Does Every Patient Require Imaging after Cervical Spine Trauma? A Knowledge Translation Project to Support Evidence-Informed Practice for Physiotherapists

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ABSTRACT

Purpose: This article evaluates, describes, and addresses a gap in British Columbia physiotherapists' knowledge of the decision making required for the diagnostic imaging of patients after traumatic neck injury. **Method:** An online survey of orthopaedic physiotherapists in British Columbia was undertaken to explore their awareness of, knowledge of, and attitudes toward the Canadian Cervical Spine Rule (C-Spine Rule) and decision making regarding the need for diagnostic imaging in managing patients with traumatic neck injury. The survey included questions about managing clinical scenarios; respondents' awareness, knowledge, and use of a specific clinical decision rule—the C-Spine Rule—and any perceived barriers to using clinical practice guidelines in general and the C-Spine Rule in specific. The survey also included questions about the facilitators of and barriers to using the C-Spine Rule. These data were used to guide development of a tool kit to facilitate use of the rule. **Results:** Of 889 physiotherapists, 467 (52.5%) completed the survey. Given a scenario in which imaging was indicated according to the C-Spine Rule, 95.2% of the respondents correctly recommended imaging. However, in a scenario in which imaging was not indicated, 42.7% incorrectly recommended it. The barriers to using the guidelines included their perceived rigidity, role limitation, and reliance on clinical judgment. The results indicated a need for, and guided development of, resources to facilitate the use of the C-Spine Rule by British Columbia physiotherapists. **Conclusions:** We identified a gap in the knowledge of British Columbia physiotherapists in identifying which patients were most likely to require imaging after sustaining a traumatic neck injury. We developed a tool kit to address these barriers. British Columbia physiotherapists have accessed this resource extensively. Evaluating its impact on clinical practice, although desirable, was not feasible.

Key Words: imaging; knowledge translation; neck injuries; radiography; survey.

RÉSUMÉ

Objectif : évaluer, décrire et corriger une lacune dans les connaissances des physiothérapeutes de la Colombie-Britannique (C.-B.) sur les prises de décision nécessaires à l'égard de l'imagerie diagnostique après un traumatisme cervical. **Méthodologie :** les chercheurs ont lancé un sondage en ligne auprès des physiothérapeutes orthopédiques de la C.-B. pour évaluer leurs connaissances et leurs attitudes au sujet des règles canadiennes relatives à la colonne cervicale (RCC) et de la prise de décision entourant la nécessité de procéder à une imagerie diagnostique pour traiter les patients atteints d'un traumatisme cervical. Le sondage comprenait des questions sur la gestion des scénarios cliniques, les connaissances des répondants au sujet d'un outil de décision clinique (les RCC), leur utilisation de cet outil et les obstacles perçus à l'utilisation de guides de pratique clinique en général et des RCC en particulier. Le sondage contenait également des questions sur les incitations et les obstacles à l'utilisation des RCC. Les chercheurs ont utilisé ces données pour orienter l'élaboration d'un outil visant à faciliter le recours à ces règles. **Résultats :** au total, 467 des 889 physiothérapeutes (52,5 %) ont rempli le sondage. À la lecture d'un scénario où l'imagerie était indiquée d'après les RCC, 95,2 % des répondants ont bien recommandé l'imagerie. Cependant, dans un scénario où l'imagerie n'était pas indiquée, 42,7 % recommandaient l'imagerie à tort. Les obstacles à l'utilisation des lignes directrices incluaient une perception de rigidité, les limites de leur rôle et le fait de se fier au jugement clinique. Les résultats démontraient la nécessité de préparer des ressources pour faciliter l'utilisation des RCC par les physiothérapeutes de la C.-B. et en ont orienté la préparation. **Conclusions :** les chercheurs ont constaté une lacune dans les connaissances des physiothérapeutes de la C.-B. qui doivent repérer les patients les plus susceptibles d'avoir besoin d'imagerie après un traumatisme cervical. Ils ont préparé un outil pour vaincre ces obstacles. Les physiothérapeutes de la C.-B. ont abondamment consulté cette ressource. Même s'il aurait été souhaitable d'en évaluer les répercussions sur la pratique clinique, il n'a pas été possible de le faire.

