, irrelevant, or possibly relevant. In Phase II, the same pairs of reviewers independently screened possibly relevant articles to determine eligibility. Reviewers reached consensus through discussion.

Random pairs of reviewers independently appraised the internal validity of eligible studies using the Scottish Intercollegiate Guidelines Network (SIGN) Checklists for RCTs, cohort studies, and case-control studies and the National Institutes of Health Checklist for pre-post intervention trials [32, 33]. These checklists were used to determine the internal validity of studies and identify bias that significantly impacted the validity of the results. Reviewers used methodological judgement to weigh the preponderance of information derived from the checklists to determine if the studies should be deemed to have a low risk of bias and be included in the review [34-36]. Reviewers reached consensus through discussion.

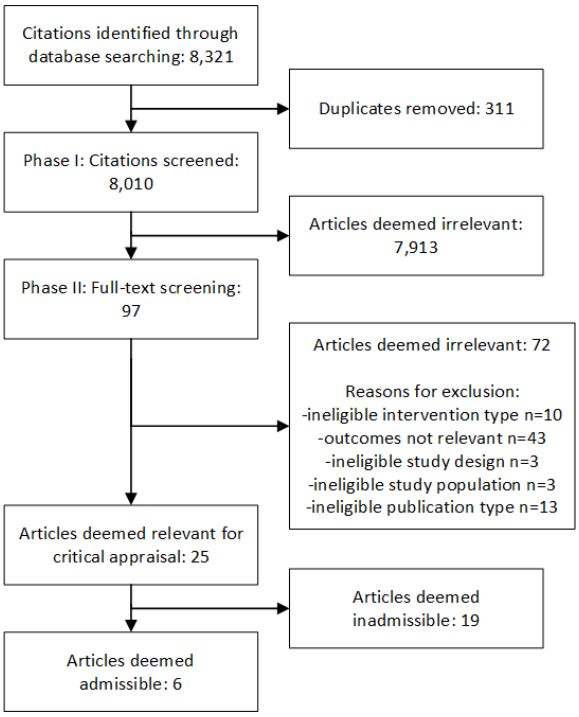
Data Extraction

The lead author extracted data from low risk of bias studies into evidence tables. A second reviewer independently verified the accuracy of the extracted data. We synthesized the evidence using best-evidence synthesis [37]. We stratified our results according to types of educational interventions. We computed the mean differences between groups and 95% confidence intervals (95% CI) to quantify the effectiveness of interventions when possible. Where this was not possible, we reported values and significance as reported in the studies. More weight was given to results of RCTs.

Results

Our search identified 8,321 articles. We removed 311 duplicates and screened 8,010 articles for eligibility (Figure 1). Phase I screening yielded 97 articles, and 25 articles were relevant following Phase II screening. Reasons for exclusion in Phase II (n=72) were: 1) ineligible intervention type (n=10); 2) outcomes not relevant (n=43); 3) ineligible study design (n=3); 4) ineligible study population (n= 3); 5) ineligible publication type (n=13).

Figure 1: Flow Chart



Study Characteristics

We critically appraised 25 articles. Of those, six had a low risk of bias and were included in our synthesis. Four low risk of bias studies were RCTs, and the remaining two were pre-post intervention trials. The studies focused on 1) primary care following myocardial infarction in resident physicians [38]; 2) detection, evaluation, and treatment of high blood cholesterol in physicians [39]; 3) hematuria, priapism (HP), staghorn calculi, infertility, and antibiotic prophylaxis (SIA) in urologists and urology residents [40, 41]; 4) healthcare-associated infections in healthcare workers (nurses, physicians, and other healthcare workers including pharmacists, paramedics, respiratory therapists, and physiotherapists) [42]; and 5) whiplash management in general practitioners [43]. The educational interventions investigated included: module-based online education (n=4) [38, 39, 42, 43]; spaced-education combined with case studies (n=1) [40]; and spaced-education combined with a game (n=1) [41]. Module-based online education is a series of online sequentially-ordered modules each focusing on a particular topic. Modules are often combined to teach larger, more complex topics to learners. Spaced-education refers to educational interventions delivered over a prolonged period. It includes "spaces" or times without intervention between learning intervals which is said to improve long-term memory [44]. The prolonged period between learning intervals is variable. No standard length of time appears to exist for this type of intervention. The length of the intervals included in this review are noted.

Risk of Bias within Studies

The low risk of bias RCTs had: 1) clear research questions; 2) adequate randomization processes; 3) baseline similarities between groups; 4) interventions as only differences between groups; 5) adequate outcome measurement tools; and 6) intention-to-treat analyses (Table 1) [38-41]. Loss to follow-up was no greater than 30% for each study [38-41]. However, concealment methods were not clearly described for three studies [39-41], blinding did not occur in one study [38] and was not clearly described for two studies [40, 41].

Two pre-post intervention studies had a low risk of bias [42, 43]. They had: 1) clear research questions; 2) clearly described eligibility criteria; 3) representative study populations; 4) adequate enrollment procedures; 5) adequate sample sizes; 6) clearly described

interventions; and 7) adequate outcome measurement tools (Table 2). Loss to follow-up was less than 20% for one study [43], and the studies did not report on blinding procedures (researcher blinding to participant allocation). All six studies justified the selection of their knowledge measurement through content expert review [38, 42, 43], pilot testing [39, 40], or a previous trial [41].

We excluded nineteen studies due to important methodological limitations; seven RCTs [45-51], and twelve pre-post intervention trials [52-63]. Limitations of the RCTs included undisclosed or inadequate: randomization (2/7) [45, 50]; concealment methods (6/7) [45-47, 49-51]; blinding methods (6/7) [46-51]; baseline differences between groups (5/7) [45, 47, 48, 50, 51]; differences between groups other than intervention (4/7) [46, 48, 50, 51]; outcome measurement tools (2/7) [47, 50]; loss to follow-up >20% (5/7) [45-47, 49, 50]; and intention-to-treat analyses (4/7) [45, 47, 48, 50]. The pre-post intervention trials had inadequate or unreported: eligibility criteria (8/12) [54, 56-60, 62, 63]; representative study populations (3/12) [53, 58, 59]; enrollment criteria (8/12) [54, 56-60, 62, 63]; sample size calculations (5/12) [54, 56, 57, 59, 63]; intervention descriptions (3/12) [55, 59, 61]; outcome measurement tools (5/12) [53, 55, 58, 59, 62]; blinding (9/12) [53-57, 59-61, 63]; loss to follow-up >20% (9/12) [52, 55-59, 61-63]; statistical analyses pre-post (1/12) [59]; and multiple outcome measurement collections (10/12) [52-59, 62, 63].

Interventions Involving Spaced-Education

Two studies aimed to improve knowledge about the management of HP and SIA from CPGs using spaced-education in combination with a game or online case studies [40, 41]. These studies provide preliminary evidence suggesting that spaced-education may be associated with improvement in knowledge of clinical practice guidelines in urologists or urology residents. However, the effectiveness of space-education is not established because it has not been compared to a different education strategy. Moreover, the length of the spacing did not appear to influence knowledge change.

An RCT randomized 1470 urologists to one of two spaced-education game intervention groups (n=735 per group) [41]. The game consisted of an automated email containing multiple-choice questions about the CPGs. The objective of the game was to remove as

many questions as possible from circulation within the 34-week period. Group A was emailed two questions every two days, and group B was emailed four questions every four days. Questions were removed from the game if answered correctly twice consecutively. Median knowledge assessment results were collected at baseline and again as a completion percentage of removed multiple-choice questions (Table 3). Although knowledge improved in both groups [Group A: 52/100 increase; Group B: 53/100 increase], the difference between groups was not statistically significant [Group A: 100/100 (IQR 3.0); Group B: 98/100 (IQR 8.0)].

The second RCT included urologists and urology residents (n=240 per group) who received spaced-education in combination with case studies focusing on one of two CPGs [40] The only difference between the two interventions was the CPG being instructed . Therefore, the results of this study cannot be used to determine differences in the effectiveness of spaced-education between groups therefore we only used within-group results. The intervention consisted of a clinical scenario and multiple-choice questions presented through three cycles. During each cycle, participants were sent three emails per week containing two scenarios per email. Cycles 1 and 2 were 4-weeks in length, and each contained 24 questions about the guideline. After a 4-week, no intervention interval, cycle 3, lasting 8 weeks, contained 24 questions about the guideline. Outcomes were collected at baseline and following each cycle (Table 4). The results suggest that both groups significantly improved their knowledge following the intervention (cycle-3) ($P<0.05$); within-group difference in means (95% CI) Group A: 29.1/100 (28.06-30.14); Group B: 24.6/100 (23.73-25.47).

Interventions Involving Module-based Online Education

Four studies aimed to improve knowledge about the management of CPGs using module-based online educational programs [38, 39, 42, 43]. Based on this review, preliminary evidence suggests online module-based education may be effective in improving knowledge about CPGs in healthcare professionals. However, may not be superior to paper-based self-learning or face-to-face workshops.

An RCT randomized resident physicians to either a module-based education program (n=83) or a printed guideline group (n=79) [38]. The module system consisted of guideline passages, links to supporting evidence, and interactive case-style studies. Participants in the control group were provided with printed guidelines for individual self-learning. Both interventions were completed in a single session lasting approximately 1.25 hours. Median knowledge assessment scores were collected at baseline, immediately following and 4-6 months following the intervention (Table 3). The results indicate participants in the intervention group scored a median of 0.5/20 higher than the control group post-intervention (F1) and 1.0/20 4-6 months following the intervention (F2). These results were not statistically significant between groups [Intervention: F1: 15.0/20 (95% CI 14.0-15.0); F2: 12.0/20 (95% CI 11.0-13.0); Control: F1: 14.5/20 (95% CI 14.0-15.0); F2: 11.0/20 (95% CI 10.0-12.0)]. Knowledge increased in both intervention groups; however, the statistical significance is unknown [Intervention F1: 5.0/20; F2: 2.0/20 increase; Control F1: 5.5/20; F2: 2.0/20 increase].

In the second RCT, physicians were randomized to either an online multi-format education group (n=52) or a live workshop (control) (n=51) [39]. The online education group consisted of multi-format didactic presentations, case studies, guideline summary, quick reference guide, and interactive discussions via live web-conferencing. This intervention lasted 2-weeks. The live workshop group received didactic lectures with question and answer sessions, interactive case discussions, guideline summary, and a quick reference guide. Participants attended 1-5 identical 1.5-2-hour workshops over a 10-day period. Mean knowledge assessment scores were collected at baseline, immediately following (F1), and 12-weeks following the intervention (F2) (Table 3). There was no statistical mean difference between groups [F1: 1.01/39 (95% CI: -0.39-2.41); F2: 0.66/39 (95% CI: -0.65-1.97)]. However, participants in both groups significantly increased their knowledge [Difference in mean test scores: Intervention: F1: 11.62/39 (95% CI 10.58-12.66); F2: 13.89/39 (95% CI: 12.86-14.92); Control: F1: 12.63/39 (95% CI: 11.70-13.59); F2: 14.55/39 (95% CI: 13.75-15.36)].

The first pre-post intervention study included 971 healthcare workers [42]. The educational intervention included guideline content, case studies with immediate feedback, and fill-in-the-blank (cloze) exercises. Median knowledge assessments were collected at baseline, immediately following-, and 3-months following the intervention. Results were stratified by health profession. The results indicated that each group significantly increased their knowledge immediately post- (F1) as well as 3-months following the intervention (F2) ($P<0.05$). [Nurses: F1: 26/100; F2: 22/100 increase; physicians: F1: 24/100; F2: 15/100 increase; other healthcare workers: F1: 24/100; F2: 22/100 increase].

The second pre-post intervention study included 233 general practitioners [43]. The educational intervention consisted of written content, interactive case studies, key messages, and external links. Mean knowledge assessment scores were collected at baseline and immediately following the intervention (Table 4). The results indicated a statistically significant mean difference following the intervention [1.8/9 (95% CI: 1.65-1.95)].

Discussion

Summary of Evidence

Our systematic review examined the best evidence on the effectiveness of technology-based learning tools designed to improve knowledge of evidence-based CPGs by healthcare professionals. We found preliminary evidence suggesting that spaced-education is associated with improved knowledge of clinical practice guidelines in urologists and urology residents[40, 41]. However, its effectiveness remains unknown because it has not been compared to a control intervention. While those who participated in spaced-education in combination with a game or case studies did demonstrate an improvement in knowledge, the length of the spacing did not appear to influence this outcome. Finally, we found preliminary evidence from two RCTs and preliminary evidence from two pre-post intervention trials suggesting that interventions involving online module-based education may be effective in improving knowledge about CPGs in physicians and resident physicians [38, 39, 42, 43]. Results from the two RCTs suggests that module-based educational

interventions may not be superior to paper-based self-learning [38] or in-person workshops [39].

Results in Comparison to Previous Reviews

Our results are similar to the previous review which aimed to identify perceived usability and practice behaviour change following technology-based interventions disseminating CPGs [27]. Three of the four RCTs captured in our present review were also captured within the previous review [38-40]. Knowledge was one of 12 domains measured in influencing behaviour change within this review. Results of the knowledge domain were similar for all studies between reviews. They also categorized studies by intervention-type; however, our categories differed.

Strengths

Our review has strengths. We implemented a rigorous search strategy that was developed with the assistance of an experienced health sciences librarian to help minimize errors. We defined clear inclusion/exclusion criteria for the selection studies a priori. All independent reviewers were trained to screen and critically appraise to minimize error and bias. We used the SIGN checklist and the NIH pre-post checklist to standardize the critical appraisal process and to help inform the reviewers in their scientific judgment. Last, our conclusions were based on best-evidence synthesis, eliminating studies of low quality to minimize the risk of bias.

Limitations

Our review has limitations. We limited our search to studies published in the English language, which may have excluded some relevant studies; however, this is an unlikely source of bias [64-68]. In addition, the critical appraisal process involves scientific judgment which may vary between reviewers. However, this methodology is widely used in systematic reviews and was minimized by training reviewers on the use of the standardized critical appraisal tools [34, 69, 70]. Our review is limited to the quality of the outcome measurements used in the low risk of bias studies. Specifically, misclassification of the outcomes may have led to biased results in studies of spaced-education and module-based

education [38-43]. Finally, the heterogeneity between the studies, such as differences in health professions, CPGs, and intervention types may have had an impact on the results.

Conclusions

Our review examined the effectiveness of technology-based learning tools to improve knowledge of practicing healthcare professionals about CPGs. The evidence on the effectiveness of technology-based learning tools used to enhance knowledge about CPGs is limited. As most of the current literature is preliminary, future high-quality research is required to review these interventions appropriately and to better understand their effectiveness. Our review provides insight regarding types of technology-based educational interventions that warrant further study and that should be considered when designing knowledge translation strategies. More research is needed to determine which technology-based educational interventions are effective in promoting behavioural changes in healthcare professionals.

Table 1: Risk of Bias for Scientifically Admissible Randomized Controlled Trials Based on the Scottish Intercollegiate Guideline Network Criteria

Author (Year)	Research question clearly described	Adequate Random-ization method	Adequate Conceal-ment method	Are subjects Blinded?	Are groups similar at baseline?	Only diff. between groups is intervention	Outcomes measure-ment(s) standard, valid & reliable	Was loss to follow-up ≤20%?	Intention to treat used?	Compar-able results between sites
Bell D.S., et al. (2000)[33]	Y	Y	Y	N	Y	Y	Y	Y	Y	NA
Fordis M. et al. (2005)[34]	Y	Y	CS	Y	Y	Y	Y	Y	Y	NA
Kerfoot B., et al. (2009)[35]	Y	Y	CS	CS	Y	Y	Y	N	Y	NA
Kerfoot B., et al. (2012)[36]	Y	Y	CS	CS	Y	Y	Y	N	Y	NA

Y: yes; N: no; CS: can't say; NA: not applicable

Table 2: Risk of Bias Assessment for Scientifically Admissible Pre-/Post-intervention Trials Based on the NIH Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group Criteria

Author (Year)	Research question clearly described	Eligibility/Selection Criteria Clearly Described	Representative study population	Were all eligible participants Enrolled?	Adequate sample size for confidence in results	Adequate intervention description
Labeau S., et al. (2016)[37]	Y	Y	Y	Y	Y	Y
Rebbeck T., et al. (2013)[38]	Y	Y	Y	Y	Y	Y
Author (Year) Cont'd	**Outcomes measurement(s) standard, valid & reliable?**	**Are researchers blinded?**	**Was loss to follow-up ≤20%?**	**Stat. analyses performed pre/post?**	**Outcome measure collection**	**Stat. Analysis at group-level**
Labeau S., et al. (2016)[37]	Y	NR	N	Y	Y	Y
Rebbeck T., et al. (2013)[38]	Y	NR	Y	Y	Y	NA

Y: yes; NR: not reported; NA: not applicable

Table 3: Evidence Table for Accepted Randomized Controlled Trials on Technology-based Learning Tools Designed to Change Knowledge of Clinical Practice Guidelines for Healthcare Professionals

Author (year)	Study Design	Type of Educational Intervention	Population	Topic of CPG	Data Collection Times	Results
Bell D.S. et al. (2000)[33]	RCT Intervention: n=83; Control n=79	*Intervention involving module-based online education* Intervention: web-based tutorial system. Focused on components of the guidelines they answered incorrectly in baseline testing. Included guideline passages, links to supporting evidence, narrative description of evidence, interactive graphic presentations (case studies).	162 resident physicians in family and internal medicine	Primary care of patients following myocardial infarction.	Baseline, immediately post-intervention (following ~1.25 hour intervention) (F1), and 4-6 month follow-up (F2)	Highest knowledge assessment score is 20. Median (95% CI): **Intervention:** Baseline: 10.0 (9.0-11.0); F1: 15.0 (14.0-15.0); F2: 12.0 (11.0-13.0) **Control:**

		Control: printed guidelines for self-learning. Included printed guidelines for review and printed narrative descriptions of evidence. Both interventions completed in a single session lasting 1.25 hours.				Baseline: 9.0 (9.0-10.0); F1: 14.5 (14.0-15.0); F2: 11.0 (10.0-12.0)
Fordis M. et al. (2005)[34]	RCT Intervention: n= 52; Control n= 51	*Intervention involving module-based online education* Intervention: Online education. Included online multi-format didactic presentations (able to view more than one time), interactive cases studies,	103 physicians	Detection, evaluation, and treatment of high blood cholesterol in adults	Baseline, immediately post-intervention (following 2-week intervention) (F1) and 12-week follow-up (F2)	Highest knowledge assessment score is 39. Mean (SD)[1]: **Intervention:** Baseline: 17.7 (6.25); F1: 29.32

		enabling tools (guideline summary, quick desk reference), and an option to send questions to faculty by email. Participated online during a 2-week period. Control: In-person workshop. Included live didactic presentations with question and answer session and discussion, interactive case discussions with faculty, guideline summary. Attended 1-5 identical 1.5-2-hour small-group workshops over a 10-day period.				(5.76); F2: 31.59 (4.53) **Control:** Baseline: 15.29 (3.88); F1: 27.92 (5.55); F2: 29.84 (4.88) **Mean difference between groups** (95% CI): F1: 1.01 (-0.39-2.41); F2: 0.66 (-0.65-1.97) **Mean difference within groups:** **Intervention:** F1: 11.62 (SD

		Both groups were provided access to faculty following the interventions and an online 45-min live web-conference with real-time interactivity (Q&A session)				3.83) (95% CI 10.58-12.66 ; F2: 13.89 (SD3.78) 95% CI 12.86-14.92 **Control:**F1: 12.63 (SD 3.38) 95% CI 11.70-13.59; F2: 14.55 (SD2.93) 95% CI 13.75-15.36
Kerfoot B., et al. (2009)[35]	RCT A: n= 80 urologists and 160 residents; B: n= 80 urologists	*Spaced-education in combination with online case study* Cohort A: H-P CPGs throughout cycles and 24 control items on the SIA CPGs in cycle 3. Including multiple-choice question	480 urologists and urology residents (160 urologists and 320 residents)	A: HP: hematuria and priapism, B: SIA: staghorn calculi, infertility, and antibiotic prophylaxis	Baseline, Cycle 1 (4-week intervention), Cycle 2 (4-week intervention), and Cycle 3 (8-week intervention).	Highest knowledge assessment score is 100% Mean (SD)[1]: **A:** baseline 46.6% (10.6); cycle 1: 44.9%

	and 160 residents	based on a clinical scenario and an educational component (correct answer, explanation of incorrect answers, and take-home message) Cohort B: SIA CPGs throughout cycles and 24 control items on H-P CPGs in cycle 3. Including multiple-choice question based on a clinical scenario and an educational component (correct answer, explanation of incorrect answers, and take-home message)				(14.9); cycle 2: 74.0% (15.0); cycle 3: 75.7% (13.7) **B:** baseline 44.9% (10.0); cycle 1: 45.2% (12.9); cycle 2: 65.5% (14.6); cycle 3: 69.5% (11.4) Mean difference within groups (95% CI): **Group A:** F1: 1.7 (SD 9.04) (0.56-2.84); F2: 27.4 (SD9.12)

		Both groups received 3-cycle ISE course over 20 weeks.				(26.25-28.56); F3: 29.1 (SD 8.23) (28.06-30.14) **Group B:** F1: 0.3 (SD 7.75) (-0.68-1.28); F2: 20.6 (SD8.92) (19.47-21.73); F3: 24.6 (SD 6.90) (23.73-25.47)
Kerfoot B., et al. (2012)[36]	RCT A: n= 735; B: n= 735	*Spaced-education in combination with a game* A: sent 2 multiple-choice questions via email every 2 days	1470 international urologists	Hematuria, priapism, staghorn calculi, infertility, and antibiotic prophylaxis	Baseline scores (percentage of correct answers to first-time presentation of questions) and completion scores	Highest knowledge assessment score is 100% Median (IQR): **A:** Baseline: 48% (18.0);

		B: sent 4 multiple-choice questions via email every 4 days Participants received an email with a hyperlink linking to a web-page where participants answered the multiple-choice questions. Both groups participated over a 34-week period.			Completion scores calculated as percentage of questions answered correctly twice in a row separated by a 24-day period	completion: 100% (3.0) **B:** Baseline: 45% (15.0); completion: 98% (8.0)

[1]Additional information received from authors

Table 4: Evidence Table for Accepted Pre-/Post-intervention trials on Technology-based Learning Tools Designed to Change Knowledge of Clinical Practice Guidelines for Healthcare Professionals

Author (year)	Study Design	Type of Educational Intervention	Population	Topic of CPG	Data Collection Times	Results
Labeau S., et al. (2016)[37]	Single-group pretest/post test	*Intervention involving module-based online education* Module included learning content (text), case studies with immediate feedback, cloze exercises, multiple-choice knowledge tests	2472 healthcare workers (nurses n= 1865; physicians n= 309 ; other HCW n=298)	Healthcare-associated infections	Baseline, immediate posttest (8-week intervention), and 3-months following intervention	Highest knowledge assessment score is 50 points (100%). Median % (IQR) **Nurses:** Pretest: 54% (46-62); Posttest: 80% (68-88); F2: 76% (64-84) **Physicians:** pretest: 60% (54-66); posttest:

						84% (74-92); f2: 75% (68-80) **Other:** Pretest: 54% (46-64); post: 78% (66-88); F2: 76% (66-84)
Rebbeck T., et al. (2013)[38]	Single-group pretest/post test	*Intervention involving module-based online education* Included learning content (text), interactive case studies, key messages, links to content in guidelines	233 general practitioners	Whiplash	Baseline and immediate posttest (length of intervention not reported)	Highest knowledge assessment score is 9. Mean (SD): Baseline: 5.1 (1.8); Posttest: 6.9 (1.0)

						Mean difference: 1.8 (95% CI: 1.65-1.95)

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Chapter Three The Development and Evaluation of a Technology-based Learning Tool Designed to Improve Knowledge about the Evidence-based Clinical Management of Neck Pain by Teaching Faculty at the Canadian Memorial Chiropractic College

Abstract

Background

Over 4 million Canadians access chiropractic care every year. Musculoskeletal conditions, such as back and neck pain, are the primary reasons for accessing chiropractic care. In Canada, there are two accredited chiropractic educational programs. These programs aim to educate the next generation of the chiropractic profession using evidence-based practice. Maintaining high-quality education, emphasizing the use of evidence-based practice, is essential for a future of competent chiropractic graduates. Educating chiropractic teaching and clinical faculty may help to ensure chiropractic students are educated using evidence-based practice guidelines throughout their clinical training.