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Canadian physiotherapists, as primary care practitioners, provide first-contact assessment and care for persons with undiagnosed health concerns. Thus, it is of paramount importance that they apply the knowledge and skills necessary to identify significant pathology that requires immediate medical management. A prime example is detecting potentially serious injury, such as fracture, dislocation, or ligamentous instability, in patients presenting to a physiotherapist for neck pain secondary to recent trauma. In 2011, the Physiotherapy Association of British Columbia (PABC) struck a task force to ascertain the awareness and knowledge of, attitudes toward, and decision making among its members about the need for diagnostic imaging in managing patients with traumatic neck injury. The C-Spine Advisory Task Force was composed of expert clinicians (MB, AMH, CK, JH, BL, GW, AZ, SH, MK, PF) and supported by an established research partner (LCL). Our goals were (1) to determine whether there was a need for resources that could guide a physiotherapist's decision as to whether to direct a patient with cervical trauma to a physician for imaging to rule out significant cervical injury and (2) if there was a need, to develop and disseminate these resources.

The purpose of this article is to describe (1) the results of the survey that we undertook to explore the awareness, knowledge, and attitudes of physiotherapists toward the Canadian Cervical Spine Rule (C-Spine Rule) and their decision making about this area of practice and (2) how we used the findings of the survey to develop resources to support evidence-informed practice.

Addressing a potential practice issue is not easy. Historically, simply finding "the answer" and sharing it with the relevant stakeholders has proven woefully ineffective in health care. Indeed, the literature is replete with descriptions of the challenges of, and limited success in, supporting evidence-informed practice. Previous researchers have identified barriers at multiple levels, including health care practitioners (e.g., difficulty accessing or appraising literature), organizations (e.g., providing resources, training, protected time), regulatory agencies (e.g., developing mandated and enforced practice standards), and patients (e.g., patient preferences that differ from recommendations derived from research evidence, lack of applicability of available research to facilitate patients' and practitioners' decision making in complex clinical cases).¹⁻⁴ This "malfunction of passive diffusion and mediation"^{5(p.66)} is illustrated by the distressing and often-cited example that it can take an estimated 17 years for 14% of research findings to be adopted into practice.^{5,6} It has also fuelled the recent proliferation of knowledge translation (KT) courses and KT job positions developed to narrow this formidable gap. In 2009, the Faculty of Medicine's Department of Physical Therapy at the University of British Columbia, in conjunction with the PABC, created the Physical Therapy Knowledge Broker (PT KB) position. One year later, Vancouver Coastal Health Research Institute and Providence Health Care

Research Institute also became funding partners for the PT KB position. Details regarding the PT KB position and activities are available online⁷ and documented in both a guest editorial in *Physiotherapy Canada* and in a descriptive article.^{8,9}

To ensure that the process undertaken for this project was founded on best practice regarding KT theory and KT science, our group, the C-Spine Advisory Task Force, applied for, and was accepted into, the Foundations of KT course provided by the Knowledge Translation Program of the Li Ka Shing Knowledge Institute in Toronto. This course included a series of workshops supported by KT specialists and delivered over a 13-month period that supported our work on the KT project described in this article. The PT KB (AMH), the research partner (LCL), and two clinician experts (MB, CK) attended the course on behalf of the task force. Our group selected the Knowledge-to-Action (KTA) Process model to guide our work on the project.¹⁰

In accordance with the Knowledge Creation Funnel of the KTA Process, we performed a literature review to discover what evidence and tools currently existed to guide practice for identifying significant injury in cervical trauma. We narrowed our scope to focus on evidence guiding the appropriate use of imaging in alert patients who had experienced blunt neck trauma.