Objective

Our study aimed to evaluate the learning, design, and engagement constructs of a technology-based learning tool designed to improve knowledge about the evidence-based management of neck pain in teaching and clinical faculty at CMCC.

Methods

We conducted a cross-sectional survey and evaluated the learning, design, and engagement constructs of a module-based, asynchronous learning tool in a sample of teaching and clinical faculty (including residents) at CMCC. The development of the learning tool was informed by a Knowledge User Advisory Committee, a review of the literature, and pedagogical theories and principles common to online learning. Data collection took place between February and May 2018. Participants were asked to evaluate the three constructs of the learning tool and provide suggestions for improvement. A median evaluation score was calculated for each item of the evaluation questionnaire. A median score less than 4 was suggestive of a component of the learning tool requiring further development. We also conducted a content analysis of participant written suggestions, cross-referencing them with pedagogical themes derived *a priori* in order to inform recommendations for further development of the tool.

Results

Sixteen participants completed this evaluation study (12.6%). Seventy-five percent of participants were male, and 56% were between the ages of 25 and 44 years. Most (68.8%) were chiropractors and half reported having previous experience with technology-based learning tools. At least 75% of participants agreed with each of the thirteen items in the LOES-S questionnaire. Median scores of 4.0 were determined for each construct of the learning tool. The suggestions for improvements from participants were used to inform three recommendations for the future development of the learning tool.

Conclusions

Overall, the results of this study indicate that the chiropractic teaching and clinical faculty generally agreed with the learning, design and engagement constructs of the learning tool designed to improve knowledge of a clinical practice guideline. Further development of the learning tool is recommended in order to increase educational engagement for this population.

Background

Over 4 million Canadians access chiropractic care each year [1]. Musculoskeletal conditions, such as back and neck pain, are the primary reasons for accessing chiropractic care [2]. However, the use of evidence-based clinical practice guidelines is suboptimal in many healthcare professions including chiropractic [3-5]. There is a need to increase the knowledge and use of evidence-based clinical practice guidelines for the management of these conditions in clinical care [6, 7].

Evidence-based practice aims to increase the adoption of evidence-based interventions and limit the use of ineffective or potentially harmful interventions to patients [8]. The use of evidence-based practice is said to have an improvement on quality of care, reduction of healthcare expenditures, as well as increase patient safety [9, 10]. Clinical practice guidelines are a method of informing evidence-based care.

In Canada, there are two accredited chiropractic educational programs. Together, these institutions aim to train the next generation of the chiropractic profession using evidence-based practice [11, 12]. The literature suggests that students' classroom experiences are directly related to their use of evidence-based practice throughout their chiropractic careers [9, 13, 14]. Maintaining high-quality education, emphasizing the use of evidence-based practice, is essential for a future of competent chiropractic graduates [9]. Technology-based tools provide a convenient method for accessing and distributing clinical practice guidelines while allowing for review and updates in accordance with emerging evidence [10, 15, 16]. Educating chiropractic teaching and clinical faculty may help to ensure chiropractic students are educated using evidence-based practice guidelines throughout their clinical training.

We developed and evaluated a technology-based learning tool using an iKT approach. The tool was developed with the aim to improve knowledge of the evidence-based management of neck pain in chiropractic teaching and clinical faculty at the Canadian Memorial Chiropractic College (CMCC). We aimed to understand which pedagogical properties of the learning tool faculty agreed with and which required further development.

Methods

Study Design

We conducted a cross-sectional study to evaluate the learning, design, and engagement constructs of the technology-based learning tool in a sample of teaching and clinical faculty at CMCC from February 1st to May 31st, 2018. The aim of the learning tool was to improve knowledge of the clinical management of recent-onset neck pain based on a recent evidence-based clinical practice guideline [17]. The guideline provides a resource for managing neck pain (grades I-III) by providing various recommendations for care. This guideline was chosen for two reasons: 1) neck pain is one of the main reasons to consult chiropractors; and 2) the guideline was developed using a rigorous methodology.

This study was approved by the University of Ontario Institute of Technology Research Ethics Board on January 9, 2018 (REB#14677) and by the Canadian Memorial Chiropractic College Research Ethics Board on January 29, 2018 (REB#182001).

Study Population

Participants were recruited from the teaching and clinical faculty employed by CMCC between February 1st and May 31st, 2018 (N=127). Individuals who were eligible included: 1) all faculty, including clinicians and teaching assistants/residents who were employed at CMCC between February 1st and May 31st, 2018 regardless of teaching focus; and 2) those who were able to give written informed consent in English. Members of the Knowledge User Advisory Committee were not eligible to participate. The inclusion/exclusion questionnaire, created using Google Forms and administered online prior to gaining access to the study, is provided in Appendix B.

Initial Recruitment and Study Sample

We recruited a convenience sample using three strategies: 1) emails sent by department leaders; 2) an online posting on the CMCC learning management system platform, KIRO; and 3) face-to-face interactions. Recruitment emails were sent from the department leads to teaching and clinical faculty, clinicians, and teaching assistants/residents. The recruitment emails included an information letter outlining the details of the study and

information regarding participation. Department leads were asked to forward these emails to their respective groups of individuals that report to them. We involved department leads in the recruitment process to maintaining the privacy of potential participants. As they are highly recognized within the CMCC community, we also involved them in the study to try to encourage a greater number of study participants.

An invitation to participate was posted on KIRO. KIRO is the learning management system at CMCC. It acts as the main resource for students and faculty to access course materials and grades. The KIRO system also includes a page from the Office of Research Administration to track, report, and deliver information about upcoming research and resources to faculty and staff. The invitation to participate included an information letter as well as a direct link to the study, contact information, and ethics details.

We also actively recruited participants through face-to-face interactions. Members of the research team met with each target group to promote the study and answer any questions regarding participation. We provided eligible participants with a recruitment package, which included an information letter and a card that listed the study URL and contact information. Clinicians were actively recruited in early March. Teaching assistants/residents were actively recruited at the end of March 2018. We recruited them by presenting the study at a weekly meeting. All residents were in attendance during this meeting. At the end of April 2018, a member of the research team reminded the teaching assistants/residents of the study. General teaching and clinical faculty were actively recruited first at the beginning of April 2018, where we met with them in their classrooms and offices to present the study and ask for their consideration in participation.

Secondary Recruitment

Due to a low participation rate midway through the data collection period, the length of the intervention was shortened from six-modules to one. These changes are described further. The updated intervention was launched on April 27, 2018. Teaching and clinical faculty were actively recruited again at the beginning of May 2018 to inform them of the changes in the hope to increase participation rates. Recruitment materials are provided in Appendix

C. Participants interested in participating were required to complete an online informed consent form (Appendix D).

Learning Tool Development

We used four strategies to develop the learning tool. First, using an integrated knowledge translation approach, we designed the tool in collaboration with the Knowledge Users Advisory Committee (Advisory Committee). The Advisory Committee included nine members from a variety of healthcare (chiropractors, chiropractic resident, medical doctor), education (CMCC department administrators, Ph.D. student in knowledge translation), and Information Technology (IT) (IT specialist) backgrounds. They provided feedback on the design of the learning tool via face-to-face interactions as well as electronically through surveys (SurveyMonkey). A description of the Advisory Committee's roles and responsibilities, as well as all discussion summaries, are provided in Appendix E.

Second, the design of the learning tool was informed by a systematic review of the literature (Chapter 2). The review provided evidence toward the effectiveness for learning tool designs aiming to improve knowledge of clinical practice guidelines for practicing healthcare professionals. Based on the best available evidence, and input from the Advisory Committee, it was decided that the structure of the learning tool would resemble an online module-based design. Elements of the module design were considered, however, the included studies provided limited descriptions or design evaluations.

Third, pedagogical theories and principles were used to inform the design of the learning tool. The choice of which theories and principles to use was based on feedback from the Advisory Committee and the systematic review. We focused on theories and principles relevant to educational motivation (internal and external factors influencing participation in learning [18, 19]). We focused on this concept because it was a recurring issue discussed by the Advisory Committee and an important issue identified from the literature for a variety of healthcare professions [16, 20-22]. A summary of the pedagogical theories and principles incorporated into the learning tool is provided in Appendix F.

Finally, a CMCC Investigator Committee, comprised of CMCC staff and faculty in administrative roles, was established to inform the design and facilitate the conduct of the study at CMCC. The composition of the Investigator Committee, their role, and summary of the meeting discussions are provided in Appendix G.

Self-study

The learning tool, designed using Wix.com, aimed to translate information from an evidence-based clinical practice guideline on the management of recent-onset neck pain into a series of interactive, asynchronous learning modules.

The learning tool included six short modules (each is three web-pages in length), focusing on a major component of the treatment of recent-onset neck pain. The first page of each module outlined the learning outcomes. The second page provided the learners with necessary instructions for completing the module, the learning content, links to external resources, where appropriate, and highlights, including main "take-home" messages from the module. The last page included a short assessment of knowledge using multiple choice quizzes with feedback for each question. The assessments were for educational purposes only; no data was collected from these assessments. The last section of the tool was a series of three case studies. Each case study provided background information on a patient as well as their neck pain complaints. Embedded within the case study, was a multiple-choice quiz for learners to complete and apply the newly gained knowledge to treat the patient with neck pain.

The learning tool length was adjusted from six content modules to one during the data collection period on April 27, 2018. The learning tool was amended due to low participation, participant feedback, and expert opinion. During the recruitment of the study, teaching faculty expressed that they had begun participating in the study; however, they had minimal time to spare and completing the learning tool was taking too long. Following several similar participant interactions, we consulted methodological and education experts to ensure that the amendment would not affect the design of the study. This amendment aimed to minimize the burden on participants as the length of time needed to complete the

study was reduced from 30 minutes to approximately 10 minutes. The three case studies which followed the content modules were also reduced from three cases to one. An outline of the modules before and after the change is available in Appendix H.

Data Collection

Participants completed a questionnaire to collect demographic and professional information (Appendix I): 1) sociodemographic characteristics (age and gender); 2) years of experience in the chiropractic profession; 3) years of experience in a chiropractic teaching role; 4) number of hours worked per week at CMCC; 5) department or division; 6) familiarity with the neck pain guideline by the OPTIMa Collaboration (using a 5-point numeric rating scale (NRS)); 7) experience with technology-based learning tools; and 8) self-rated proficiency with computers. Following completion of the demographic questionnaire, participants were instructed to progress through the learning tool at their own pace.

Following completion of self-learning, participants were prompted to complete the Learning Object Evaluation Scale for Students (LOES-S) where they were asked to evaluate three main constructs: learning, design, and engagement through a series of 13 items. The three constructs and coinciding 13 items were developed in accordance with the literature [23]. This evaluation tool was chosen for this study because of its focus on the student-centred constructs of learning within the tool rather than an evaluation of knowledge. To our knowledge, there are no other valid and reliable evaluation tools that provide this type of feedback. Most learning tool evaluations focus on the development and design of the learning tool and miss the impact the learning tool has on the learner [23]. This perspective is particularly important as it has a direct relationship to knowledge gained through the use of the tool [23].

The LOES-S is an evaluation tool designed for students to rate the impact of a technology-based learning tool on their learning experience [23]. The psychometric properties of the tool were measured in two previous studies [23, 24]. The first, in middle and secondary school students (10-22 years old) for any subject appropriate for their respective curriculums [24],

and the second, in middle and secondary school students (11-17 years old) for math and science [23]. The tool was found to have acceptable internal reliability, construct validity, convergent validity, and predictive validity [23, 24].

We modified the language of the LOES-S to the target population of this study. Specifically, we changed the original term "learning object" to "learning tool". This was made to limit any confusion by users because the term "learning object" is not widely used in this population. We also added one open-ended statement, using a suggestion-box format, following the questionnaire's 13 items which read: "Please provide any suggestions you may have to improve this technology-based learning tool". This was included in order to engage participants in further evaluation of the learning tool. The adapted LOES-S questionnaire is provided in Appendix J.

Finally, we tracked participation trends in order to determine which recruitment interventions were most successful for this population. We grouped the number of participants for each week of data collection (n=18). Recruitment strategies were also logged for each week of data collection. Week-by-week trends were compared to determine which recruitment trends coincided with increases in participation. These data were used to inform recommendations for future recruitment strategies for this population.

Analysis

We computed descriptive frequency statistics to describe the sample and their evaluations. The analysis was conducted using SPSS Statistics Version 24 (IBM Corp., 2016).

We assumed participants would evaluate the learning, design, and engagement constructs of the learning tool as "agree". An agreeable evaluation was a score of 4 or 5, Agree or Strongly Agree respectively, on the 5-point Likert scale. A disagreeable evaluation was a score of 1 or 2, Strongly Disagree or Disagree respectively. A score of 3 was classified as a neutral evaluation. We calculated the median evaluation scores and interquartile ranges (IQR) for each of the items 1 through 13 due to the non-normal distribution of the data.

We performed a content analysis of the suggestions provided by participants. Comments were removed of any identifying information and separated into individual comments (if participants provided more than one distinct suggestion). Three reviewers independently completed a content analysis worksheet where they were asked to match comments provided by the participants to the most relevant pedagogical theme from a list provided. Reviewers completed a discussion-based consensus. Results were stratified by recurring pedagogical themes used as references throughout the development phase of the learning tool. The content analysis framework used is outlined in Appendix K.

We used the evaluations from the LOES-S questionnaire as well as the open-ended feedback to develop general recommendations for the further development of the learning tool for this population.

Results

Twenty-eight teaching and clinical faculty participated (28/127, 22%). Four participants completed either the demographic questionnaire or the evaluation questionnaire more than once. This may have occurred if participants did not complete the study in one sitting because they would be prompted back to the beginning if they did not note the URL they previously stopped at. The first complete entry only (both questionnaires) of each of these participants was included in the analysis. Sixteen participants completed the entirety of the study (12/28, 43% failed to complete the survey).

Sample Characteristics

Most participants who completed the study (demographic questionnaire and evaluation questionnaire, n=16) were males (n=12, 75%) between the ages of 25-44 years (n=9, 56.3%) (Table 5). A majority (n=11, 68.8%) of participants disclosed that their highest level of education was a Doctor of Chiropractic degree (DC). Most (n=10, 62.5%) participants disclosed no previous experience with clinical practice guideline development. Most (n=14, 87.5%) participants self-identified as being proficient with computers, and half of the participants reported previous experience with technology-based learning tools (n=8, 50%). Participants' mean rating of their working knowledge of the neck pain guideline by the OPTIMa Collaboration was 3.8/5. Most participants (n=12, 75.0%)

identified as having 1-10 years of experience in a chiropractic teaching role and most taught more than 10 hours per week (n=11, 68.8%) (Table 5).

Twelve participants completed the demographic questionnaire only (Table 5). Those participants were male (n=12, 100%), and half were between the ages of 25-44 years (n=6, 50%). Most of these participants also disclosed their highest level of education to be a DC degree (n=9, 75%). No participants in this group identified as having previous experience with clinical practice guideline development. Most (n=11, 91.7%) participants self-identified as being proficient with computers, and 66.7% (n=8) reported having had no previous experience with technology-based learning tools. When asked to rate their working knowledge of the neck pain guideline, the mean rating of participants was 3.2/5. Finally, half (n=6, 50%) reported 1-10 year experience in a chiropractic teaching role and 58.3% (n=7) reported dedicating more than 10 hours per week to this role.

Table 5: Demographic Characteristics

Characteristic	**Completed Demographic Survey Only (n=12)**	**Completed Evaluation Surveys (n=16)**	**Total Eligible Population (N=127)**
	n (%)	n (%)	n (%)
Age			
25-44	6 (50%)	9 (56.3%)	Mean 46 (SD 10.07); Min 26, Max 77
45-74	6 (50%)	7 (43.8%)	
Sex			
Male	12 (100%)	12 (75%)	73 (57%)
Degrees			
DC	9 (75%)	11 (68.8%)	80 (63%)
Other (MD, PhD, Master's Degree, other)	3 (25%)	5 (31.3%)	47 (37%)
Previous experience with clinical practice guidelines development			
No	12 (100%)	10 (62.5%)	--
Previous experience with Technology-based Learning Tools			
No	8 (66.7%)	8 (50%)	--
Proficiency with computers			
Yes	11 (91.7%)	14 (87.5%)	--
Rating of knowledge of OPTIMa neck pain guideline			

Mean (SD) NRS 1-5 rating	3.2 (0.937)	3.8 (0.931)	--
Years of experience in a chiropractic teaching role			
1-10 years	6 (50%)	12 (75%)	--
More than 10 years	6 (50%)	4 (25%)	--
Hours per week dedicated to teaching role			
1-10 hours	5 (41.7%)	5 (31.3%)	--
More than 10 hours	7 (58.3%)	11 68.8%)	--

-- No data available

Evaluation of Learning Tool

Sixteen participants completed the LOES-S questionnaire (Table 6). We categorized the evaluations of the three constructs as either agree, neutral, or disagree. At least 75% of participants agreed with each item in the questionnaire. Median scores less than four determined a need for improvement.

Learning Construct

The learning construct consists of five items (e.g. working with the tool helped me learn, the feedback from the tool helped me learn). All items within this construct had a median score of 4.0 (categorized as an agreeable evaluation on the 5-point Likert scale). One participant disagreed with item #4: "the tool helped teach me a new concept" and three participants scored this item as neutral. Three participants also scored item #3: "the graphics and animations from the tool helped me learn" as neutral.

Design Construct

The design construct consists of four items (e.g. the help features in the tool were useful, the instructions in the tool were easy to follow). All items within this construct had a median score of 4.0 (categorized as an agreeable evaluation on the 5-point Likert scale). One participant disagreed with items #7: "the instructions in the tool were easy to follow"; #8: "the tool was easy to use"; and #9: "the tool was well organized". Four participants scored item #6: "the help features in the tool were useful" as neutral, and three participants scored item #7 as neutral.

Engagement Construct

Last, the engagement construct consists of four questions (e.g. I like the overall theme of the tool, I found the tool engaging). All items within this construct had a median score of 4.0 (categorized as an agreeable evaluation on the 5-point Likert scale). One participant disagreed with items #10: "I like the overall theme of the tool" and #13: "I would like to use the tool again". Three participants scored item #12: "The tool made learning fun" as neutral, and two participants score item #13 as neutral.

Table 6: Learning Object Evaluation Scale – For Students Results

LOES-S Items (n=16)	Agree[1] n (%)	Neutral[2] n (%)	Disagree[3] n (%)	Median[4] (IQR)
Learning				
1. Working with the tool helped me learn	16 (100%)	0 (0%)	0 (0%)	4 (1)
2. The feedback from the tool helped me learn	15 (93.8%)	1 (6.3%)	0 (0%)	4 (0)
3. The graphics and animations from the tool helped me learn	13 (81.3%)	3 (18.7%)	0 (0%)	4 (1)
4. The tool helped teach me a new concept	12 (75%)	3 (18.7%)	1 (6.3%)	4 (2)
5. Overall, the tool helped me learn	16 (100%)	0 (0%)	0 (0%)	4 (1)
Design				
6. The help features in the tool were useful	12 (75%)	4 (25%)	0 (0%)	4 (1)
7. The instructions in the tool were easy to follow	12 (75%)	3 (18.7%)	1 (6.3%)	4 (1)
8. The tool was easy to use	15 (93.8%)	0 (0%)	1 (6.3%)	4 (0)
9. The tool was well organized	14 (87.5%)	1 (6.3%)	1 (6.3%)	4 (1)
Engagement				
10. I like the overall theme of the tool	15 (93.8%)	0 (0%)	1 (6.3%)	4 (1)
11. I found the tool engaging	15 (93.8%)	1 (6.3%)	0 (0%)	4 (0)
12. The tool made learning fun	13 (81.3%)	3 (18.7%)	0 (0%)	4 (0)
13. I would like to use the tool again	13 (81.3%)	2 (12.5%)	1 (6.3%)	4 (0)

[1]Evaluation of 4 or 5 (Agree or Strongly Agree) was classified as "Agree"
[2]Evaluation of 3 (Neutral) was classified as "Neutral"
[3]Evaluation of 1 or 2 (Disagree or Strongly Disagree) was classified as "Disagree"
[4]Overall median score less than 4.0 on a 5-point Likert scale (min score of 1, max score of 5) determined a need for improvement

Feedback from Participants

Following the completion of the LOES-S, participants were asked to provide suggestions to improve the learning tool. Twenty-three comments were submitted by the 16 participants who completed the study. Comments were removed from the content analysis for the following reasons: 1) six comments indicated no suggestions (ex. no comment or n/a); 2) one comment related to enjoying the tool, however, provided no suggestions for improvements; 3) one comment pertained to difficulty experiencing clicking on a button within the tool; 4) one comment pertained to the demographic questionnaire; and 5) one comment was from a participant who participated more than one time (only their first comment was included in the analysis to limit information bias). Thirteen comments remained and were included in the content analysis.

Comments were cleaned to remove identifying information. Similar comments were grouped to create eight distinct comments prior to analysis. Three reviewers independently completed the content analysis worksheet followed by a discussion-based consensus. Three pedagogical themes were identified (Table 7).

Table 7: Suggestions from participants (open-ended question following LOES-S)

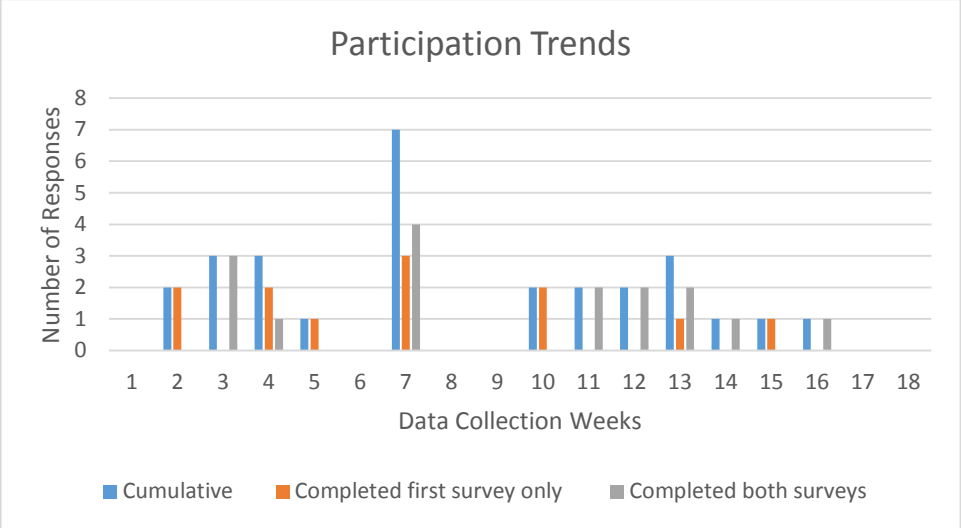
Please provide any suggestions you may have to improve this technology-based learning tool		
Comments/Suggestions	**Count**	**Pedagogical Theme**
The "next" button leading to the next quiz question was not located in an intuitive location on the screen	3	Learner Control
Missing home/menu page (layout, flow of content, accessibility)	3	Learner Control
There could have been more graphics	2	Multimedia
Include more contrasting colours	1	Multimedia
Videos would be more engaging than reading	1	Multimedia
The quiz questions were a bit easy	1	Thinking Skills
I found the single-answer questions misleading	1	Thinking Skills
There could have been a more exciting case	1	Thinking Skills

Participation Trends

In order to determine the reasons for low participation, we compared our recruitment strategy and the trends in participation week-by-week (Figure 2). Increases in participation were compared to the recruitment activities occurring throughout each week of collection.

The largest increase in participation occurred throughout week 7. During this week, recruitment strategies included a second wave of emails sent to teaching and clinical faculty from the department leads. This week also included personal interaction in the clinic targeting clinicians. Week 13 included the date wherein the intervention was shortened. However, no further increases in participation occurred following this date.

Figure 2: Participation Trends throughout Data Collection Weeks



Discussion

Overall, evaluations demonstrated that participants agreed with the learning, design, and engagement constructs of the tool. The open-ended feedback demonstrates three components of the tool could benefit from further development. These open-ended evaluations are supported by three pedagogical themes including learner control, multimedia and thinking skills.

Our sample consisted of approximately 13% of the eligible population. A census of CMCC teaching and clinical faculty during the 2017-2018 academic year suggests that more employees were male (57%), the average age was 46 years and a majority (63%) reported their highest level of education to be a DC degree (Faculty Demographics provided by CMCC – August 2018). Though the demographic characteristics of these census data were limited, the presented characteristics seem to be similar to those who participated in this study.

Further, the comparison between weekly participation rates and weekly recruitment strategies indicates that face-to-face, personal interaction may be the most appropriate recruitment strategy for this population. Our results demonstrated an increase in participation when face-to-face strategies were implemented. Although this is not an in-depth investigation of recruitment strategies for this population, we recommend considering this strategy for future studies with a chiropractic education population.

Strengths and Limitations

A strength of our study is the integrated knowledge translation approach used to develop the tool [25]. The design of the learning tool was informed by three sources: 1) a Knowledge User Advisory Committee; 2) a systematic review of the literature; and 3) pedagogical theories and learning principles. This methodology ensured the intervention was designed based on informed sources and thorough evaluation. This methodology is also designed to increase the uptake and impact of research findings by knowledge users beyond the scientific scope of the study [25].

This study had limitations. The Learning Object Evaluation Scale for Students (LOES-S) is a valid and reliable tool for use in the middle- and high school environments; however, we do not know its psychometric properties for use in this healthcare provider/educator population. Although this is a limitation, there are limited evaluation tools specifically designed to evaluate technology-based learning tools that focused on the impact on learners compared to solely evaluating an outcome of the educational intervention [23]. Previous studies suggest that this tool is valid and reliable [23, 24]. The simplicity and intuitiveness of the language of the evaluation tool as well as the Likert scale-style of the tool provide some confidence in its use for a more educated population such as the chiropractic teaching and clinical faculty. The outcome from the evaluation helped to inform recommendations for the possible further development of the technology-based learning tool for this population. With the inclusion of the open-ended question following the LOES-S, we received a more thorough evaluation of the learning tool from participants rather than the LOES-S evaluation alone.

Another limitation is the potential for selection bias. It is unclear if those individuals who participated in the study were representative of the entire eligible CMCC teaching and clinical faculty population. Basic demographic characteristics of the eligible population suggest that they may be similar. It is possible that those who participated were more willing and/or interested in adopting technology-based learning education. The results may reflect a more favourable evaluation of the tool.

Finally, we invited teaching and clinical faculty to participate regardless of their area of teaching. Participation may have been effected by this broad eligibility criteria because the content of the learning tool focused on the management of neck pain which may not be relevant to all educators. However, we aimed to mitigate this potential selection bias during recruitment by explaining that the study focused on evaluating the learning tool itself and not the content of the learning tool. Nevertheless, it is possible that participants with a teaching focus that includes the management of neck pain may have differed from those who focus on other topics.

Other Evaluation Studies

To our knowledge, no other learning tool evaluation studies have been conducted on chiropractic teaching and clinical faculty. However, learning tool evaluations have been conducted in other healthcare professions. We identified three studies aiming to evaluate technology-based educational interventions within a healthcare setting [26-28]. All three aimed to evaluate user satisfaction using a Likert scale tool as well as provide feedback using open-ended questions [26-28]. Two studies provided recommendations for subsequent use of the learning tools based on the satisfaction results [26, 27]. However, none of the studies referred to pedagogical theories or principles with regard to their users' satisfaction. Overall, the technology-based learning tools were evaluated favourably in the physician [27, 28], and nurse practitioner [26] populations. The evaluations by these populations are comparable to our present study.

This current study is unique from those identified in the literature. While we used a similar format for measuring outcomes, the purpose of the evaluation was to focus on the user-centred constructs of the learning tool rather than satisfaction with use and whether they found it helpful. Pedagogical theory and principles were incorporated into the design of the tool as well as the development of recommendations for its improvement.

Barriers to Participation

The inclusion of the Advisory Committee for this study was intended to help understand the culture of chiropractic teaching and clinical faculty in the hope to enhance study participation. The input of the Advisory Committee helped guide decisions for creating the tool. They also provided insight toward which component of the overall clinical practice guideline they thought that teaching and clinical faculty would be most interested in (treatment of acute neck pain from the CPG). Focusing on a topic of interest for this population was intended in order to motivate participation. Unfortunately, participation in our study remained low. This finding is consistent with other studies surveying chiropractors [29].

Barriers to participation in educational interventions by healthcare professionals have been reviewed in the literature [4, 30, 31]. The most frequently occurring barrier to participation is a lack of time. Other common barriers include incentives to participation, financial constraints, personal constraints such as health status and motivation, lack of awareness of educational activities, and job-status (part-time vs. full-time) [4, 30, 31].

Reflections related to possible contributors to the limited participation rate was warranted for this study. Our study provided preliminary information about an effective recruitment strategy. However, a more thorough investigation of recruitment strategies as well as barriers specific to the chiropractic teaching and clinical faculty is recommended for enhancing participation in future studies.

Suggested Revisions to Learning Tool

Based on the suggestions from participants and LOES-S evaluations, the following revisions are recommended for the further development of the learning tool for this population. To our knowledge, pedagogically-focused recommendations for the further development of technology-based learning tools to improve healthcare-focused knowledge of healthcare professionals has not been provided elsewhere.

The following recommendations were developed to directly reflect the pedagogical themes derived through the content analysis as previously described. Recommendations are supported by the literature describing pedagogical theories and principles common to online or web-based learning.

Recommendation #1: Include a wider variety of media (graphics, videos, etc.) to break up the text and keep learners engaged.

Multimedia is a pedagogical design principle which emphasizes using a combination of text and graphics to provide the learner with a richer learning experience [32]. All media should, however, be relevant to the learning material and serve a specific purpose; graphics or animations for the sole purpose of aesthetics are not recommended [32]. This recommendation also refers to the Modality Principle wherein presenting information in a narrative format rather than text may beneficial to the learner. Narration, however, should not be used to present long and complex information [33].

Recommendation #2: Consult content experts to ensure review material (e.g., quizzes, case studies) are appropriate for learners and the learning environment.

The Thinking Skills pedagogical principle outlines the cognitive processes learners use to accomplish tasks in a learning environment, which are: 1) generating new ideas and perspectives; 2) applying, analyzing, synthesizing and evaluating information; and 3) awareness and analysis of one's thoughts [34]. Learning tool components, such as review quizzes and case studies, allows learners to follow these cognitive processes in order to

apply new knowledge more effectively. Consulting content experts to ensure the review of components are appropriate for the learners and the difficulty of the content. This allows for a more adequate step-wise cognitive process in order to learn the new concept or skill.

Recommendation #3: Include a main menu to allow learners to control the sections of the learning tool they wish to review or skip to.

Learner Control is a pedagogical principle which describes the degree of control a learner has over their learning experience [35]. Types of learner control include: 1) content sequencing: having control over the order of the course material; 2) pacing: having control of the time spent on each section of the lesson; and 3) access to learning support: having the ability to access additional resources to add to the learning experience [35]. It is recommended that asynchronous online learning should incorporate some degree of learner control. However, the degree of learner control is directly related to the degree of difficulty and complexity of the learning content, learners' previous knowledge of the subject matter, and learner metacognition [35]. Therefore, if the degree of difficulty and complexity is high, learners' previous knowledge of the subject matter is low, and learner metacognition is low, there should be a lesser degree of learner control.

Conclusions

The evaluation of the learning tool by chiropractic teaching and clinical faculty at the Canadian Memorial Chiropractic College demonstrated that a majority of participants agree with the learning, design, and engagement constructs of the learning tool. However, three components of the learning tool, pertaining to three pedagogical theories, were demonstrated to require additional development. Further development of the learning tool is recommended in order to increase educational engagement for this population. Future research is recommended to investigate chiropractic professionals' barriers to educational participation further as well as to investigate the efficacy of the learning tool for increasing knowledge of clinical practice guidelines within this population.

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Chapter Four Discussion and Conclusion

Thesis Summary

The overall aim of this thesis was to develop a pedagogically sound technology-based learning tool aimed at improving knowledge of an evidence-based clinical practice guideline in teaching and clinical faculty at the Canadian Memorial Chiropractic College (CMCC). The findings described were established through two complementary studies. Specifically, this thesis was informed by a systematic review of the literature and a cross-sectional evaluation study.

Objective One – Systematic Review

The first objective of this thesis was to systematically review and synthesize the literature in order to answer the following question: Is interaction with a technology-based learning tool associated with improvement in knowledge about the management of health conditions, using clinical practice guidelines, in practicing healthcare professionals?

We found preliminary evidence suggesting spaced-education is associated with improvement in knowledge; however, its effectiveness, relative to other interventions in unknown [1, 2]. Furthermore, we found evidence that module-based online educational interventions are associated with improvement in knowledge of clinical practice guidelines. However, they may not be superior to paper-based self-learning or in-person workshops [3-6].

This review provides useful information on educational interventions that are associated with improvements in knowledge of clinical practice guidelines in healthcare professionals. However, the RCTs included in this review are dated. The breadth of technology has significantly advanced even within the last 5 years. Therefore, the results of these studies should be interpreted with this in mind. Nonetheless, this review was used to inform the development of the technology-based learning tool outlined in objective two.

Objective Two – Development of the Learning Tool

The second objective of this thesis was to develop a technology-based learning tool designed to improve knowledge about the management of neck pain using an evidence-based clinical practice guideline for teaching and clinical faculty at CMCC.

Using an integrated knowledge translation strategy, I developed a technology-based learning tool in the form of a series of interactive, asynchronous online modules. The development of the learning tool was informed by the Knowledge User Advisory Committee, systematic review of the literature as well as pedagogical theories and principles common to online learning.

Integrated knowledge translation (iKT) combines knowledge exchange and dissemination strategies [7, 8]. I developed a Knowledge User Advisory Committee comprised of individuals from a variety of healthcare, education and IT backgrounds to ensure the learning tool was designed based on informed sources and thorough evaluation. The Advisory Committee was also used to provide input toward the culture of the teaching and clinical faculty population which informed the recruitment strategies used in objective three.

Objective Three – Evaluation of the Learning Tool

The third objective of this thesis was to evaluate the learning, design, and engagement constructs toward the technology-based learning tool by teaching and clinical faculty at CMCC.

I used a cross-sectional evaluation study design to evaluate the learning, design, and engagement constructs of the learning tool using the Learning Object Evaluation Scale for Students (LOES-S). Participants were asked to provide their evaluation following self-study using the learning tool. The evaluation was supplemented with an open-ended feedback question asking for suggestions for improving the tool. At least 75% of participants agreed with all 13 items of the LOES-S evaluation. Comments provided by participants were assessed through a content analysis to identify common pedagogical

themes. The pedagogical themes including learner control, multimedia, and thinking skills, were used to inform three recommendations for the further development of the learning tool for teaching and clinical faculty at CMCC.

Furthermore, I compared increases in the participation to the recruitment strategies used week-by-week to identify which strategies may have been most fruitful throughout the study. These data were used to provide insight into possible effective recruitment strategies for future studies focusing on this population. I determined that face-to-face discussion recruitment strategies seem to be most effective for recruiting teaching and clinical faculty at CMCC.

Significance – Knowledge-to-Action Cycle

The results of my studies are meaningful. Overall, they demonstrate the use of a feedback mechanism for developing targeted educational knowledge translation interventions for healthcare educators. Specifically, I used the combination of source literature and Knowledge User engagement to develop an educational intervention targeted toward chiropractic teaching and clinical faculty. The quantitative and qualitative end-user feedback was used to improve the learning tool to best suit the targeted audience. This feedback mechanism enabled the development of a well-informed knowledge translation intervention specific to chiropractic teaching and clinical faculty at CMCC. My research focused on the first four steps of the Knowledge-to-Action cycle. Future research is recommended to complete the remaining steps of the cycle and investigate the effectiveness of the educational intervention within this population as well as address barriers and facilitators in doing so.

Knowledge-to-Action, as described by CIHR, involves the creation and application of knowledge through a series of phases beginning with the collection of new knowledge and ending with developing mechanisms for knowledge use sustainability [8]. Knowledge translation using a feedback mechanism such as the Knowledge-to-Action cycle can help to contextualize the research findings for the knowledge user, thereby limiting known barriers to its implementation [9].

Current Knowledge Translation

Regularly translating knowledge into clinical practice has had limited success [10-12] and there is limited evidence toward describing how to best select knowledge translation interventions for healthcare professionals [12-14]. Developing end-user-focused knowledge translation educational interventions is, however, recommended to limit profession-specific barriers [15-18].

Chiropractic professionals encounter a number of significant barriers limiting their access and use of evidence-based research in practice. Some of these barriers include time limitations, perceptions that resources lack clinical relevance, lack of incentives for completing continuing education, and limited skills in locating, interpreting and critically appraising research findings [19-21]. Nonetheless, chiropractic professionals are not any more hindered compared to other healthcare professionals with regard to the consideration and adoption of evidence-based practice [22]. Technology-based interventions provide a convenient method of accessing evidence-based clinical practice guidelines [23]. Developing knowledge translation interventions specific for chiropractic professionals may contribute to limiting these barriers while increasing the adoption of evidence-based guidelines into clinical practice [10, 15, 23].

One systematic review investigated the effectiveness of knowledge translation educational interventions specific to improving clinical practice guideline uptake [24]. They determined multi-component interventions were generally the most effective strategies; however, their conclusions were based on studies of mixed quality, and they did not investigate the use of technology-based interventions. Furthermore, one systematic review of online knowledge translation strategies in health-related populations determined that online strategies may be effective modes of delivery of knowledge between knowledge users (providers, policymakers, and consumers) [25]. However, the description of learning tools are limited, and again, their conclusions are based on studies of mixed quality.

Knowledge translation strategies including meetings, outreach visits, opinion leaders, lectures and workshops have been summarized in previous literature [26-29]. However, the use of technology-based strategies is becoming increasingly favourable [10, 30, 31]. Additional research is recommended to support the implementation of technology-based knowledge translation interventions for healthcare professionals moving forward.

Strengths

This thesis has strengths. First, I conducted a systematic review with a best-evidence synthesis to minimize the risk of bias. This review was used to inform the development of the learning tool used in the evaluation study. Second, the development of the learning tool was informed using an integrated knowledge translation strategy. This method ensured the intervention was designed based on informed sources and a thorough evaluation by Knowledge Users. Third, the evaluation of the learning tool used the combination with the LOES-S tool and open-ended feedback. This strategy allowed for a more detailed evaluation of the learning tool helped to better inform recommendations for its further development. Finally, this thesis provides a thorough example of the development of a targeted technology-based educational intervention using a feedback mechanism informed from a variety of sources.

Limitations

This thesis has limitations. My findings may not be transferable to, or representative of, teaching and clinical faculty outside of CMCC. Evaluations of educational interventions may differ by those with additional experiences in technology-based learning or institutions with different proportions of faculty with additional research backgrounds (ex. DC Ph.D.). Second, the limited quantity and quality of previous studies aiming to improve knowledge of clinical practice guidelines using technological resources may have limited the information used to inform the development of the learning tool. Finally, the cross-sectional evaluation study yielded a low participation rate. The evaluations of the learning tool may not be accurately representative of the overall eligible study population. However, basic demographic characteristics of the eligible population suggest that they may be

similar to those within the sample. Nonetheless, this limitation could have led to a biased representation of the evaluation results.

Conclusions and Next Steps

My research describes the development of a knowledge translation educational intervention aimed to improve knowledge of clinical practice guidelines in order to enhance its use in chiropractic education. Further, my findings demonstrate the use of an integrated knowledge translation strategy in order to develop learning tool interventions tailored to specific audiences using a feedback mechanism. A significant number of Canadians access chiropractic care yearly. Therefore, the need for well-developed technology-based learning tools for chiropractic educators to improve their knowledge of evidence-based practice guidelines is imperative.

To my knowledge, this is the first study to focus on chiropractic teaching and clinical faculty to improve their knowledge of clinical practice guidelines. Continued investigation is needed to assess the efficacy of the learning tool for the teaching and clinical faculty population. Further understanding of the specific barriers chiropractic faculty face is also recommended. Through the implementation of the evaluation study, I have learned that busy schedules (limited time) play a significant role in the willingness to participate in voluntary educational interventions. However, when the learning tool was shortened in length to minimize the burden of time, I found no significant changes in participation. Future research in this field should consider investigating the culture of their intended healthcare professional audiences in order to tailor appropriate recruitment and compensation strategies to promote adequate participation. Increased participation in the evaluation of these tools will provide a more thorough understanding of the favourable components of learning tools for that specific population in order to tailor the tool for them.

Continued research in this area will help promote the development of high-quality, and pedagogically sound technology-based learning tools to improve knowledge of clinical practice guidelines to healthcare professionals. Increasing knowledge and awareness of

clinical practice guidelines in chiropractic education is anticipated to improve the quality of care provided to patients by emerging chiropractors.

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Appendix A: MEDLINE Search Strategy

Search run April 11, 2017 and updated on July 1, 2018 in Ovid MEDLINE: Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE® Daily and Ovid MEDLINE® 1946-Present.