Our literature search identified two commonly cited, validated tools for determining the appropriateness of imaging post-trauma: the National Emergency X-Radiography Utilization Study (NEXUS) Criteria for C-Spine Imaging¹¹ and the C-Spine Rule.¹² Both tools are "third-generation knowledge,"^{10(p.19)} which Graham and colleagues described as a knowledge product or tool that has "the intent of influencing what stakeholders do."^{10(p.19)} Although the American College of Radiology has endorsed both tools,¹³ Stiell and colleagues¹⁴ found the C-Spine Rule to be superior to the NEXUS Criteria in terms of sensitivity (99.4% vs. 90.7%; $p < 0.001$) and specificity (45.1% vs. 36.8%; $p < 0.001$) for clinically significant cervical spine injury. In the same prospective cohort study of 8,283 patients, Stiell and colleagues determined that the C-Spine Rule would have resulted in lower imaging rates (55.9% vs. 66.1%; $p < 0.001$).¹⁴ Extensive evaluation has been performed on both clinical decision rules.¹²⁻²² In 2012, Michaleff and colleagues published a systematic review comparing the two and reported that sensitivity for the C-Spine Rule ranged from 0.90 to 1.00, and specificity ranged from 0.01 to 0.77.¹⁹ They also reported that sensitivity ranged from 0.83 to 1.00, and specificity ranged from 0.02 to 0.46 for the NEXUS Criteria.

Bandiera and colleagues demonstrated that relying on clinical judgment alone resulted in over-prescription of radiological imaging, 18% higher than that indicated by adhering to the C-Spine Rule.¹⁷

Consequently, in this phase of our project we established that the C-Spine Rule was an appropriate, valid, highly sensitive, and moderately specific tool that could

be used to guide clinical decision making about the need for diagnostic imaging after cervical spine trauma.^{12–22}

The C-Spine Rule applies to alert (Glasgow Coma Scale score of 15), cooperative, and medically stable adults (age ≥ 16 years) and consists of three steps.¹²

1. Determine from the history whether a patient fits at least one of three criteria that put him or her in the high-risk category for clinically significant injury (age ≥ 65 years; patient reporting paresthesia in one or more extremities; patient reporting a dangerous mechanism of injury); radiography is indicated if any of these criteria are met.
2. Determine from history, observation, and palpation whether at least one of five low-risk criteria is present (involved in simple rear-end motor vehicle accident, sitting in emergency department, ambulatory at any time, delayed onset of neck pain, absence of midline tenderness); radiography is indicated if no low-risk criteria are met.
3. If there are no indications for radiography in steps 1 and 2, then proceed to assessing active cervical rotation; if a patient is unable to rotate the neck 45° in each direction, radiography is indicated.

If a health care practitioner follows all three steps and determines that no indications for radiography exist, then, according to the C-Spine Rule, the cervical spine has been cleared for clinically significant injury.

The next stage in the KTA process is applying knowledge to practice. This stage is directed by a series of steps depicted in the Action Cycle that surrounds the Knowledge Creation Funnel. These steps are derived from planned action theories, are dynamic, can influence each other, and can be affected by the process undertaken in the Knowledge Creation Funnel.

The first step in the Action Cycle is to identify that there is a problem or issue that warrants attention. Accordingly, our group, the C-Spine Advisory Task Force, needed to determine whether there was a need for the C-Spine Rule in physiotherapy practice. Our literature search revealed that although the C-Spine Rule had been validated in multiple acute care settings by several types of health care providers (paramedics, physicians, and nurses), there was no literature describing its use by physiotherapists.^{12–22} With respect to the potential use of the C-Spine Rule by physiotherapists, specifically in British Columbia, the scope of practice does not currently include ordering imaging. However, identifying those patients with cervical trauma who are most likely to require imaging to rule out clinically important injuries is clearly critical to safe practice.