1. Guideline Adherence/
2. Practice Guidelines as Topic/
3. CPGs.ab,ti.
4. (guideline* adj4 (adher* or application or clinical or concensus or disseminat* or implement* or practice or strateg*)).ab,ti.
5. GItools*.ab,ti.
6. (practice adj4 parameter*).ab,ti.
7. or/1-6
8. Computer-Assisted Instruction/
9. Simulation Training/
10. Internet/
11. Social Media/
12. blog*.ab,ti.
13. e-learning.ab,ti.
14. (electronic adj4 (device* or learn* or teach*)).ab,ti.
15. Facebook.ab,ti.
16. (interactive adj4 (learning or lecture* or multimedia)).ab,ti.
17. Internet.ab,ti.
18. LinkedIn.ab,ti.
19. (mobile adj4 phone*).ab,ti.
20. ((online or on-line) adj4 (educat* or instruction or lecture* or learn* or model* or teach* or tool*)).ab,ti.
21. podcast*.ab,ti.
22. Second Life.ab,ti.
23. ((smart adj phone*) or smartphone*).ab,ti.

24. social media.ab,ti.

25. (virtual adj4 (educat* or learn* or world*)).ab,ti.

26. ((web or technolog*) adj4 (educat* or instruction or learn* or tool*)).ab,ti.

27. or/8-26

28. 7 and 27

29. limit 28 to english language

Appendix B: Inclusion and Exclusion Questionnaire

The inclusion/exclusion questionnaire was administered online using Google Forms. If a participant was deemed eligible to participate, they were redirected to the informed consent form (Appendix D). If a participant was deemed ineligible to participate, they were redirected to a "Thank You" page and were not allowed to access the remainder of the study.

Question	**Yes**	**No**
If "yes" is selected to the following questions, participants are eligible to participate in the study and will be redirected to the informed consent questionnaire.		
1. Are you a current teaching faculty member (including clinician and/or teaching assistant) at the Canadian Memorial Chiropractic College?		
2. Are you capable of providing written informed consent in the English language?		

If "yes" is selected to the following questions, participants are ineligible to participate in the study and will be redirected to a thank you page and informed of their ineligibility.		
3. At any time, have you been a member of the Advisory Committee developed to inform the design of the learning tool?		

Appendix C: Recruitment Procedures

The recruitment strategy included four stages: 1) advertising; 2) providing additional information; 3) assessment of eligibility; and 4) administration of informed consent.

Stage 1 – Advertising

We advertised the study to the teaching faculty at the Canadian Memorial Chiropractic College (CMCC) using four means: 1) email; 2) link in KIRO; 3) appearing at an internal teaching assistant/resident meeting; and 4) via personal interaction. Recruitment strategy scripts and materials are outlined below.

Emails were sent to clinicians, teaching faculty, and teaching assistants/residents advertising the study by the respective department leads. The email included an introduction and the purpose of the study. A link to the study website was also included asking recipients to visit the learning tool for further information to participate.

Second, each CMCC faculty member is equipped with a KIRO account (username and password). KIRO is the interface the Canadian Memorial Chiropractic College uses for teaching faculty and students to access course-specific information as well as information pertaining to the college. A link to the study website was posted to the KIRO system. Faculty members were able to click on the link within their KIRO account which redirected them to the study website.

Third, the project was presented at an internal teaching assistant/resident meeting. A short synopsis of the project was presented referencing all those interested in participating to contact the research team for more information or to access the study website directly to participate. An information letter was also provided in person to those who were interested.

Last, the research team actively advertised the study using personal interactions. The information letter, as well as a small hand-out card, was distributed to potential participants at this time. The hand-out card provided the study link, and contact information and the

information letter consisted of highlights of the study including the purpose, study design and contact information for participation.

Table C-1: Recruitment Schedule

	Week (Sunday-Saturday)	**Action/Notes**
1	Jan 28 - Feb 3, 2018	Feb 1st, 2018 – Data collection period begins Feb 2nd - Recruitment emails sent to residents from department lead
2	Feb 4 – Feb 10, 2018	KIRO post goes live and sends an email to all members associated with the KIRO account Recruitment emails sent to clinicians from department lead
3	Feb 11 – Feb 17, 2018	
4	Feb 18 – Feb 24, 2018	Feb 23rd – Study recruitment meeting with CMCC Investigators Committee. Discussed recruitment strategies. Clinician department lead sent email to clinicians allowing them to use participation in this study as unstructured continuing education hours
5	Feb 25 – March 3, 2018	Email from clinician department lead to clinicians advertising the use of participation for unstructured CE hours (as discussed in recruitment meeting)
6	March 4 – March 10, 2018	
7	March 11 – March 17, 2018	Recruitment emails sent to teaching faculty leads from department lead. This email asked faculty leads to distribute the recruitment email and accompanying documents to all teaching faculty within their departments

		March 12th, 2018 – personal interaction recruitment with clinicians (morning and afternoon shift on the main campus) March 13th, 2018 – personal interaction recruitment with clinicians (morning and afternoon shift on the main campus)
8	March 18 – March 24, 2018	
9	March 25 – March 31, 2018	March 28th, 2018 – presented study at internal teaching assistant/resident meeting
10	April 1 – 7, 2018	April 5th, 2018 – personal interaction recruitment of teaching faculty on the main campus
11	April 8 – 14, 2018	
12	April 15 – 21, 2018	
13	April 22-28, 2018	Research team member, Dr. Silvano Mior, presented the study at internal teaching assistant/resident meeting
14	April 29 – May 5, 2018	April 30th, 2018 – personal interaction recruitment of teaching faculty on the main campus
15	May 6 – May 12, 2018	May 7th, 2018: personal interaction recruitment of teaching faculty on the main campus May 8th, 2018: personal interaction recruitment of teaching faculty on the main campus
16	May 13 - May 19, 2018	
17	May 20 – May 26, 2018	
18	May 27- June 2, 2018	Data collection period ends May 31st, 2018

Stage 2 – Providing Additional Information

If a potential participant required additional information about the study, research team contact information (name, phone number, and email address) was provided. If contacted for additional information, descriptions from the information letter and informed consent form were used to answer any questions.

Stage 3 – Assessment of Eligibility

Once a participant clicked on the web link to participate, they were prompted to complete a questionnaire to assess eligibility. Those who are ineligible for the study were redirected to a "Thank You" page, and were not provided access to the remainder of the study. The Inclusion/Exclusion Questionnaire is provided in Appendix B.

Stage 4 – Administration of Informed Consent

To be included in the study, participants had to provide informed consent. Informed consent documentation was provided to participants who were deemed eligible based on the previous inclusion/exclusion questionnaire. Informed consent was completed online using a Google Form embedded within the study website. All information was stored securely on Google Drive and managed by the UOIT IT department (Bevin Moolenschot). The informed consent form provided participants with the purpose, significance, risks, benefits, and participant requirements of the study. It informed participants that the study was to take place online and that a reliable computer/laptop with access to the internet was required to participate. The informed consent form is provided in Appendix D.

Participants who did not complete the informed consent form were redirected to a "Thank You" page and were not provided access to the remainder of the study.

Supplemental Information - Email

Good (Morning/Afternoon),

My name is Leslie Verville and I am a Master's student at the University of Ontario Institute of Technology.

I am conducting an evaluation of a technology-based learning tool developed to enhance the understanding of the clinical practice guideline for the management of neck pain and associated disorders (NAD I-II ≤ 3 months duration) in teaching faculty members at the Canadian Memorial Chiropractic College.

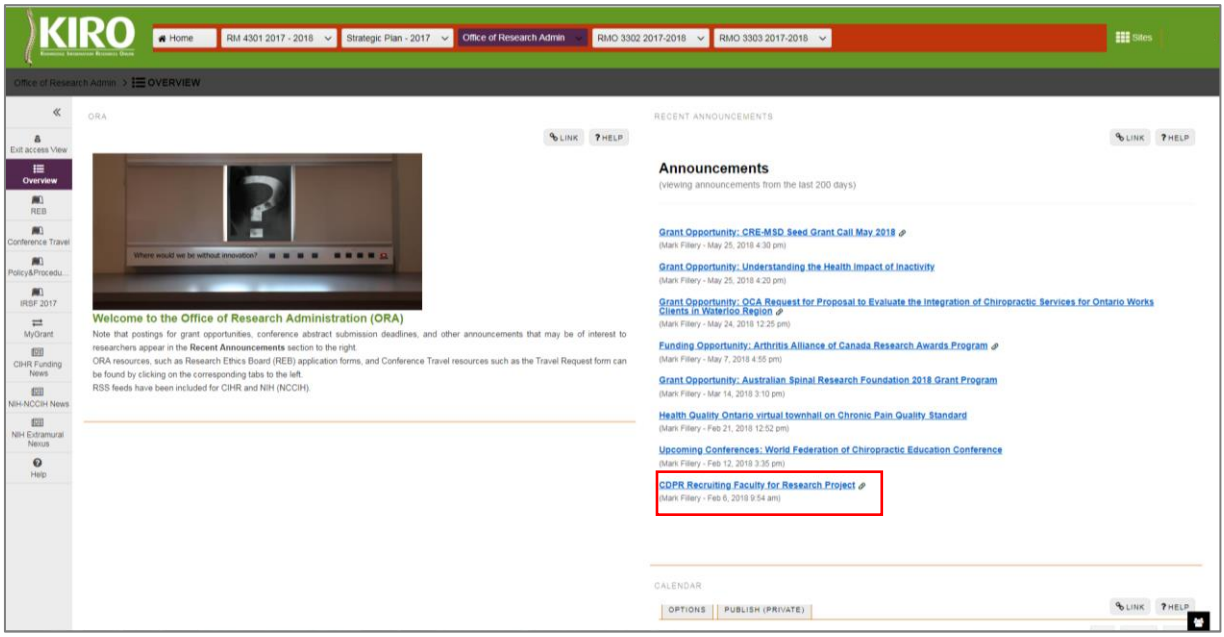
If you might be interested in becoming a participant, please review the attached information letter for more information. If you have any questions about the study, please do not hesitate to contact me at leslie.verville@uoit.net.

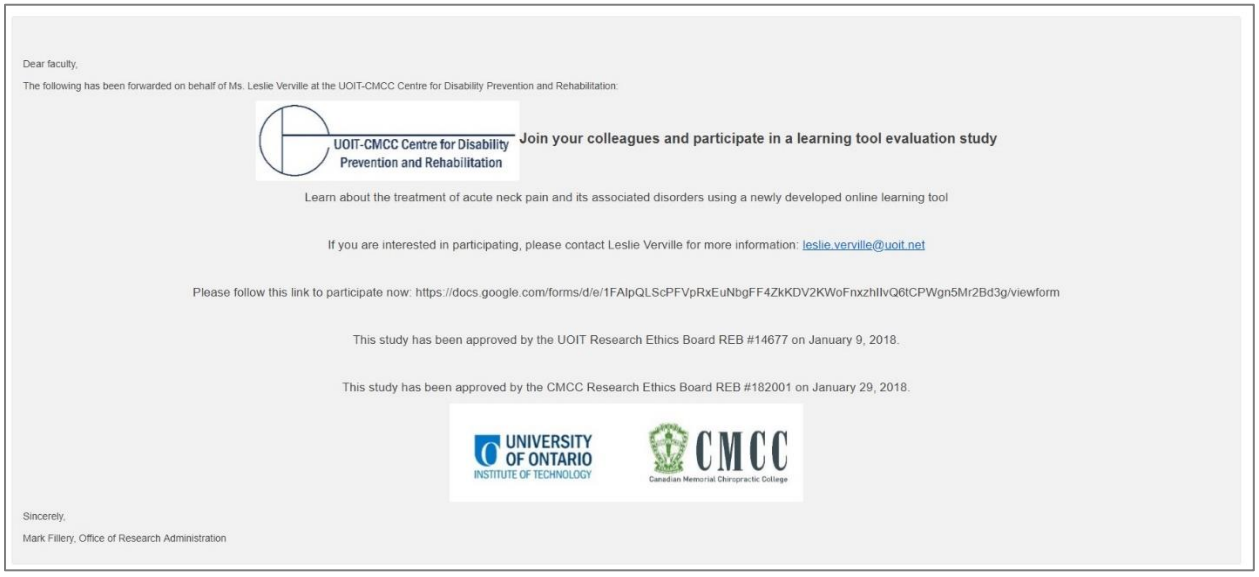
Please follow this link to participate now:

Thank you kindly for your consideration in participating in this study.

Leslie Verville MHSc (candidate)
UOIT-CMCC Centre for Disability Prevention and Rehabilitation
University of Ontario Institute of Technology – Faculty of Health Sciences

Supplemental Information – KIRO Post





Dear faculty,

The following has been forwarded on behalf of Ms. Leslie Verville at the UOIT-CMCC Centre for Disability Prevention and Rehabilitation:

UOIT-CMCC Centre for Disability Prevention and Rehabilitation **Join your colleagues and participate in a learning tool evaluation study**

Learn about the treatment of acute neck pain and its associated disorders using a newly developed online learning tool

If you are interested in participating, please contact Leslie Verville for more information: leslie.verville@uoit.net

Please follow this link to participate now: https://docs.google.com/forms/d/e/1FAIpQLScPFVpRxEuNbgFF4ZkKDV2KWoFnxzhIIvQ6tCPWgn5Mr2Bd3g/viewform

This study has been approved by the UOIT Research Ethics Board REB #14677 on January 9, 2018.

This study has been approved by the CMCC Research Ethics Board REB #182001 on January 29, 2018.

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY CMCC Canadian Memorial Chiropractic College

Sincerely,

Mark Fillery, Office of Research Administration

Supplemental Information – Personal Interaction Script

Good (Morning/Afternoon),

My name is Leslie Verville and I am a Master's student at the University of Ontario Institute of Technology.

I am conducting an evaluation of a technology-based learning tool developed to enhance the understanding of the clinical practice guideline for the management of neck pain and associated disorders (NAD I-II ≤ 3 months duration) in teaching faculty members at the Canadian Memorial Chiropractic College.

If you might be interested in becoming a participant, please click on the link within your KIRO account or within the email that was sent to you to learn more about the study and how you can participate. If you have any questions about the study, please do not hesitate to contact me at leslie.verville@uoit.net.

Thank you kindly for your consideration in participating in this study.

Supplemental Information – Hand-out

Supplemental Information – Information Letter (original version used from Feb 1st, 2018 – April 27th, 2018)

Dear CMCC Faculty Member,

You are invited to participate in a study that aims to evaluate a technology-based learning tool designed to improve knowledge about the evidence-based clinical practice guideline on neck pain.

Title of Study: The Development and Evaluation of a Technology-based Learning Tool to Improve Knowledge about the Evidence-based Management of Neck Pain by Teaching Faculty at the Canadian Memorial Chiropractic College

Principal Investigator:

Pierre Côté DC, Ph.D. Canada Research Chair in Disability Prevention and Rehabilitation, Associate Professor, Faculty of Health Sciences, University of Ontario Institute of Technology, Director, UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Leslie Verville BHSc, MHSc (candidate) Graduate Student, Faculty of Health Sciences, University of Ontario Institute of Technology

Purpose: The purpose of this study is to evaluate the learning, design, and engagement constructs of a technology-based learning tool designed to improve knowledge about the evidence-based management of neck pain and its associated disorders for teaching faculty at the Canadian Memorial Chiropractic College.

Participants: Participants must be a teaching faculty member (clinicians and teaching assistants included) at the Canadian Memorial Chiropractic College and must be capable of giving written informed consent in the English language.

Type of Study: This study is an evaluation of a technology-based learning tool designed for chiropractic teaching faculty at the Canadian Memorial Chiropractic College.

What will happen when I participate? In order to participate, you must follow the link that has been provided to you within KIRO and/or your email. You will be prompted to complete an eligibility questionnaire. If eligible, an informed consent form will be required to progress. Completion of the online informed consent form will confirm your consent to participate; no signature is required.

Once the online informed consent is completed, you will be prompted to complete a demographic questionnaire. The questionnaire will collect: 1) sociodemographic characteristics (age and gender); 2) educational degree; 3) years of experience as a practicing chiropractor; 4) years of experience in a chiropractic teaching role; 5) hours per week dedicated to teaching role; 6) clinician at a CMCC teaching clinic; 7) hours per week dedicated to clinician appointment; 8) department/division belonging to at CMCC; 9) working knowledge of OPTIMa neck pain clinical practice guideline; 10) previous experience with clinical practice guideline development; 11) previous experience with technology-based learning tools; and 12) self-rated proficiency with computers.

Following the demographic questionnaire, you will progress through the learning tool at your own pace. The learning tool will be divided into short modules, each focusing on a major component of the learning material.

Once self-learning is completed using the learning tool, you will be prompted to complete the Learning Object Evaluation Scale for Students (LOES-S) to evaluate the learning, design, and engagement constructs of the learning tool. This questionnaire will allow you to rate the three constructs of the learning tool (13 items) using a 5-point Likert scale. The questionnaire also includes one open-ended question for additional feedback.

How will knowledge be measured? A measurement of knowledge will not be collected during this study. Brief quizzes assessing knowledge will be provided within the learning

tool, however, any answers provided here will not be collected, evaluated, or linked to any questionnaire responses.

How will your evaluation be measured? Following participation in the learning tool, an evaluation of learning, design, and engagement constructs using the Learning Object Evaluation Scale for Students (LOES-S) will be completed. This questionnaire will allow you to rate the three constructs of the learning tool (13 items) using a 5-point Likert scale. The questionnaire also includes one open-ended question for additional feedback.

Time commitments: Approximately 30 minutes of your time is required to complete the learning intervention and evaluation.

Participation: You are under no obligation to participate in the study. You can also change your mind about participating at any time during the study. Participation in this study will not affect your employment at the Canadian Memorial Chiropractic College. If you wish to withdraw your data from the study after their data is entered, you will be required to send an email to Dr. Pierre Côté requesting that your data be removed. Dr. Côté will then contact the UOIT IT department providing them with your name and email address. The UOIT IT department will locate your data and delete it from google drive eliminating your data from the dataset.

Confidentiality: You will be assigned a unique study identification number which will link all of your study data. This information will be kept secure on the UOIT google drive network. In 2025, seven years following the study, the data will be destroyed from the UOIT google drive. Only the research team (including IT personnel) will have access to this password-protected information during the length of the study.

Participate: If you would like to participate in this study, please click on the link provided within the email or on KIRO.

REB: This study has been approved by the UOIT Research Ethics Board [REB #14677] on January 9, 2018. This study has been approved by the CMCC Research Ethics Board [REB #182001] on January 29, 2018.

Supplemental Information – Information Letter (amended version used from April 27th, 2018 – May 31st, 2018)

Dear CMCC Faculty Member,

You are invited to participate in a study that aims to evaluate a technology-based learning tool designed to improve knowledge about the evidence-based clinical practice guideline on neck pain.

Title of Study: The Development and Evaluation of a Technology-based Learning Tool to Improve Knowledge about the Evidence-based Management of Neck Pain by Teaching Faculty at the Canadian Memorial Chiropractic College

Principal Investigator:
Pierre Côté DC, Ph.D. Canada Research Chair in Disability Prevention and Rehabilitation, Associate Professor, Faculty of Health Sciences, University of Ontario Institute of Technology, Director, UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Leslie Verville BHSc, MHSc (candidate) Graduate Student, Faculty of Health Sciences, University of Ontario Institute of Technology

Purpose: The purpose of this study is to evaluate the learning, design, and engagement constructs of a technology-based learning tool designed to improve knowledge about the evidence-based management of neck pain and its associated disorders for teaching faculty at the Canadian Memorial Chiropractic College.

Participants: Participants must be a teaching faculty member (clinicians and teaching assistants included) at the Canadian Memorial Chiropractic College and must be capable of giving written informed consent in the English language.

Type of Study: This study is an evaluation of a technology-based learning tool designed for chiropractic teaching faculty at the Canadian Memorial Chiropractic College.

What will happen when I participate? In order to participate, you must follow the link that has been provided to you within KIRO and/or your email. You will be prompted to complete an eligibility questionnaire. If eligible, an informed consent form will be required to progress. Completion of the online informed consent form will confirm your consent to participate; no signature is required.

Once the online informed consent is completed, you will be prompted to complete a demographic questionnaire. The questionnaire will collect: 1) sociodemographic characteristics (age and gender); 2) educational degree; 3) years of experience as a practicing chiropractor; 4) years of experience in a chiropractic teaching role; 5) hours per week dedicated to teaching role; 6) clinician at a CMCC teaching clinic; 7) hours per week dedicated to clinician appointment; 8) department/division belonging to at CMCC; 9) working knowledge of OPTIMa neck pain clinical practice guideline; 10) previous experience with clinical practice guideline development; 11) previous experience with technology-based learning tools; and 12) self-rated proficiency with computers.

Following the demographic questionnaire, you will progress through the learning tool at your own pace. The learning tool will be divided into short modules, focusing on a major component of the learning material.

Once self-learning is completed using the learning tool, you will be prompted to complete the Learning Object Evaluation Scale for Students (LOES-S) to evaluate the learning, design, and engagement constructs of the learning tool. This questionnaire will allow you to rate the three constructs of the learning tool (13 items) using a 5-point Likert scale. The questionnaire also includes one open-ended question for additional feedback.

How will knowledge be measured? A measurement of knowledge will not be collected during this study. Brief quizzes assessing knowledge will be provided within the learning

tool, however, any answers provided here will not be collected, evaluated, or linked to any questionnaire responses.

How will your evaluation be measured? Following participation in the learning tool, an evaluation of learning, design, and engagement constructs using the Learning Object Evaluation Scale for Students (LOES-S) will be completed. This questionnaire will allow you to rate the three constructs of the learning tool (13 items) using a 5-point Likert scale. The questionnaire also includes one open-ended question for additional feedback.

Time commitments: Approximately 10 minutes of your time is required to complete the learning intervention and evaluation.

Participation: You are under no obligation to participate in the study. You can also change your mind about participating at any time during the study. Participation in this study will not affect your employment at the Canadian Memorial Chiropractic College. If you wish to withdraw your data from the study after their data is entered, you will be required to send an email to Dr. Pierre Côté requesting that your data be removed. Dr. Côté will then contact the UOIT IT department providing them with your name and email address. The UOIT IT department will locate your data and delete it from google drive eliminating your data from the dataset.

Confidentiality: You will be assigned a unique study identification number which will link all of your study data. This information will be kept secure on the UOIT google drive network. In 2025, seven years following the study, the data will be destroyed from the UOIT google drive. Only the research team (including IT personnel) will have access to this password-protected information during the length of the study.

Participate: If you would like to participate in this study, please click on the link provided within the email or on KIRO.

REB: This study has been approved by the UOIT Research Ethics Board [REB #14677] on January 9, 2018. This study has been approved by the CMCC Research Ethics Board [REB #182001] on January 29, 2018.

Appendix D: Informed Consent Form

The Informed Consent Form was provided to those participants who were deemed eligible to participate following the completion of the inclusion/exclusion questionnaire (Appendix B). The completion of this form was mandatory for participants to continue in the study.

Title of Research Study: The Development and Evaluation of a Technology-based Learning Tool to Improve Knowledge about the Evidence-based Management of Neck Pain by Teaching Faculty at the Canadian Memorial Chiropractic College

You are invited to participate in a research study entitled: the development and evaluation of a technology-based learning tool to improve knowledge about the evidence-based management of neck pain. This study has been reviewed by the University of Ontario Institute of Technology Research Ethics Board (REB #14677).

Before agreeing to participate in this study, it is important that you read and understand the following explanation of the proposed study procedures. The following information describes the purpose, procedures, benefits, and risks associated with this study. It also describes your right to refuse to participate or withdraw from the study at any time. In order to decide whether you wish to participate in this research study, you should understand enough about its risks and benefits to be able to make an informed decision. This is known as the informed consent process. Make sure all your questions have been answered to your satisfaction before signing this document.

If you have any questions about your rights as a participant in this study, please contact the Research Ethics Coordinator at 905 721 8668 ext. 3693 or researchethics@uoit.ca.

Researcher(s): Leslie Verville
Principal Investigator: Dr. Pierre Côté
Departmental and Institutional affiliations: University of Ontario Institute of Technology, Oshawa, ON; Canadian Memorial Chiropractic College, Toronto, ON

Contact number: 905-721-8668 x.5920
Contact e-mail: leslie.verville@uoit.net
Funding: Canadian Memorial Chiropractic College

Background

The growing use of technology is challenging the traditional methods of knowledge sharing in health care. The integration of technology in healthcare education is growing rapidly, however, there is a lack of understanding of how to make technology-based learning more effective for those who need it.

Purpose and Procedure

The purpose of this study is to evaluate the learning, design, and engagement constructs of a technology-based learning tool designed to improve knowledge about the evidence-based management of neck pain and its associated disorders for teaching faculty at the Canadian Memorial Chiropractic College.

You will first participate in a technology-based learning tool designed to improve knowledge about the evidence-based management of neck pain, completed strictly online, and at your own pace. Following the learning intervention, you will be prompted to evaluate the learning tool using a questionnaire. The evaluation is also accompanied by an open-ended question so that you can tell us more about your overall learning experience.

Potential Benefits

Your participation in this study is beneficial. You will be exposed to and learn about an evidence-based clinical practice guideline on the management of neck pain. Upon completion of the learning tool, you will have had to opportunity to learn about the new evidence on the treatment of neck pain as well as be better prepared, as teaching faculty, to share your new knowledge with your students at CMCC.

More broadly, exposing your chiropractic students to evidence-based practice early on in their careers, might improve willingness and ability to incorporate evidence-based care into

their practice following their education at CMCC, which, in turn, will benefit those seeking chiropractic treatment for neck pain.

Potential Risk or Discomforts

The use of the learning tool poses low risk to you as a participant. There are no physical risks (bodily contact, physical stress or administration of substances). There are no psychological risks (feeling demeaned, embarrassed, worried, upset, or emotional stress). There are no social risks (loss of status, privacy, or reputation) greater than encountered in everyday life.

The learning tool will be completed online, and therefore poses no additional risk. The only potential risk to the study is the possibility of feeling coerced by CMCC, your employer, to participate in the study. To minimize this risk, a statement will be clearly outlined within the website landing page describing that participation is strictly voluntary. Autonomy will be respected by administering informed consent which will clearly explain that the study is voluntary and you are free to withdraw at any time.

Confidentiality

All information collected for the purpose of the research study will be kept in strict confidence. This includes the information collected within the inclusion/exclusion, demographic, and evaluation questionnaires.

Confidentiality of the data will be protected by storing the data securely using Google Suite. Google Suite will include encryption of data and only the UOIT IT department (Neil Hopkins and Bevin Moolenschot), Dr. Pierre Côté, and I, Leslie Verville, will have access to the data.

All evaluations will be de-identified and stripped of direct identifiers following data collection and prior to data analysis. You will be required to use your CMCC email account to access the study. Once the data is collected, the UOIT IT department will remove all identifying information and assign a Study ID. The Study ID will bear no resemblance to

any of your personal identifiers. The IT department will destroy the identifiers and provide Dr. Côté with de-identified data files that will be stored on the UOIT cloud. A code will not be kept to allow future re-linkages of identifiers.

Right to Withdraw

Your participation is voluntary, and you can answer only those questions that you are comfortable with. The information that is shared will be held in strict confidence and discussed only with the research team. You have the right to withdraw at any time. If you withdraw from the research project at any time prior to the end of data collection, any data that you have contributed will be removed from the study and you need not offer any reason for making this request. If you wish to withdraw information you have submitted, please contact the principle investigator, Dr. Pierre Côté. You will be given information that is relevant to your decision to continue or withdraw from participation. Participation in this study will not affect your employment at the Canadian Memorial Chiropractic College.

Compensation

You will not be compensated for their participation in this study.

Debriefing and Dissemination of Results

You will be informed of the results of the study, if interested, once published to a peer-reviewed journal. If you are interested in learning the results of the study, please contact Pierre Côté, the principle investigator, at pierre.cote@uoit.ca.

Participant Concerns and Reporting

Any questions regarding your rights as a participant, complaints or adverse events may be addressed to Research Ethics Board through the Research Ethics Coordinator – researchethics@uoit.ca or 905.721.8668 x. 3693.

If you have any questions concerning the research study or experience any discomfort related to the study, please contact Leslie Verville at 905-721-8668 x.5920 or leslie.verville@uoit.net.

By consenting, you do not waive any rights to legal recourse in the event of research-related harm.

REB:

This study has been approved by the UOIT Research Ethics Board [REB #14677] on January 9, 2018.

This study has been approved by the CMCC Research Ethics Board [REB #182001] on January 29, 2018.

Consent to Participate

1. I have read the consent form and understand the study being described;
2. I have had an opportunity to ask questions, and my questions have been answered. I am free to ask questions about the study in the future;
3. I freely consent to participate in the research study, understanding that I may discontinue participation at any time without penalty. A copy of this Consent Form has been made available to me.

_____ _____

(Name of Participant) (Date)

_____

(CMCC Email Address)

☐ I have read the consent form and understand the study being described. I have had an opportunity to ask questions, and my questions have been answered. I am free to ask questions about the study in the future. I freely consent to participate in the research study, understanding that I may discontinue participation at any time without penalty. A copy of this Consent Form has been made available to me.

Appendix E: Knowledge User Advisory Committee

A Knowledge User Advisory Committee was established and included nine members from a variety of healthcare professionals (e.g. Chiropractor, medical doctor, resident, etc.), IT specialists, administrators (e.g. department leaders) and educators (e.g. Chiropractic educators, teaching clinicians, etc.).

Table E-1: Knowledge User Advisory Committee

	Profession	**Role**
	Chiropractor, Dean of Clinics, CMCC	Chair
	Chiropractor, Professor, UOIT	Facilitator
	Chiropractor, Director, Clinical Education & Patient Care, CMCC	Facilitator
	Chiropractor, Director, Research Partnerships & Research, CMCC	Facilitator
1	Chiropractor, Ph.D. Student	Member
2	Chiropractor, Department Administrator	Member
3	Chiropractor, Department Administrator*	Member
4	Medical Doctor	Member
5	IT Specialist	Member
6	Chiropractor	Member
7	Chiropractor	Member
8	Chiropractor, Resident	Member
9	Department Administrator**	Member

*retired during length of project and dropped out of committee following first meeting.

**joined the committee in November 2017.

The committee was established through formal letters of invitation by the research team. Interested individuals were sent detailed information about the study and their role within the committee.

The role of this committee was to 1) advise on the development and structure of the technology-based learning tool; 2) advise on the barriers and implementation of new educational interventions (e.g. perceptions of new learning tools within this population and suggestions on how to overcome these barriers); and 3) provide post-study involvement advice on the dissemination and implementation of the study results.

In order to maintain the integrated knowledge translation approach, the Advisory Committee was also consulted to reconcile any differences in opinions of the other information sources.

The Advisory Committee met for the first time, in person, on October 11, 2016. This meeting provided the committee with context to the learning tool and what the study hoped to accomplish. A large proportion of the meeting was dedicated to understanding perspectives of technology-based learning and how it can be improved from the perspective of teaching faculty at a Canadian Chiropractic college. The meeting was audio recorded and summarized for future reference.

Advisory Committee meeting questions were developed in association with pedagogical theories and/or principles which helped formulate the development of the learning tool.

The Advisory Committee was consulted five additional times throughout the development phase of the learning tool between June and November, 2017. Using an online survey software, (Survey Monkey), the research team sent the Advisory Committee links to portions of the learning tool as well as a link to a survey to provide guidance and feedback. The feedback provided by the committee during these consultations were logged for future reference. All six development phase meetings are outlined below.

Advisory Committee Meeting #1

Title: Advisory Committee – Inaugural Meeting	
Administered in person at the Canadian Memorial Chiropractic College	
Date: October 11, 2017	**Total Attendees:** 8

1. What is your opinion of online education? / For those of you who have completed online courses, what did you like? What didn't you like?

Discussion Points	• Wide audience • Flexibility – any day of the week, no session that needs to be attended • Cons – wait and not access it • Wide variety of formats • Availability for busy people • Asynchronous vs. synchronous • Educational principles are important to incorporate • The "doing" of learning. Needs to be more than regurgitation of information • Needs to be well designed to be effective • Content is essential • Needs to be done in such a way that is important to the learners • Saves classroom space and time • Gray question – which needs to be discussed when learning information will be missing from an online learning environment • Be mindful of new technologies • Accept what we can and cannot do online • Replicating a classroom is not effective for online learning

2. What is most important to you when you are accessing online material/media? What are some visual characteristics you tend to be drawn to?

Discussion Points	• Quicker the better • Few clicks the better • Easy access • Intuitive • User-friendly • Focused – need to make sure the key point is clear • Content needs to be relevant – get me to the piece that is relevant to me • Example of complex concepts • Real-life examples • Captivating – not flashy, the content needs to be interesting and informative while keeping the learner engaged. Pre-assessment to see change in knowledge as the learner • Variety of mediums (videos, text, "games," etc.) • Don't try to do too much all at once • Engaging • Focused content and design • Limit distractions • Access to full-text material • Digestible bits of information • Is it relevant? Is it practical? • Relevance is obvious right off the bat • Future implications need to be known asap • Struggle in the past was getting to it – ease of access and finishing it – easier way to access more than just sending a link through email – save their certificate as pdf or printing • How do I get there and how do I finalize the process • Clear instructions • Everything in the same location – tool, assessment, resources, certificate, etc.

3. When you're accessing information online, do you prefer to read or view a video when concepts or ideas are illustrated?

Discussion Points	• Nice to have both – variety of media to keep learners engaged • Reading material – go at own pace • Video – too slow, I get it, let's go • Balance is important • Needs to be more creative than just text or video – there are many more options • Video – modelling – likelihood of me doing it after seeing it is more likely • Nice to have the option of reading the text of a video in case of personal constraints (on the train and can't watch video but want to read the information) • May not be able to download – • Design for small screen – iPhone/iPad and computer viewing • Pacing – literature says option of pacing is best for learning • Summary of videos is important to going back to information that was important to the learner – take away information for key points • Table of contents for videos – so that you can find important parts within a video to refer to later • Suggest timetable for learners (30 minutes per day to learn content) – setting learners up for success – "to be successful, consider spending 30 minutes per day" • Letting learners know the approximate time for learners to spend on each module • Additional piece to access take away message • "how much time to I need to devote to keep myself current on this material" – suggest time to learn for the future

	• Course part of prep-time for teaching faculty to learn new material – do not have to screen for current and important literature – provided for them within the course

4. When accessing information online, do you prefer to read language that is more conversational or in a more formal tone? Does this depend on the topic you are learning about?

Discussion Points	• We tend to overestimate the language capabilities of our peers – more conversational language might be more inclusive • Transcript of course made available, so there are options for the learner to read. When the learner might find the teacher boring and uninteresting • Important when the teacher is interested in and passionate about the content to engage the learners

5. What helps you to remember information when you access such content online? Is there something about the format that helps you learn better, for example, videos, songs, colours, etc.?

Discussion Points	• Pre-exams (questions throughout the content to keep the learner interested and engaged) • Exams for each section • Online blog/interaction between learners is important to keep learners on track because they are relying on each other to learn • Modelling – seeing someone do it so they can do it too • Someone showing visibly and explaining it at the same time • Using examples • Story telling – clinical vignettes • Doing is a great way to remember • Case studies – making it relevant to their work

	• Contextualizing the guideline – if it's not a threat to what you've done in the past – uptake and willingness to learn will be greater • Cognitive dissonance – if this is close to what I'm doing now then the feelings of acceptance will be better and more trusting of the content • Segmenting

6. What sort of incentives would encourage you to complete an online learning module? If you have taken online courses in the past, was there an incentive for you to complete the course? For example, did you receive CE hours or a certificate to put on a resume?

Discussion Points	• Request that the information will relate to other courses and content in the curriculum • Be explicit with the purpose and usefulness of the course (outcomes as the user) – this is incentive for this type of population because it will be potentially useful to their everyday lives but also will make their lives easier in the long run • Student incentivizing – course evaluations • Students want their instructors to know information – this might be incentive for instructors to brush up on their knowledge of this topic • This course will help instructors/clinicians get ahead (promotion, performance reviews, publications, etc.) • This is a course I <u>want</u> to take – makes it easier and less burdensome • Intentions of the learner to keep them on track for learning – "next week, I plan to…" • "push and a pull" – I need to know this information because I need to apply it

7. If you have taken an online course in the past, did you find it burdensome to complete? Did it interrupt your day? What would motivate you to complete an online course?

Discussion Points	• Not burdensome because knew a lot of the information already; however, could be burdensome if the information was all new • If there is a tight deadline, it might be more burdensome or if it is falling on a busy time of year (summer time, etc.) • Everything is burdensome; if it is valuable to you it might feel a little bit less burdensome • What am I getting out of this as well? • Presentation of information is important • Help save time in the long run – knowing these things as a student is important • Telling students about the importance of content and how long it will take to complete – being explicit right up front • Overly repetitive can be burdensome because it takes too long to complete when you already know the content • Being upfront with the "time it will take to complete" course can be overwhelming if it is a long time – or time for the whole course can seem burdensome if it is a long period of time for them to complete "on their own time" • Interest and relevance to my day is what makes it less burdensome. AODA is burdensome, even though it's important, it's not relevant to my work • The format of AODA is not interactive so it is boring and hard to complete with interest • AODA content is common sense so I found it boring and burdensome

Advisory Committee Meeting #2

Title: Advisory Committee – Content Preferences	
Administered through Survey Monkey	
Date: June 29, 2017	**Total Responses:** 7

1. From a clinician's perspective, please rate which topic you would find most useful to learn with respect to the evidence-based management of neck pain and associated disorders. Please rate each topic from 1-4 (1=most useful; 4=least useful).

Clinical Assessment and Diagnosis:

	1	**2**	**3**	**4**
Clinical assessment and diagnosis	1	1	1	1
Prognosis and prognostic factors	0	2	2	0
Treatment	3	0	1	0
Measurement of outcomes (including recovery)	0	1	0	3

2. Question 1 does not apply to me because I am not a clinician at CMCC

I am not a clinician	3

3. From a teaching faculty (or teaching assistant) perspective, please rate which topic you would find most useful to learn with respect to the evidence-based management of neck pain and associated disorders. Please rate each topic from 1 to 4 (1 = most useful; 4 = least useful).

	1	**2**	**3**	**4**
Clinical assessment and diagnosis	2	1	1	1
Prognosis and prognostic factors	1	2	2	0
Treatment	2	0	2	1
Measurement of outcomes (including recovery)	0	2	0	3

4. Question 3 does not apply to me because I am not teaching faculty at CMCC

I am not teaching faculty	2

Advisory Committee Meeting #3

Title: TbLT Development Survey 1	
Administered through Survey Monkey	
Date: October 11, 2017	**Total Responses:** 4

1. Did you find this section of the learning tool user-friendly? If yes, what made you feel this way? If no, please explain why not.

1	Please change the font to Calibri or something else.
2	- overall yes -- I like the "book" concept and turning pages; - the LARGE "paperclick" to open the guideline was very noticeable and easy to find - improvements: -- too much info one slide 2 -- for us older folk the font size may be too small to see on one screen; maybe 3 slides that merge into one at the end? - the ability to enlarge the "book" was not easy to know - font size for the algorithm can be larger
3	There was a lot of really good information but I got lost in the amount of it. I found there was too much text and it was too wordy. Also, some of the fonts seemed really small. It was also very technical to read, but I don't know if there is a way around that.
4	Yes. It was brief and easy to digest. One feeling was that there was a lot of text on the second page. Perhaps spreading more white space could help.

2. Do you feel that the content of this section was broken up into easily digestible bits of information? If not, please explain why not and suggest a correction in the segmenting of content.

1	I would try to make the care pathway and quick reference guide more visually appealing...adding colours???
2	- if the slides had fewer info, it would appear less daunting
3	The text was separated according to natural breaks in the content, which I liked. However, because there was too much text the bits of info weren't really digestible.

4	Yes. Also like the book idea and the way the other parts were PDF's opening in a new tab.

3. Do you feel there was an adequate variety of formats (text, video, etc.) for the learning material? Were there any formats you particularly liked? Were there any formats you disliked? Please explain your answer.

1	More short videos to describe the content would be helpful.
2	- good to have video and text for different learning styles
3	I like the idea of variety, however, I found the book and the care pathways/quick reference guide difficult to get through. Small text and a lot of it.
4	Yes, the book! Very nice and presentable way. The flowchart may be better if done in a web tool like Prezi where it was more interactive or colourful.

4. Please consider the overall 'look' of this section. What did you like? What would you like to see changed? Please provide suggestions for changes, if any.

1	It is simple... which is good, but I think adding some "life" to it would be helpful.
2	- see question 1
3	Please see above for comments. One additional comment: near the beginning, you mention that this is important for people "such as yourself in providing the best course of care for your patients" (or something similar). I suggest re-wording this component as many of the people completing the module don't necessarily see patients and so can't relate (may simply be educators -- and so would use the guideline in their teaching). Hope that helps.
4	The PubMed link was a bit difficult to read, however, the full text link was much easier to read and should consider using this link if possible: https://link.springer.com/article/10.1007%2Fs00586-016-4467-7

Advisory Committee Meeting #4

Title: TbLT Development Survey 2	
Administered through Survey Monkey	
Date: October 11, 2017	**Total Responses:** 3

1. Did you find this section of the learning tool user-friendly? If yes, what made you feel this way? If no, please explain why not.

1	I found it user friendly in some ways but not others. The general format and layout were good. The font size was good and the amount of text was appropriate. However, there were some things that I did not find user friendly. For example, the wording and/or layout of the area that described structured educ was not clear to me (at the end of the day I still did not know what you meant by structured educ). On slide #8 I wasn't sure what item #2 meant. Was the diabetes video a place holder? I would also like to be told at the beginning approx how long it will take me to complete the module. In the quiz section, the "next" button did not work, and it wasn't clear to me (until after the first question) that I should be picking only one right answer (the buttons looked like I could pick more than one)
2	Yes. It was a good combination of text, video and assessment. Felt like I learned something in the short interaction with the content. The instructions above the slide box was very useful.
3	Very. All links worked without issue and I found them to be interactive- keeping my attention.

2. Do you feel that the layout of this module was appropriate for use by teaching faculty at CMCC? Consider the learning goals, instructions, content, and resources. Please explain your answer.

1	Yes - further explanation above
2	Yes. It was clear and concise. I could see students adapting to more to this type of module if it were consistent across courses.

3	One missing component is a case example to see how you would implement structured patient education.

3. Consider the overall look of the module. Do you have any suggestions to make the module look and "feel" more appealing? Please describe your answer.

1	See above. Having the "next" buttons work in the quiz and making it clear that I am to select only one answer are ways to make the module more appealing. Hope this helps!
2	I tested this on an iPad and iPhone. It was responsive which is important considering all students will have an iPad in the coming years. From a look and feel, I suggest having a bit more colour, perhaps looking at CMCC's branding guidelines and using some colours for buttons and having some imagery.
3	No. I really enjoyed the tech used in this module. However, there is a mistake in last answer box (in the Firebox powered quiz)- Reads linician rather than clinician.

Advisory Committee Meeting #5

Title: TbLT Development Survey 3	
Administered through Survey Monkey	
Date: November 10, 2017	**Total Responses:** 2

1. Did you find this section of the learning tool easy to use? If yes, what made you feel this way? If no, please explain why not.

1	Yes, it is excellent! I would recommend the following changes: 1. Increase font size of the main text section; 2. Change font from Times Roman to something softer.
2	Yes. All links worked and where you had to click was obvious.

2. Do you feel that the content of the learning tool was broken up into easily digestible bits of information? If not, please explain why not and suggest a correction in the segmenting of content.

1	Yes, but the section of the development of recommendations could be shorter. It could even be made into a video where you interview Côté and have him explain in plain language how the recommendations were developed.
2	Yes. At first glance there is a lot of information that the task force synthesized. The broken down modules allow the reader to gain an understanding on each without becoming overwhelmed.