The benefits of imaging must be weighed against the disadvantages. On one hand, ensuring the appropriateness of imaging is important because the disadvantages range from inconvenience to the patient to unnecessary exposure to radiation when radiographs or computed

tomography (CT) scans are not essential. Moreover, the inappropriate use of imaging contributes to the burden on limited health care resources. On the other hand, clinically important injuries post-trauma have been defined as fractures, dislocations, or ligamentous instability requiring consultation with a spine surgeon and bracing, surgery, or both,²³ and the potential consequences of missing such injuries include spinal cord injury and even death.^{24–29} Given that 91%–99% of the findings from cervical radiography—X-rays, CT scans, or both—in the emergency department are negative for clinically significant injury,^{12,30,31} it is possible that most patients have received radiography unnecessarily. Therefore, it is important to distinguish individuals who need a physician's referral for diagnostic imaging from those who do not.

Thus, although we determined there was a rationale to justify including the C-Spine Rule in physiotherapist practice in British Columbia, it was imperative that we ascertain whether there truly was a practice gap that required intervention.

METHODS

Because there were no data on the current practice patterns of British Columbia physiotherapists in recommending that patients with acute cervical trauma follow up with a physician for diagnostic imaging, our next step was to conduct a province-wide survey to establish existing practice. The implementation science literature stresses the importance of evaluating not only a target group's awareness and knowledge of an issue but also its prevailing attitudes and behaviours.^{16,32–35} As a result, we designed our survey to determine the current awareness and knowledge of, attitudes toward, and decision making about the C-Spine Rule (see the Appendix online). We received ethics approval from the University of British Columbia (UBC) Behavioural Research Ethics Board (Application No. H12–00923).

Between January and May 2013, PABC sent a link to our online survey to 889 physiotherapists who were members of the PABC and its Orthopaedic or Sport Physiotherapy Divisions. The survey was created using Fluid Survey (Fluidware, Ottawa, ON) and hosted at Fluidsurveys.com (see the online Appendix). In the initial portion of the survey, we requested demographic information, including years of practice, highest physiotherapy degree, postgraduate manual therapy training, practice settings, areas of practice, and questions about whether respondents treated patients who would fit the criteria for use of the C-Spine Rule. In the second portion of the survey, we included two clinical vignettes to examine physiotherapists' recommendations regarding radiographic investigations. Our first vignette depicted a scenario in which, according to the C-Spine Rule, radiography was not indicated (see Box 1). In our second vignette, it would have been advisable to recommend radiography (see Box 2).

Box 1 Clinical Vignette 1: Imaging Not Indicated According to the C-Spine Rule**Subjective findings**

A woman aged 55 years is seen at your physiotherapy clinic the day after a low-velocity-impact motor vehicle accident in which the car she was driving was rear ended. She began to notice pain later in the day in the right side of her upper neck as well as a headache and slight dizziness. She does not report any paraesthesia in her extremities. She rates her pain at 5 out of 10 (numerical pain rating scale: 0 = *no pain*; 10 = *worst pain imaginable*). She is having difficulty sleeping and feels unable to go to work. She reports no other health issues or past neck problems. She has not been seen by any medical professional and now refers herself to your clinic.

Objective findings

- Pain on neck extension at one-quarter of normal range
- Neck rotation painfully limited to 50°
- Painful resisted neck rotation
- Midline tenderness on palpation
- Pain and slight hypermobility on anterior translational stability testing at C4/C5.

In the third section of our survey, we asked about general attitudes toward clinical practice guidelines and about the respondents' awareness and knowledge of the C-Spine Rule. We designed our survey so that all participants were then exposed to the C-Spine Rule and a page of frequently asked questions (FAQs) about it.³⁶ In the fourth and final section of our survey, we asked participants to share any potential barriers to and facilitators of implementing the C-Spine Rule in their practice.

RESULTS

A total of 467 physiotherapists completed our survey (response rate = 52.5%); of those, 339 (72.6%) had practiced more than 5 years. Most practiced in private clinics (92.3%) and in orthopaedics or sport physiotherapy (97.4%). A full 457 respondents (97.9%) completed the entire survey, including the clinical vignettes. The other 2.1% were taken directly to the end of the survey because they indicated that they did not see patients with acute traumatic cervical injuries in their practice. For the vignette that required radiography, 435 of 457 physiotherapists (95.2%) correctly recommended imaging on the basis of their subjective and objective findings, but their reasons were often inconsistent with the C-Spine Rule. For the vignette that did not require radiography according to the rule, 195 of 457 respondents (42.7%) recommended imaging. See Figures 1 and 2 for an analysis of the responses to clinical vignette 2.

Of the British Columbia physiotherapists who responded, 57.8% (264 of 457) reported that they had never heard of the C-Spine Rule; however, after they had been exposed to it and our FAQs, 97.4 % of the respondents (445 of 457) indicated that they would consider using the rule in their practice in the future. Although 89.0% (407 of 457) indicated that they did not foresee any

Box 2 Clinical Vignette 2: Imaging Indicated According to the C-Spine Rule**Subjective findings**

A healthy male aged 67 years reports falling off a ladder 2 days ago. He experienced immediate pain in his neck, more so on the left side, which he rates as 6 out of 10 (numeric pain rating scale: 0 = *no pain*; 10 = *worst pain imaginable*). The pain radiates into his left forearm, and he has noticed intermittent tingling in his left thumb. He has no dizziness or headache. He reports sharp pain on left rotation, which makes it difficult for him to drive. He has been unable to tolerate sitting at his computer since the accident. He has been to a walk-in clinic doctor and was prescribed Tylenol and a week off work.

Objective findings

- Unable to extend neck past neutral because of pain
- Neck rotation painfully limited to 35°
- Diminished biceps reflex
- Pain on axial compression loading
- Upper limb neural tension (median nerve) limited to -20°, reproducing arm pain.

barriers to incorporating the rule into their clinical practice, 10.9% (50 of 457) identified several barriers to implementing the rule. The barriers they selected most frequently and ranked highest were (1) it was too rigid, (2) it addressed content outside the physiotherapy scope of practice, (3) they were afraid of missing serious injuries, (4) they believed that clinical judgment was as good or better, and (5) they might forget the details of the rule.

The respondents indicated that the potential facilitators of the C-Spine Rule in their practice were having one or more laminated flowcharts in their office (89.3%; 408 of 457), having access to the rule on the PABC Web site (55.8%; 255 of 457), viewing live or video depictions of the rule in use in patient simulations (41.1%; 188 of 457), receiving occasional email reminders about it (26.7%; 122 of 457), and having the ability to contact a knowledgeable physiotherapist for advice (19.0%; 87 of 457). In addition, 3.5% (16 of 457) of the respondents provided additional ideas, including having access to the rule through a cell phone app, learning the rule in pre-licensure training, including it in postgraduate clinical orthopaedic courses, and being able to refer directly for imaging rather than through a physician.

DISCUSSION

The findings from our survey indicated that orthopaedic physiotherapists in British Columbia were vigilant in recommending cervical radiography to patients who might need it. However, there was a tendency to over-recommend it to those who might not require it. Their reasons for recommendation, either way, were often inconsistent with the C-Spine Rule. This is not surprising given that the majority of the respondents lacked awareness, detailed knowledge, or both of the rules. Furthermore, the range of barriers they identified suggested

Figure 1 Respondents' opinion of subjective findings that indicate a need for x-ray imaging

Note: In Clinical Vignette 2, according to the Cervical Spine Rule, the patient's age, injury mechanism, and thumb tingling are appropriate reasons to refer the patient for imaging.

that multifaceted interventions would be beneficial to improve the number of physiotherapists adopting the rule.

Previous researchers have noted that, after identifying the barriers to adopting knowledge, mapping or tailoring specific strategies to target each barrier is essential.^{32,36} Interestingly, the survey respondents, when asked which strategies would be helpful to facilitate their use of the C-Spine Rule, identified multiple strategies that corresponded to several of the stated barriers.