3. Please consider the "slides" within each module. In your opinion, did you feel the lessons were appropriately formatted? (Were they cluttered? / Did they have appropriate images? / Did they have enough images?) Please explain your answer.

1	Yes, they were very good. I suggest that you include sound bites to emphasize important components of the tool.
2	The slides within each module were nicely formatted. It was easy to read through and obtain the take home points

4. Please consider the overall “look” of this section. What did you like? What would you like to see changed? Please provide suggestions for changes.

1	See above
2	Change- see below. Overall the look is appealing. Clean and not cluttered.

5. Please provide any additional comments you may have here.

1	Excellent work! you are breaking new grounds!
2	For the quiz, I would recommend if possible keeping a tally and if the responder didn't get all/majority correct they should have to repeat in order to progress through the slides.

Advisory Committee Meeting #6

Title: TbLT Development Survey 4	
Administered through Survey Monkey	
Date: November 29, 2017	**Total Responses:** 6

1. Do you feel the learning tool is user-friendly? If not, please describe which section, and why.

1	Yes
2	Yes, good introduction video. I like that there are quizzes (not marked) to keep the learner focused.
3	Yes
4	Very user friendly
5	Very user friendly. All links work, the advance cue are conveniently located and easy to find
6	Very easy to use

2. Do you think that the lessons are presented in a clear and concise manner? Are they presented in a logical way? Are they uncluttered? Are there any unnecessary or distracting multimedia?

1	Logical and uncluttered. I found no unnecessary or distracting multimedia
2	Yes. Good learning objectives, and the use of google slides is great. I enjoyed the video on shared decision-making/ Slide decks are the right length.
3	The module is presented in a concise manner
4	Yes, clear and concise – female pic in quiz 2 doesn't look to be 148lbs
5	Same as above
6	Yes

3. Do you find the learning tool engaging? We are trying to project the main "take-home" messages of this section of the guideline, do you feel like this was

accomplished in an interesting fashion? Is there anything that is missing which would make the learning tool more engaging for a learner?

1	Engaging, nothing missing
2	A very appealing e-module!!!
3	No, I think the section is filled with plenty of text, diagrams and videos to help the learner gain all take home points
4	Possibly a completion meter or %
5	Missing- Consequences for getting a majority of questions incorrect in the module.
6	Yes

4. Are the instructions clear? Does the introductory video provide an adequate overview of the instructions for completing the learning tool? Are the instructions within the modules clear and concise? Are there any instructions missing from the learning tool that would improve the experience of the learner?

1	Yes. The only problem with the experience was that on my laptop, in landscape mode, some of the slides were fully visible and others required scrolling to see the full slide and NEXT button. Not sure if there is a fix for this, such as putting the buttons on the side rather than bottom.
2	Love the introductory video. Instructions are clear. I always enjoy a road-map at the beginning of an e-module explaining each “thing” I’m about to do in order
3	Very clear
4	Excellent
5	As noted in question #1 everything is very clear and organized, which helps user navigate.
6	Yes

5. Is there anything that is missing from the learning tool? Pictures Content, Colour, etc.

1	No
2	A road-map of the module at the beginning of the course

3	I don't think any of the sections are cluttered, however, adding additional content will make things seem bunched.
4	For Quiz 1 and 2, it wasn't clear if ADLs were or were not affected. Patient "was able to perform all her work and household duties, and was able to continue doing her leisure activities"
5	As noted in question #1 everything is very clear and organized, which helps user navigate.
6	-

6. Please provide any additional comments you may have to improve the learning tool.

1	Please see above, my comment on landscape mode on a laptop
2	Very appealing module! Congrats
3	No additional comments. I think you've taken content that can be daunting to review and made it quite digestible.
4	No
5	Great mix of the above
6	-

Appendix F: Pedagogy

Informed by educational literature on technology-based learning, pedagogical learning theories and design principles were considered throughout the development of the learning tool.

Table F-1 outlines the framework developed prior to the development of the learning tool. This framework provides pedagogical concepts to consider as well as a rationale and explanation for each. This framework is an exhaustive list of the pedagogical concepts for the development of this learning tool. Not all items listed in the framework were incorporated into its design.

A checklist was developed which included key components and definitions of the pedagogical theories and principles (Table F-2 and F-3). The checklist ensured each concept was considered in the design and development of the learning tool. The choice of which theories and principles to add was based on feedback from the Advisory Committee and the systematic review.

The technology-based learning tool design framework (Table F-1) was adopted from course material developed by Dr. Robin Kay at the University of Ontario Institute of Technology (EDUC 5104: Analysis and Design of Web-based Learning Tools) in 2016.

Table F-1: Technology-based Learning Tool Design Framework

Purpose	
Audience	Who will be the primary users of this tool? • Language (words used, vocabulary, and sentence structure) is appropriate for the age, reading level and interests of the expected user • Honour the personalization principle; content should be structured to provide a personal feeling when learning (e.g., "you" instead of "the student")

Purpose	How is this tool going to be used? • Content of the TbLT will depend on why the intended audience will require this content and what it will be used for
Learning Goals	What is the intended purpose of the outcome of the learning? /How will the learner use the information they have learned? • Learning goals should be addressed prior to TbLT development to ensure design and content are supportive of goals • Meaningful questions are addressed • Learning goals should be segmented and clearly /simply stated at the beginning of each learning unit (e.g., By the end of this section you should …)
Learning Theories	Which learning theories are important to include in this TbLT based on the learning goals, content, and audience? • ARCS, Constructivism, Connectivism, Elaboration, Experiential, Problem-based learning, Situated learning, Social development, Social learning
Design Principles	Which design principles are important to include in this TbLT based on the learning goals, content, and audience? • Coherence, Collaboration, Contiguity, Learning control, Modality, Multimedia, Personalization, Practice principles, Pre-training, Redundancy, Segmenting, Thinking Skills, Worked examples
Design	
Infrastructure	Which tool is likely to best support the goals of this TbLT? • Consider content, learning goals, activities, interactivity, assessment, etc.
Segmenting	How should the content be divided? (Sections, lessons, subsections, etc.) /How much information should be provided as supporting information for each point referred to?

	• Modules/steps/lessons need to be segmented, so no (or very little) scrolling on pages • Text in the TbLT is presented in short, concise segments • No one component of TbLT attempts to cover too much material
Text	Is there a general guideline for accessibility at CMCC? /Does this audience require any specific accessibility modifications? • Text in the TbLT is easy to read (e.g., good font size and type, clear, not fuzzy) • Text style complies with accessibility standards
Formatting	Formatting needs to be appropriate for the audience as well as the topic of learning. What are some examples of formatting aspects that are important to you when completing a course? • Components of the TbLT have a consistent look and feel to them • TbLT looks like it was professionally created (e.g., attractive, modern, appealing colours) • Strong contrast between text and background
Images/ Graphics	Would it be appropriate to incorporate images/graphics/videos of real-life scenarios for this topic and audience? • No distracting background images on any screen • All images and graphics serve a specific purpose with regard to the learning outcomes
Usability	
Navigation	What is an appropriate number of lessons for this audience? /How many navigation options should be made available? • Clear, unambiguous navigation • Modules/Lessons/Steps in TbLT should be numbered • Navigation route is simple and intuitive • Navigation labels need to match content

	• Inclusion of orienting features in the TbLT (e.g., breadcrumb navigation, menu highlighting, appropriate page titles, home, exit, previous, next buttons are present) • Navigation labels are clear and easily understood
Scrolling	• No scrolling on the home page • No inclusion of big graphics or text that force the user to scroll off the screen – Make these into links that open up a new page
Cognitive Processing	• No cognitive processing should be spent on how to use the module – it should be obvious • It is obvious how to use the TbLT or the instructions are clear and easy to follow. • TbLT is natural to use • Overall, the module has to have the feel of guiding the user through a lesson one-on-one • Provide instructions on a need to know basis • Concepts in the TbLT were addressed in a coherent, integrated manner
Educational Guidance	
Pacing	Should learners be able to control their own pacing through the TbLT or should it be restricted? • User has the ability to redo or relearn component before moving on • User has the ability to move through instructional elements at own speed • Users has the ability to make choice about the paths to take so that one can progress at own learning level
Assessment	What type of assessments are most appropriate for this audience? (Quizzes/tests, game-type assessments, assignments, etc.) /Should learners be able to re-do an assessment portion of the TbLT when learners do not receive an appropriate score for a section?

	• Assessment/student work needs to be available digitally • Activity or assessment should occur after learning content (no videos that are not connected to learning) This should be segmented and not occur at the end of a lot of content
Feedback	Should learners be given instant feedback on each question when providing incorrect answers during quizzes? Should learners be given feedback at the end of each quiz? • Feedback given to the user (when applicable) is effective in terms of learning
Interactivity	
Activities	What type of engaging activities could be used within the TbLT? • Interactions with the TbLT are meaningful and permit the user to have a much greater understanding of the concept/topic than he/she would have if she used a text-based medium • TbLT included a wide variety of learning tools (e.g., videos, animations, web-based learning tools, social media, discussion boards, question and answer sessions)
Media	What type of multimedia content are appropriate for this learning tool, audience, and topic? • Multimedia content (e.g., graphics, animations, video, audio) in the TbLT supports the learning process
Social Media	Are there any types of social media content such as discussion boards, blogs, etc. that this TbLT would benefit from? • Social media (e.g., discussion boards, blogs, Facebook, Twitter, Ning) in the TbLT supports the learning process
Engagement	
Motivation	What types of motivational tools would encourage the learner's progression through the TbLT? • Interactions, theme, and/or tasks of the TbLT would be motivating for the designated audience

	• Concepts/goals address in the TbLT would be cognitively engaging/challenging for the intended audience (e.g., there are several different levels of challenge within the TbLT)
Communication	Does this TbLT need to be transcribed for learners in this demographic? As a learner would you prefer to read through text accompanied by images/graphics/videos or would you prefer to listen to text while accompanied by images/graphics/videos? • Communication (audio or text) is personal and not excessively formal for the target audience • The relevance of the concepts addressed by the TbLT was communicated effectively • Context or big picture for the TbLT was communicated effectively • Concepts addressed in the TbLT were communicated effectively

Table F-2: Learning Theories used in design of learning tool

Learning Theory	How it was used
ARCS Model of Motivational Design [1] • A step-by-step process to efficiently maintain learner motivation. This theory contains four stages: o Attention, through active participation; Relevance, using present examples; Confidence, having clear objectives to accomplish; and Satisfaction, rewarding sense of achievement.	Attention: lessons are short, learner actively progresses through modules; Relevance: examples used in case studies are relevant to the learner's occupation and cases DCs might see in clinic; Confidence: learning outcomes are listed within each module which are directly related to the learning content and review quizzes; Satisfaction: learners are provided with instant feedback following review quizzes and case

	studies allows learners to treat a patient using new knowledge.
Elaboration [2] • Instruction should be provided to the learner in a layering fashion. Once one layer has been accomplished, subsequent layers are added to build complexity and further understanding.	Modules focusing on one portion of the guideline and then adding as the learner progresses through the learning tool.
Problem-based Learning [3] • The learner is provided with open-ended, authentic scenarios whereby they are responsible for activity-solving instead of the educator simply presenting the solution.	Each module is completed with a review quiz and at the end of the series of modules, there is are case studies for the learner to apply their knowledge.

Table F-3: Design Principles used in design of learning tool

Design Principle	How it was used
Coherence [4] • Keeping lessons uncluttered of distracting multimedia. • The addition of entertaining elements such as images or additional colour can distract the learner and actually take away from the learning as individuals are overloaded with media. • Too much content on screen diverts the learner's attention to the learning material, disrupts the organization of the learning, and creates irrelevancy and confusion. • All additional media added to learning should be logical and serve a purpose.	Modules are uncluttered. PowerPoint slides within modules only highlight the most important "take-home" points of each respective section.

Contiguity [5] • Placing words and graphics together. • While using a combination of text and graphics in learning material, ensure that the graphics are in close proximity to the text which explains it. • This reduces cognitive overload within the learner trying to process the information.	Diagrams/figures are explained with text together.
Learner Control [6] • Providing the learner with access to certain aspects of the learning material such as content sequencing, pacing, and access to learner support. • Most effective when: learners have some previous knowledge of the subject, subject is a more advanced level (more than basic), metacognitive skills are high in learners (awareness and analysis of one's thoughts).	The next and back buttons allowed learners to progress through the modules at their own pace. Limits were placed on a module menu to encourage the flow of modules in order.
Multimedia [7] • Using a combination of text and graphics in learning material provides a greater benefit to the learner than text alone. • It is important to ensure that all graphics used must serve a specific purpose towards the learning outcomes.	Where applicable, PowerPoint slides contained graphics which helped to explain concepts and definitions.
Personalization [8] • Creating opportunity for learners to feel a personal connection to their learning through choice of language and engagement. • The personalization of language used within learning material keeps learners engaged and interested in the material.	Language was discussed with Advisory Committee. Engagement through Case Studies – those who are practicing health professionals would feel a sense of connection as these might be

• Using language that is more personal such as: we, you, us, etc. using polite, human voice narration. • Learners are more engaged when content is conversational and less formal.	cases they would see in practice. Those who do not practice, may not feel this connection unfortunately.
Practice [9] • Used to promote interaction by engaging learners behaviorally and psychologically • Five principles: repetition, feedback, motivation, practice, and retrieval of prior knowledge. • Helps to store knowledge and skills into the learner's long-term memory.	Practice quizzes are provided for each module/ each new concept as well as an overall review with the case studies at the end of the learning tool.
Segmenting [10] • Breaking down large, complex content into smaller "bite-size" content is much more manageable for the learner. • This principle ensures that learners have opportunity to fully grasp the topics provided to them and do not fall behind because of content overload. • Background knowledge should always be presented first as learners will remember the chronological order in which information is presented.	The content is broken down into modules each explaining a new concept. This helps to ensure less cognitive load on the learner compared to learning all concepts at once.
Thinking Skills [11] • Development of critical thinking skills involving evaluation of products or ideas. • Most prominent thinking skills for e-learning are creative thinking skills (generating new ideas and perspectives), critical thinking skills (applying, analyzing, synthesizing, and evaluating	Learners were encouraged to participate in the case studies following learning through the modules. The case studies allowed learners to actively search through the patient's case file and retrieve

information) and metacognition (awareness and analysis of one's thoughts).	information that was relevant to the appropriate treatment of the patient. Learners would have inherently progressed through the critical thinking skills components in order to treat the patient using the content they learned throughout the modules.

References

1. David L. ARCS Model of Motivational Design Theories (Keller) Learning Theories2014 [Available from: https://www.learning-theories.com/kellers-arcs-model-of-motivational-design.html.
2. David L. Elaboration Theory (Reigeluth): Learning Theories; 2014 [Available from: https://www.learning-theories.com/elaboration-theory-reigeluth.html.
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4. Clark RC, Mayer RE. Applying the Coherence Principle E-Learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer; 2011. p. 151-76.
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10. Clark RC, Mayer RE. Applying the Segmenting and Pretraining Principles: Managing Complexity by Breaking a Lesson into Parts E-learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer 2011. p. 205-22.
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Appendix G: CMCC Investigator Committee

An Investigator Committee was established and included four members with administrative faculty roles within the institution. The role of this committee was to support the design and implementation of the study at CMCC. An outline of the committee members is provided in Table D-1.

Table G-1: Investigator Committee Members and Role

	Profession	**Role**
1	Professor	Thesis Supervisor/ Member
2	Dean of Clinics, CMCC	Member
3	Director, Clinical Education & Patient Care, CMCC	Member
4	Director, Research Partnerships & Research, CMCC	Member

The Investigator Committee met for the first time, in person, on June 20, 2016. Where the group discussed the development of the Advisory Committee. The Investigator Committee provided suggestions, through group discussion regarding invitees to the Advisory Committee during this meeting.

The Investigator Committee met four times throughout the development phase of the learning tool (June 30th, 2016, August 3rd, 2016, September 9th, 2016, and October 6th, 2017). The primary focus of these meetings was toward the development of the learning tool and recruitment strategies for the evaluation phase of the study.

A fifth meeting was called on February 23rd, 2018, during the evaluation phase of the study. This meeting was called to discuss how to increase the participation rate, within the framework of approved strategies.

Table G-2: Outline of each Investigator Committee meeting

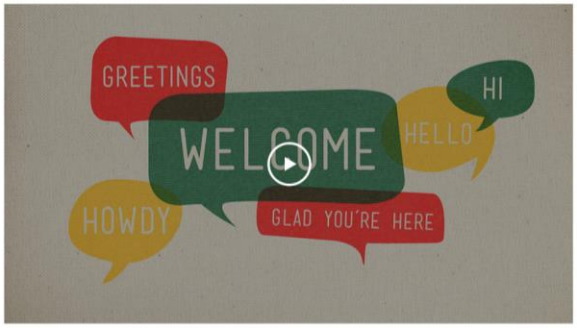
1.	**Title:** Investigator Committee – Inaugural Meeting
	Administered in person at the Canadian Memorial Chiropractic College

	Date: June 30th, 2016	**Total Attendees:** 4
	Purpose of meeting: • Presentation of preliminary study information and ideas • Discussion of the development of an Advisory Committee • Committee suggested individuals to sit on Advisory Committee	
2.	**Title:** Investigator Committee	
	Administered in person at the Canadian Memorial Chiropractic College	
	Date: August 3rd, 2016	**Total Attendees:** 3
	Purpose of meeting: • First Advisory Committee meeting preparation • Discussion of pedagogical theories and principles considered in development of learning tool	
3.	**Title:** Investigator Committee	
	Administered in person at the Canadian Memorial Chiropractic College	
	Date: September 9th, 2016	**Total Attendees:** 4
	Purpose of meeting: • First Advisory Committee meeting preparation • Discussion of what component of the clinical practice guideline should be the focus of the learning tool • Discussion of current use of online educational programs currently circulating at CMCC	
4.	**Title:** Investigator Committee	
	Administered in person at the Canadian Memorial Chiropractic College	
	Date: October 6th, 2017	**Total Attendees:** 4
	Purpose of meeting: • Presentation of learning tool to date • Committee discussed the design and methodology of the evaluation component of the study • Discussion of proposed recruitment strategies • Discussion of timeline for implementation of the study	

5.	**Title:** Investigator Committee	
	Administered in person at the Canadian Memorial Chiropractic College	
	Date: February 23rd, 2018	**Total Attendees:** 4+1 (guest invitee – CMCC Administrative Faculty Member)
	Purpose of meeting: • Discussion of participation rate to date and discussed ideas of how to improve it based on current recruitment strategies (i.e. when to target specific groups for face-to-face interaction, etc.)	

Appendix H: Learning Tool Intervention
Original Version (used from Feb 1st, 2018 – April 27, 2018)

Watch the video below to get started



NEXT

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By completing this series of modules, you will be able to:

1. define and describe each recommended intervention for the treatment of acute neck pain, grades I-II
2. define and describe each 'do not offer' recommendation for the treatment of acute neck pain, grades I-II
3. understand how to treat patients with acute, grades I-II neck pain using the neck pain guideline

BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

What is the Neck Pain Guideline?

Click here to view the Neck Pain Guideline

An evidence-based clinical practice guideline for the management of neck pain and associated disorders, grades I-III. The guideline was developed based on systematic reviews using only high-quality, low risk of bias studies.

The guideline aims to:
1) speed recovery;
2) reduce the intensity of symptoms;
3) promote early restoration of function;
4) prevent long-term pain and disability;
5) improve health-related quality of life;
6) reduce recurrences; and
7) promote the active participation of patients in their care.

Who developed it? When?

The guideline was published in the European Spine Journal in 2016 by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration

The team considered the evidence of effectiveness, the safety of interventions, cost-effectiveness, societal and ethical values, and patient experiences (obtained from qualitative research) in order to formulate the guideline and its recommendations.

BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Development of Recommendations

This guideline adapted the National Institute for Health Care Excellence (NICE) methodology to develop the wording of guideline recommendations.

Click for more on recommendation development

Scroll through the slides below

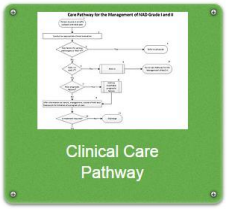
- The bottom menu will allow you to select which slides you wish to view, toggle full-screen, and download a pdf version of the content
- Once you have completed this exercise, please click next to move to the next section of the module

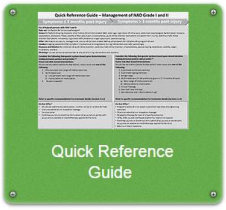
BACK NEXT

Care Pathways & Quick Reference Guide

The following modules are based on the recommendations for the management of acute (symptom duration of ≤ 3 months) neck pain and associated disorders, grade I-II.

Before getting started, click to download the Clinical Care Pathway & Quick Reference Guide.

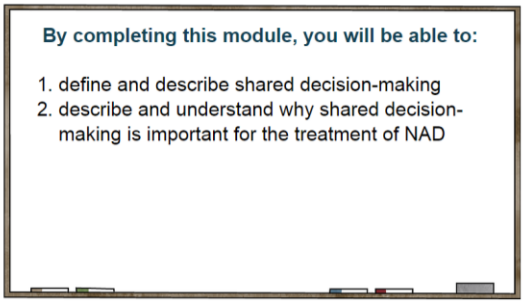

Clinical Care Pathway


Quick Reference Guide

BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Shared Decision-making



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UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Shared Decision-making

Scroll through the slides below

- The bottom menu will allow you to select which slides you wish to view, toggle full-screen, and download a pdf version of the content
- Once you have completed this exercise, please click next to move to the next section of the module

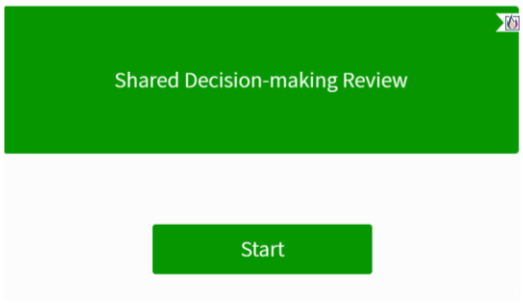
BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Shared Decision-making Review

Click the Start button below to review what you have learned in this module

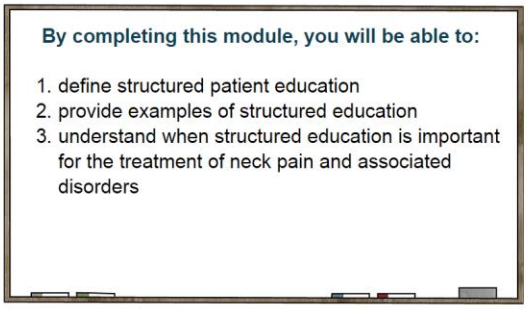
- This is a multiple choice quiz. Please select the most correct answer to each question
- Quiz scores will not be collected or analyzed in this study, they are here only for your review of the material



BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Structured Patient Education



BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Structured Patient Education

For NAD grades I-II ≤ 3 months duration, clinicians may consider **structured patient education** in combination with: range of motion exercise, multimodal care (range of motion exercise with manipulation or mobilization), or muscle relaxants.

Click here to view the Neck Pain Guideline

Scroll through the slides below

- The bottom menu will allow you to select which slides you wish to view, toggle full-screen, and download a pdf version of the content
- Once you have completed this exercise, please click next to move to the next section of the module

BACK NEXT

Structured Patient Education

Click the Start button below to review what you have learned in this module

- This is a multiple choice quiz. Please select the most correct answer to each question
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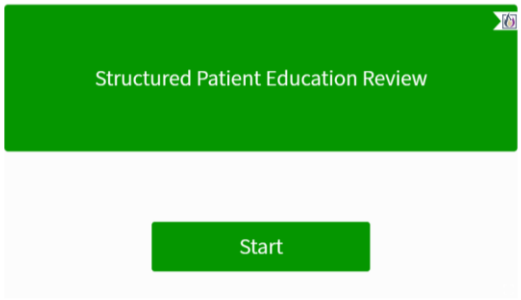

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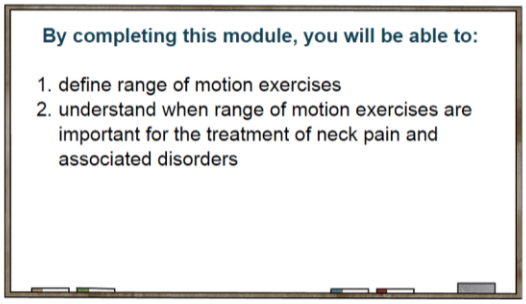
Range of Motion



BACK NEXT

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Range of Motion Exercises

For NAD grades I-II ≤ 3 months duration, clinicians may consider structured patient education in combination with: **range of motion exercise**, multimodal care (range of motion exercise with manipulation or mobilization), or muscle relaxants.

Click here to view the Neck Pain Guideline

Scroll through the slides below

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- Once you have completed this exercise, please click next to move to the next section of the module

BACK NEXT

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Range of Motion Review

Click the Start button below to review what you have learned in this module

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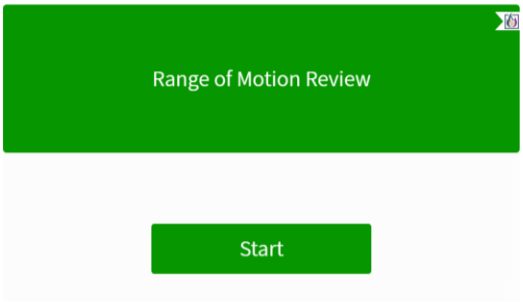

BACK NEXT

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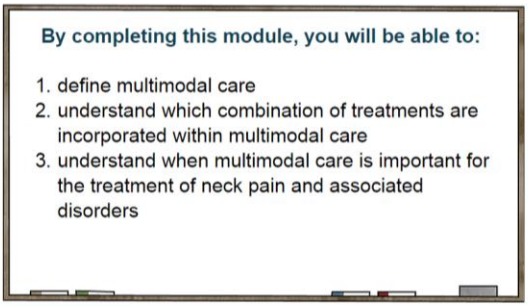
Multimodal Care



BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Multimodal Care

For NAD grades I-II ≤ 3 months duration, clinicians may consider structured patient education in combination with: range of motion exercise, **multimodal care (range of motion exercise with manipulation or mobilization)**, or muscle relaxants.

Click here to view the Neck Pain Guideline

Scroll through the slides below

- The bottom menu will allow you to select which slides you wish to view, toggle full-screen, and download a pdf version of the content
- Once you have completed this exercise, please click next to move to the next section of the module

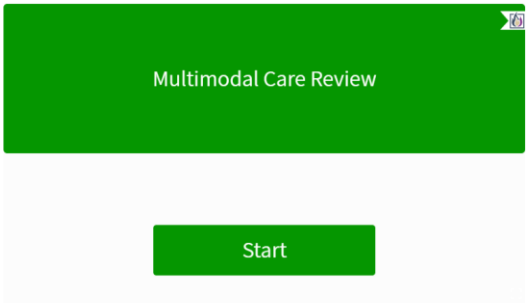
BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Multimodal Care Review

Click the Start button below to review what you have learned in this module

- This is a multiple choice quiz. Please select the most correct answer to each question
- Quiz scores will not be collected or analyzed in this study, they are here only for your review of the material



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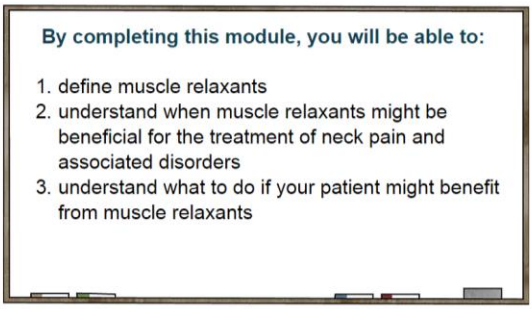
Muscle Relaxants



BACK NEXT

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Muscle Relaxants

For NAD grades I-II ≤ 3 months duration, clinicians may consider structured patient education in combination with: range of motion exercise, multimodal care (range of motion exercise with manipulation or mobilization), or **muscle relaxants**.

Click here to view the Neck Pain Guideline

Scroll through the slides below

- The bottom menu will allow you to select which slides you wish to view, toggle full-screen, and download a pdf version of the content
- Once you have completed this exercise, please click next to move to the next section of the module

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Muscle Relaxants Review

Click the Start button below to review what you have learned in this module

- This is a multiple choice quiz. Please select the most correct answer to each question
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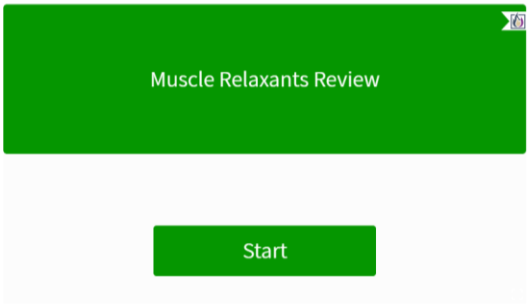

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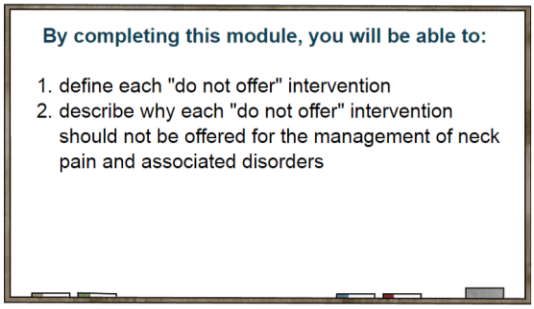
Do Not Offer



BACK NEXT

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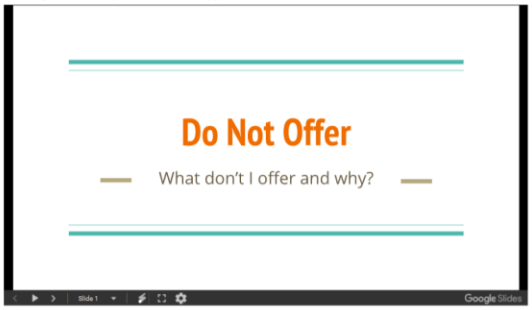
Do Not Offer

For NAD grades I-II ≤ 3 months duration, in view of evidence of no effectiveness, **clinicians should not offer structured patient education alone, strain-counterstrain therapy, relaxation massage, cervical collar, electroacupuncture, electrotherapy, or clinic-based heat.**

Click here to view the Neck Pain Guideline

Scroll through the slides below

- The bottom menu will allow you to select which slides you wish to view, toggle full-screen, and download a pdf version of the content
- Once you have completed this exercise, please click next to move to the next section of the module



BACK NEXT

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Do Not Offer Review

Click the Start button below to review what you have learned in this module

- This is a multiple choice quiz. Please select the most correct answer to each question
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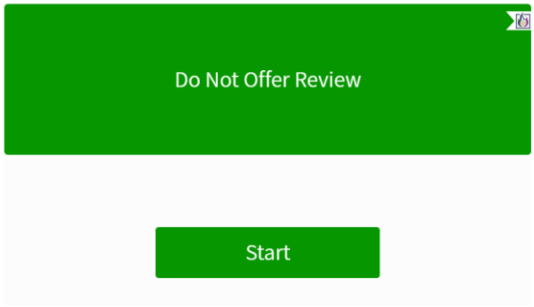

BACK NEXT

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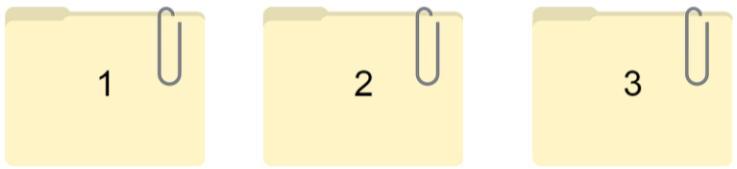
Application of Knowledge

Choose a case file below to treat a patient with neck pain



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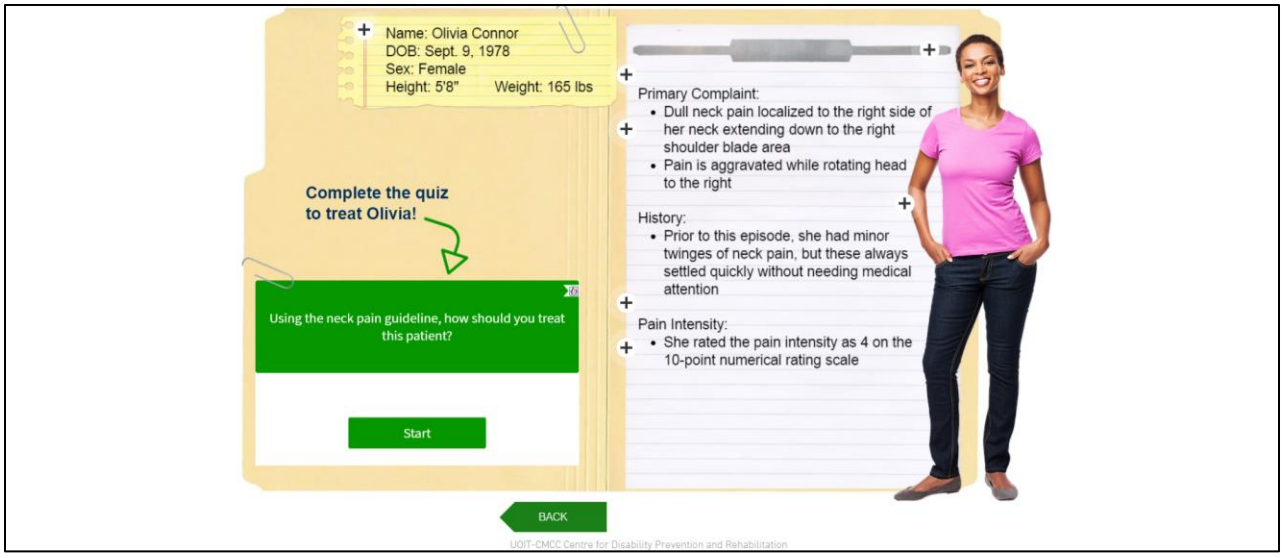
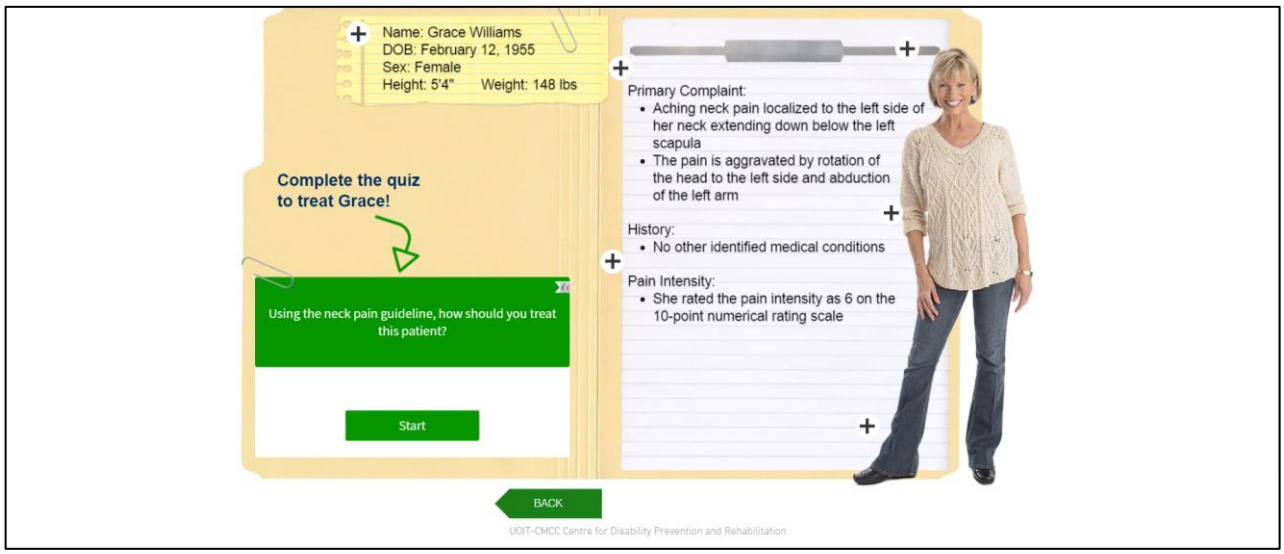
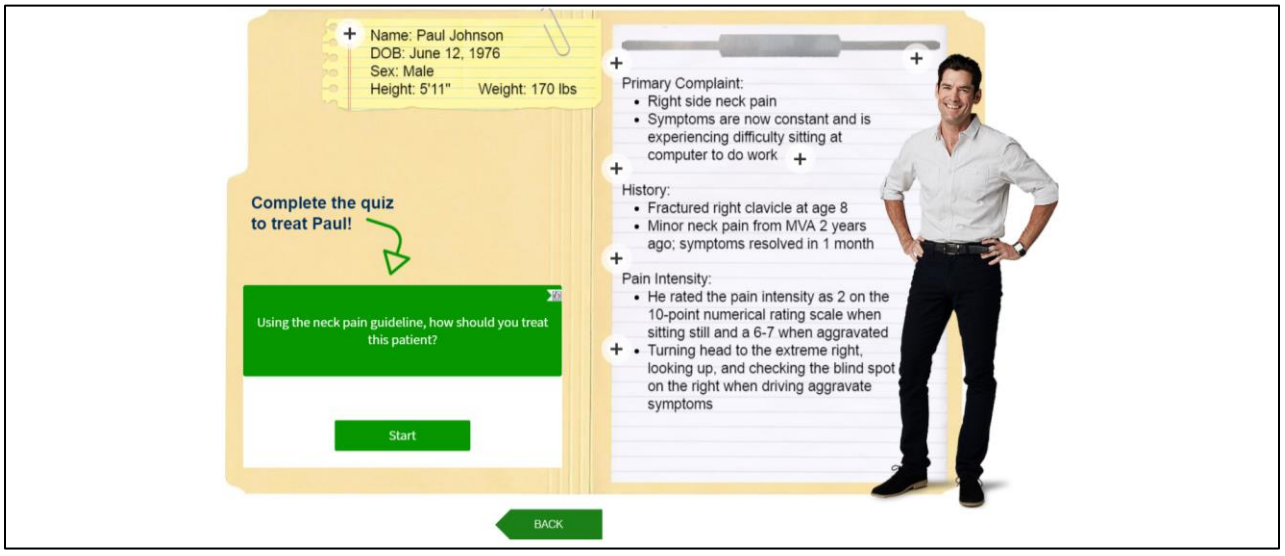

Name: Olivia Connor
DOB: Sept. 9, 1978
Sex: Female
Height: 5'8" Weight: 165 lbs
Primary Complaint:
• Dull neck pain localized to the right side of her neck extending down to the right shoulder blade area
• Pain is aggravated while rotating head to the right
History:
• Prior to this episode, she had minor twinges of neck pain, but these always settled quickly without needing medical attention
Pain Intensity:
• She rated the pain intensity as 4 on the 10-point numerical rating scale
Complete the quiz to treat Olivia!
Using the neck pain guideline, how should you treat this patient?
Start
BACK
UOIT-CMCC Centre for Disability Prevention and Rehabilitation

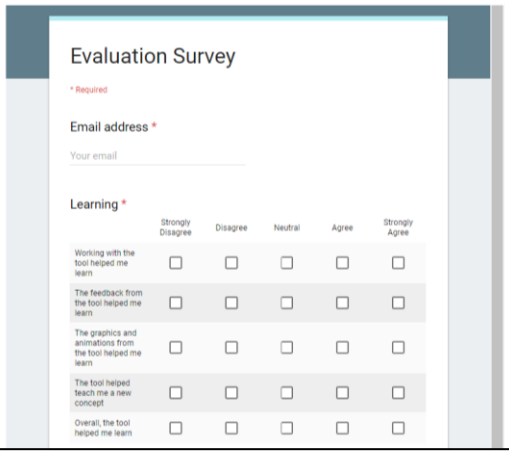

Name: Grace Williams
DOB: February 12, 1955
Sex: Female
Height: 5'4" Weight: 148 lbs
Primary Complaint:
• Aching neck pain localized to the left side of her neck extending down below the left scapula
• The pain is aggravated by rotation of the head to the left side and abduction of the left arm
History:
• No other identified medical conditions
Pain Intensity:
• She rated the pain intensity as 6 on the 10-point numerical rating scale
Complete the quiz to treat Grace!
Using the neck pain guideline, how should you treat this patient?
Start
BACK
UOIT-CMCC Centre for Disability Prevention and Rehabilitation


Name: Paul Johnson
DOB: June 12, 1976
Sex: Male
Height: 5'11" Weight: 170 lbs
Primary Complaint:
• Right side neck pain
• Symptoms are now constant and is experiencing difficulty sitting at computer to do work
History:
• Fractured right clavicle at age 8
• Minor neck pain from MVA 2 years ago; symptoms resolved in 1 month
Pain Intensity:
• He rated the pain intensity as 2 on the 10-point numerical rating scale when sitting still and a 6-7 when aggravated
• Turning head to the extreme right, looking up, and checking the blind spot on the right when driving aggravate symptoms
Complete the quiz to treat Paul!
Using the neck pain guideline, how should you treat this patient?
Start
BACK

Evaluation of Learning Tool

Please complete the evaluation survey below. Your answers will be used to develop recommendations on the future development of learning tools for teaching faculty at the Canadian Memorial Chiropractic College.

Thank you for your participation in this study.



Evaluation Survey

* Required

Email address *

Your email

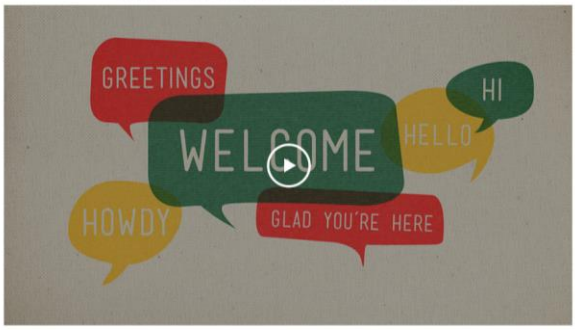
Learning *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Working with the tool helped me learn	☐	☐	☐	☐	☐
The feedback from the tool helped me learn	☐	☐	☐	☐	☐
The graphics and animations from the tool helped me learn	☐	☐	☐	☐	☐
The tool helped teach me a new concept	☐	☐	☐	☐	☐
Overall, the tool helped me learn	☐	☐	☐	☐	☐

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Amended Version (used from April 27, 2018 – May 31st, 2018)

Watch the video below to get started



NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

What is the Neck Pain Guideline?

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The guideline aims to:

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2) reduce the intensity of symptoms;
3) promote early restoration of function;
4) prevent long-term pain and disability;
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BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Development of Recommendations

Click for more on recommendation development

This guideline adapted the National Institute for Health Care Excellence (NICE) methodology to develop the wording of guideline recommendations.

Scroll through the slides below

- The bottom menu will allow you to select which slides you wish to view, toggle full-screen, and download a pdf version of the content
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BACK NEXT

Care Pathways & Quick Reference Guide

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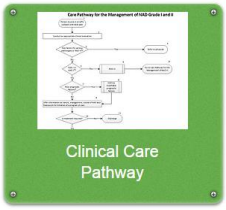
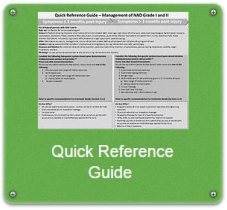


Clinical Care Pathway



Quick Reference Guide

BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Structured Patient Education

By completing this module, you will be able to:

1. define structured patient education
2. provide examples of structured education
3. understand when structured education is important for the treatment of neck pain and associated disorders

BACK NEXT

UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Structured Patient Education

For NAD grades I-II ≤ 3 months duration, clinicians may consider **structured patient education** in combination with: range of motion exercise, multimodal care (range of motion exercise with manipulation or mobilization), or muscle relaxants.

Click here to view the Neck Pain Guideline

Scroll through the slides below

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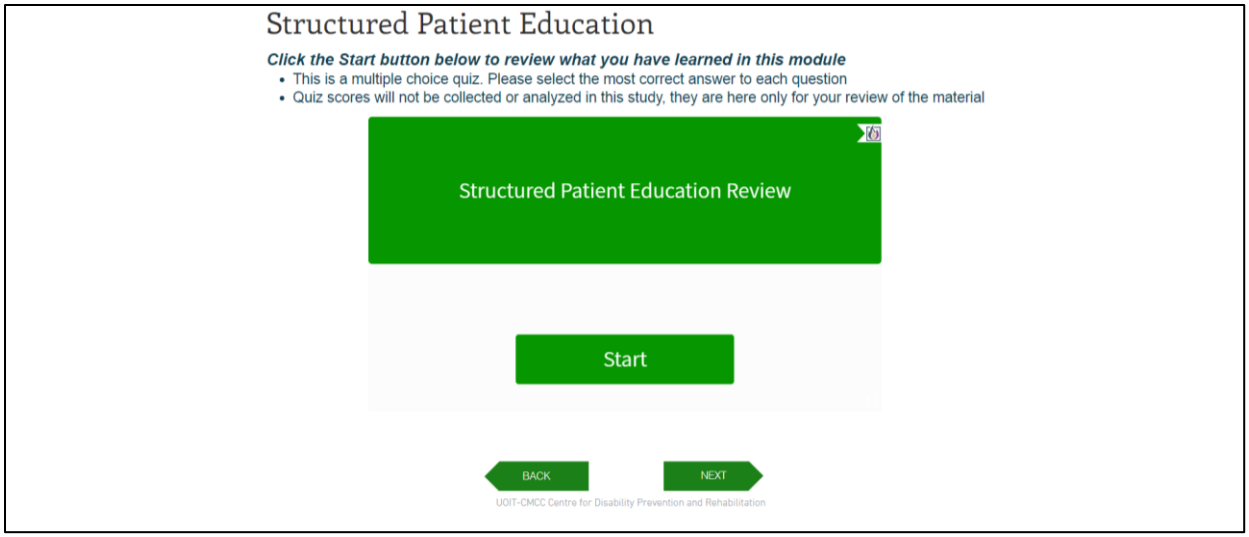
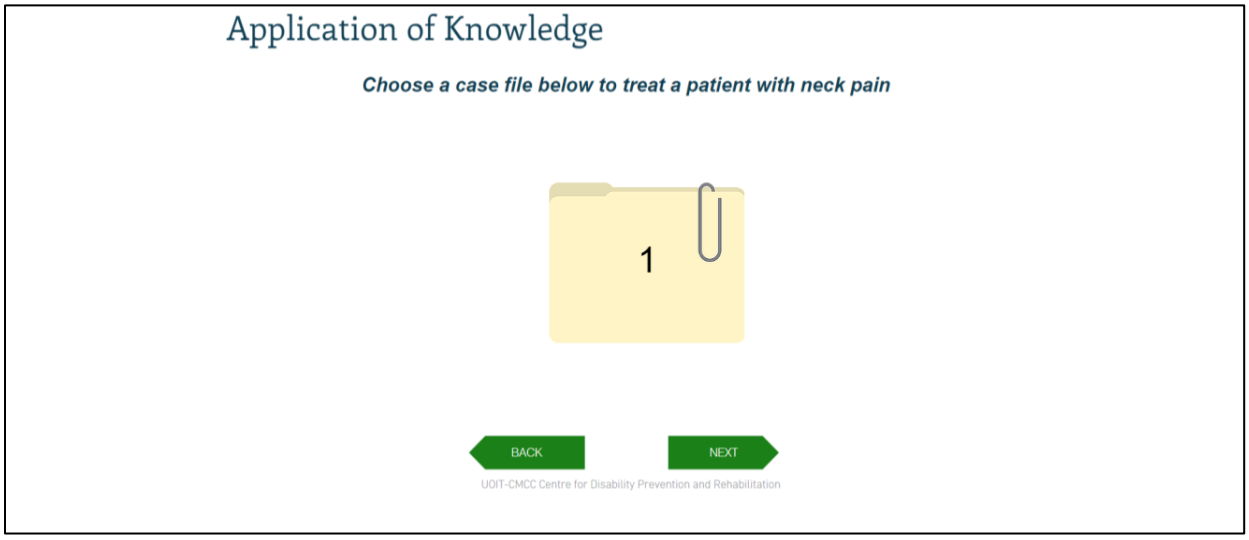
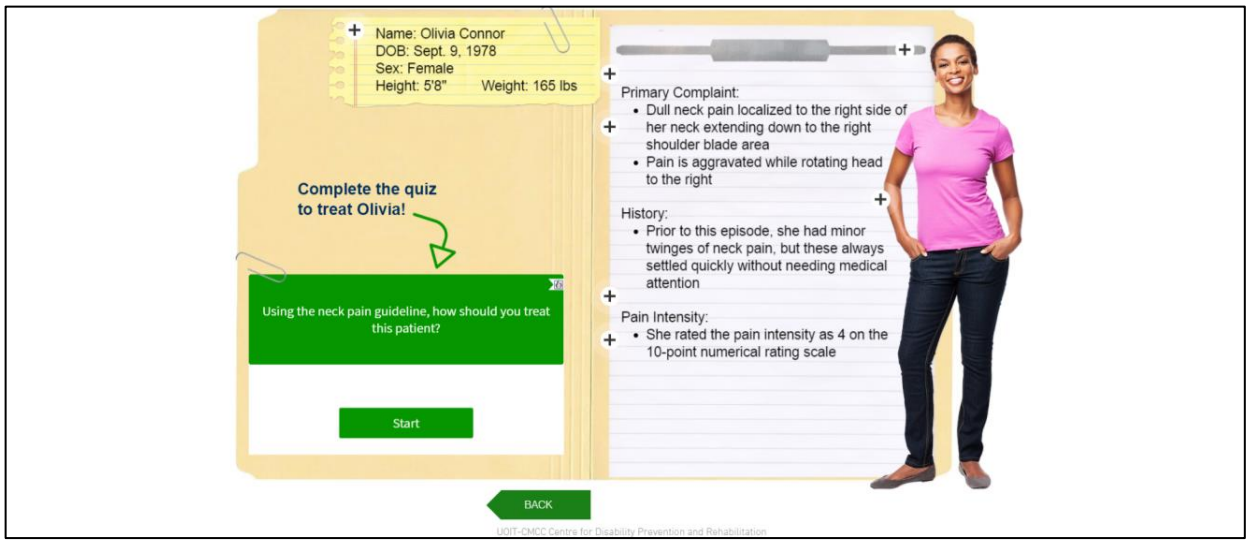
- Once you have completed this exercise, please click next to move to the next section of the module

BACK NEXT


Structured Patient Education
Click the Start button below to review what you have learned in this module
This is a multiple choice quiz. Please select the most correct answer to each question
Quiz scores will not be collected or analyzed in this study, they are here only for your review of the material
Structured Patient Education Review
Start
BACK
NEXT
UOIT-CMCC Centre for Disability Prevention and Rehabilitation

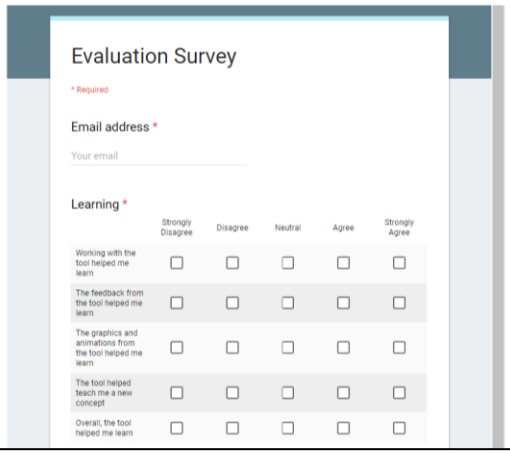

Application of Knowledge
Choose a case file below to treat a patient with neck pain
1
BACK
NEXT
UOIT-CMCC Centre for Disability Prevention and Rehabilitation


Name: Olivia Connor
DOB: Sept. 9, 1978
Sex: Female
Height: 5'8"
Weight: 165 lbs
Primary Complaint:
Dull neck pain localized to the right side of her neck extending down to the right shoulder blade area
Pain is aggravated while rotating head to the right
History:
Prior to this episode, she had minor twinges of neck pain, but these always settled quickly without needing medical attention
Pain Intensity:
She rated the pain intensity as 4 on the 10-point numerical rating scale
Complete the quiz to treat Olivia!
Using the neck pain guideline, how should you treat this patient?
Start
BACK
UOIT-CMCC Centre for Disability Prevention and Rehabilitation

Evaluation of Learning Tool

Please complete the evaluation survey below. Your answers will be used to develop recommendations on the future development of learning tools for teaching faculty at the Canadian Memorial Chiropractic College.

Thank you for your participation in this study.



Evaluation Survey

* Required

Email address *

Your email

Learning *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Working with the tool helped me learn	☐	☐	☐	☐	☐
The feedback from the tool helped me learn	☐	☐	☐	☐	☐
The graphics and animations from the tool helped me learn	☐	☐	☐	☐	☐
The tool helped teach me a new concept	☐	☐	☐	☐	☐
Overall, the tool helped me learn	☐	☐	☐	☐	☐

Appendix I: Demographic Questionnaire

Following the completion of the Informed Consent Form, participants were asked a series of demographic questions. Participants who were deemed ineligible to participate in the study were also asked a series of demographic questions. These questions are provided following the main demographic questionnaire.

1.	**Age**
	18-24 years old
	25-34 years old
	35-44 years old
	45-54 years old
	55-64 years old
	65-74 years old
	75 years and older
2.	**Which sex do you identify with?**
	Male
	Female
	Other
3.	**Which of the following degrees do you hold?**
	DC
	MD
	PhD
	Master's degree
	Other: please specify
4.	**How many years of experience do you have as a practicing chiropractor?**
	I am not a chiropractor
	1-10 years
	11-20 years
	21-30 years

- [ ] 31-40 years
- [ ] 41-50 years
- [ ] 50 years or more

5. How many years of experience do you have in a chiropractic teaching role?

- [ ] 1-10 years
- [ ] 11-20 years
- [ ] 21-30 years
- [ ] 31-40 years
- [ ] 41-50 years
- [ ] 50 years or more

6. How many hours per week are dedicated to your teaching role?

- [ ] 1-10 hours
- [ ] 11-20 hours
- [ ] 21-30 hours
- [ ] 31-40 hours

7. Are you a clinician at one of the CMCC teaching clinics?

- [ ] Yes
- [ ] No

8. If yes, how many hours per week are dedicated to this appointment?

- [ ] 1-10 hours
- [ ] 11-20 hours
- [ ] 21-30 hours
- [ ] 31-40 hours

9. Which department/division at the Canadian Memorial Chiropractic College do you belong to?

- [ ] Anatomy
- [ ] Chiropractic Therapeutics
- [ ] Physiology and Biochemistry
- [ ] Chiropractic Principles and Practice
- [ ] Clinical Diagnosis

	Clinical Education
	Diagnostic Imaging
	Pathology and Microbiology
	Research
	Graduate Studies

10. How would you rate your working knowledge of the neck pain guideline developed by the OPTIMa Collaboration in 2016? (1=not at all - 5=expert)

1	2	3	4	5

11. Do you have any previous experience with clinical practice guideline development?

	Yes
	No

12. Do you have any previous experience with technology-based learning tools?

	Yes
	No

13. Do you consider yourself proficient with computers?

	Yes
	No

Appendix J: Learning Object Evaluation Scale – for Students

The learning, design, and engagement constructs of the learning tool was evaluated using the Learning Object Evaluation Scale for Students (LOES-S).

The LOES-S is an evaluation tool designed for students to rate the impact a technology-based learning tool has had on their learning experience [12]. The psychometric properties of the tool were measured in two separate trials [12, 13]. The first, in middle and secondary school students (10-22 years old) for any subject appropriate for their respective curriculums, and the second, in middle and secondary school students (11-17 years old) for math and science [12].

The second trial was completed with the intention to limit confounding variables such as the variety of technology-based learning tools used, pre-selecting TbLT lesson plans, and developing customized measurements of knowledge [12]. The size and diversity of the second trial provide greater confidence in the psychometric properties previously demonstrated.

This study evaluated internal reliability, construct validity, convergent validity, and predictive validity with each demonstrating acceptable results. Internal reliability was evaluated by Cronbach's α for each of the tool's constructs: learning, design, and engagement; 0.93, 0.87, and 0.92 respectively [12]. These values indicate adequate internal reliability.

Second, the construct validity was evaluated to determine if the tool's three constructs were distinct factors. Shared variances ranged from 42% to 56%; minimal enough to assume their distinction [12]. It is important to note that though these constructs were deemed distinct, it is likely that these constructs interact and influence each other during learning [12].

Third, convergent validity was evaluated to measure if the learning tool constructs are related to teacher ratings, computer comfort level, and subject area comfort level, as hypothesized. A moderate relationship was measured between teacher and student ratings

of the three learning tool constructs (0.36 to 0.65) [12]. This measurement determined the importance of obtaining student (learner) input when evaluating technology-based learning tools. Second, students who indicated a higher comfort level using computers rated the constructs more favourably [12]. Similarly, students who indicated they were more comfortable with the learning material rated the constructs more favourably [12].

Last, predictive validity was measured to whether the learning tool evaluations correctly predict remembering, understanding, application, and analysis. Learning, design, and engagement constructs were demonstrated to be significantly correlated with increases in application and analysis of knowledge, but not remembering or understanding [12].

We adapted the original language within the LOES-S to reflect the demographic of this study. The original version uses the term "learning object" to describe the learning tool. We changed this to "learning tool" for the purposes of this study. We also included an open-ended question to complement the LOES-S. This question was added to engage participants in further evaluation of the learning tool.

The LOES-S was created using Google Forms and embedded within the study website. Participants had access to complete the questionnaire following their completion of the self-learning intervention (Appendix H). Once the evaluation was complete, participants were thanked for their participation in the study.

Table J-1: Learning Object Evaluation Scale – for Students (LOES-S)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Learning					
1. Working with the tool helped me learn	1	2	3	4	5
2. The feedback from the tool helped me learn	1	2	3	4	5

3. The graphics and animations from the tool helped me learn	1	2	3	4	5
4. The tool helped teach me a new concept	1	2	3	4	5
5. Overall, the tool helped me learn	1	2	3	4	5
Design					
6. The help features in the tool were useful	1	2	3	4	5
7. The instructions in the tool were easy to follow	1	2	3	4	5
8. The tool was easy to use	1	2	3	4	5
9. The tool was well organized	1	2	3	4	5
Engagement					
10. I liked the overall theme of the tool	1	2	3	4	5
11. I found the tool engaging	1	2	3	4	5
12. The tool made learning fun	1	2	3	4	5
13. I would like to use the tool again	1	2	3	4	5
14. Please provide any suggestions you may have to improve this technology-based learning tool.					

References

1. Kay R. Evaluating learning, design, and engagement in web-based learning tools (WBLTs): The WBLT Evaluation Scale. Comp Hum Beh. 2011;27:1849-56.
2. Kay R, Knaack L. Assessing learning, quality and engagement in learning objects: the Learning Object Evaluation Scale for Students (LOES-S). Education Tech Research Dev. 2009;57:147-68.

Appendix K: Content Analysis Framework

Following the completion of the LOES-S, participants were asked to provide suggestions to improve the learning tool in an open-ended suggestion box format. A content analysis was performed, and results were stratified by recurring pedagogical themes used as references throughout the development phase of the learning tool.

Three reviewers completed a content analysis worksheet where they were asked to match comments provided by the participants to the most relevant pedagogical theme. Reviewers completed the worksheets independently and a discussion-based consensus was performed afterward. The results of the independent analyses and consensus are provided below (Table L-1). The list of pedagogical principles provided to the reviewers is outlined in Table L-2.

Table K-1: Participant Comments – independent analyses by reviewer and consensus

Participant Comments	**Reviewer 1**	**Reviewer 2**	**Reviewer 3**	**Consensus**
The "next" button leading to the next quiz question was not located in an intuitive location on the screen	Multimedia	Learner Control	Learner Control	Learner Control
Missing home/menu page (layout, flow of content, accessibility)	Learner Control	Learner Control	Learner control	Learner Control
There could have been more graphics	Multimedia	Multimedia	Multimedia	Multimedia
Include more contrasting colours	Multimedia	Multimedia	Multimedia	Multimedia
Videos would be more engaging than reading	Multimedia	Multimedia	Multimedia	Multimedia

The quiz questions were a bit easy	Thinking Skills	Learner Control	Thinking Skills	Thinking Skills
I found the single-answer questions misleading	Thinking Skills	Personalization	Practice/ Thinking Skills	Thinking Skills
There could have been a more exciting case	Thinking Skills	Personalization	Thinking Skills	Thinking Skills

Table K-2: Pedagogical Principles Provided to Reviewers

Pedagogical Principles
Coherence [1] • Keeping lessons uncluttered of distracting multimedia. • The addition of entertaining elements such as images or additional colour can distract the learner and actually take away from the learning as individuals are overloaded with media. • Too much content on screen diverts the learner's attention to the learning material, disrupts the organization of the learning, and creates irrelevancy and confusion. • All additional media added to learning should be logical and serve a purpose.
Contiguity [2] • Placing words and graphics together. • While using a combination of text and graphics in learning material, ensure that the graphics are in close proximity to the text which explains it. • This reduces cognitive overload within the learner trying to process the information.
Learner Control [3] • Providing the learner with access to certain aspects of the learning material such as content sequencing, pacing, and access to learner support. • Most effective when: learners have some previous knowledge of the subject, subject is a more advanced level (more than basic), metacognitive skills are high in learners (awareness and analysis of one's thoughts).

Multimedia [4] • Using a combination of text and graphics in learning material provides a greater benefit to the learner than text alone. • It is important to ensure that all graphics used must serve a specific purpose towards the learning outcomes.
Personalization [5] • Creating opportunity for learners to feel a personal connection to their learning through choice of language and engagement. • The personalization of language used within learning material keeps learners engaged and interested in the material.
Practice [6] • Used to promote interaction by engaging learners behaviorally and psychologically • Five principles: repetition, feedback, motivation, practice, and retrieval of prior knowledge. • Helps to store knowledge and skills into the learner's long-term memory.
Segmenting [7] • Breaking down large, complex content into smaller "bite-size" content is much more manageable for the learner. • This principle ensures that learners have opportunity to fully grasp the topics provided to them and do not fall behind because of content overload. • Background knowledge should always be presented first as learners will remember the chronological order in which information is presented.
Thinking Skills [8] • Development of critical thinking skills involving evaluation of products or ideas. • Most prominent thinking skills for e-learning are creative thinking skills (generating new ideas and perspectives), critical thinking skills (applying, analyzing, synthesizing, and evaluating information) and metacognition (awareness and analysis of one's thoughts).

References

1. Clark RC, Mayer RE. Applying the Coherence Principle E-Learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer; 2011. p. 151-76.

2. Clark RC, Mayer RE. Applying the Contiguity Principle E-Learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer; 2011. p. 91-113.
3. Clark RC, Mayer RE. Who's in Control? Guidelines for e-Learning Navigation. E-learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer; 2011. p. 309-38.
4. Clark RC, Mayer RE. Applying the Multimedia Principle: Use Words and Graphics Rather Than Words Alone E-learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer 2011. p. 67-90.
5. Clark RC, Mayer RE. Applying the Personalization Principle: Use Conversational Style and Virtual Coaches. E-learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer; 2011. p. 179-204.
6. Clark RC, Mayer RE. Does Practice Make Perfect? E-learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer; 2011. p. 251-78.
7. Clark RC, Mayer RE. Applying the Segmenting and Pretraining Principles: Managing Complexity by Breaking a Lesson into Parts E-learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer 2011. p. 205-22.
8. Clark RC, Mayer RE. e-Learning to Build Thinking Skills E-learning and the Science of Instruction. 3rd ed. San Francisco, CA: Pfeiffer; 2011. p. 339-68.

Appendix L: IT Confidentiality Agreement

Confidentiality Agreement

Research Title: The Development and Evaluation of a Technology-based Learning Tool to Improve Knowledge about the Evidence-based Management of Neck Pain by Teaching Faculty at the Canadian Memorial Chiropractic College

Principal Investigator: *Dr. Pierre Côté,*
Canada Research Chair in Disability Prevention and Rehabilitation
Associate Professor, Faculty of Health Sciences, University of Ontario Institute of Technology
Director, UOIT-CMCC Centre for Disability Prevention and Rehabilitation

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- [x] I understand that all the material I will be asked to record, analyze, and/or transcribe is confidential
- [x] I understand that any digital recordings, data, and transcripts can only be discussed with the principal investigator working on this study and may not be shared with others in any format
- [x] I will not keep any copies of the information nor allow third parties to access them
- [x] I will delete all interview, datasets, and other relevant files from my computer after transcription/use is complete
- [x] I will keep my computer and any datasets and transcripts password protected and secure
- [x] I will maintain the anonymity of all participants involved in this research study
- [x] I will keep any information regarding all participants in this study in the strictest confidence and will discuss any information about the participants only with members of the research group

IT Administrator:

BRIAN MOOLENSCHOT	[signature]	JAN-17-2017
(print name)	(signature)	(date)

Principal Investigator:

Pierre Côté	[signature]	Jan 19, 2018
(print name)	(signature)	(date)

This research project will be approved by the Research Ethics Boards (REB) at the University of Ontario Institute of Technology and the Canadian Memorial Chiropractic College.