A recent systematic review provided support for the use of tool kits in health care.³⁷ Yamada and colleagues concluded that tool kits, particularly those that include information about the level of evidence, hold promise as an effective approach to facilitating evidence-informed practice.³⁷ Defined as "the packaging of multiple resources that codify explicit knowledge, such as templates, pocket cards, guidelines, algorithms, summaries, and that are geared to share knowledge, educate, and/or facilitate behaviour change,"^{38(p.123)} a tool kit provides users with an array of resources, ideally supported by evidence of effectiveness, from which they can select, at their discretion, the interventions that are most appropriate in their situation.³⁷ Clinicians can use the "translated" evidence, together with their clinical judgment, to inform their decisions about the unique characteristics of an individual patient. In the face of this overwhelming evidence, we made the decision to present the resources in the form of a tool kit.

We considered evidence from the Search Rx for Change Database when selecting our strategies for addressing each barrier.³⁹ Members of the task force self-assigned the tasks associated with each targeted strategy. We subsequently refined multiple iterations of each resource among the task force and piloted them with subsets of colleagues to ensure that each resource was understandable, usable,

Figure 2 Respondents' opinion of objective findings that indicate a need for x-ray imaging

Note: In Clinical Vignette 2, according to the Cervical Spine Rule, pain at 35° rotation is the only objective finding that is an appropriate reason to refer the patient for imaging.

and meaningful to physiotherapy clinicians. The final tool kit included an array of resources.

Our tool kit, which is publicly accessible,⁴⁰ has four components. The first is a laminated copy of the C-Spine Rule with FAQs addressing the barriers identified in the survey.⁴¹ The second is a YouTube video featuring a local opinion leader applying the rule in two clinical scenarios.⁴² Part of our rationale for creating the video was that a Cochrane Review found use of opinion leaders to be effective in changing clinical practice.⁴³

For the third component, we developed, in partnership with a physician, letters for physiotherapists to distribute to local family physicians. Our aim with the first letter was for physiotherapists to inform physicians about the project and include a copy of the C-Spine Rule. We wrote the second letter for physiotherapists who wanted to inform a physician about the need for their patient to have imaging to rule out a serious neck injury. We designed the letter templates so physiotherapists could adapt them, such as by adding their own clinic's logo. In addition, we provided a one-page document, suggesting strategies for physiotherapists using these templates.

For the final component of the tool kit, we provided access, in partnership with a Vancouver-based health software company, QxMD Medical (Vancouver, British Columbia) to a free mobile application that included the C-Spine Rule calculator for clinical use.

We disseminated the C-Spine Rule Toolkit in several ways. It was posted on three Web sites: PABC, the physiotherapist KB Web page of the UBC Department of Physical Therapy, and the international wiki Physio-pedia.⁴⁰ In addition, for PABC members, we presented a live webinar on how to apply the tool kit and subsequently added it to the members-only section of that Web site.

Box 3 PABC Tweets Regarding the Canadian C-Spine Rule**Intro tweet**

For all #CspRules scenarios RT – No Xray, Fav –Xray. They'll be posting all week. Reply to the answers w/ feedback.

Clinical scenarios

1. 42M dirt bike accident 30km/h. States he's "fine." Friends say he hit his head + was "woozy" Fav –Xray, RT – No
2. 58F Passenger MVA rear-ended @ stop light by Smart car. Neck is "sore" @ work. Rot 70deg bilat Fav –Xray, RT – No
3. 52M gradual onset, sore neck w/ midline tenderness on C4–6. No vertebral disease. 40deg rot bilat Fav –Xray, RT – No
4. 36F hockey player. Checked sideways into boards. 60deg rot R, 50deg rot L. No midline tenderness Fav –Xray, RT – No
5. 30M rugby player. Fell to bottom of scrum + had back stepped on. Has a stiff neck. Rot 60deg bilat Fav –Xray, RT – No
6. 66F Rear-end MVA @ stop light by SUV. Has intermittent "numbness and tingling" into both arms. Fav –Xray, RT – No
7. 28M tackled head on @ football + whipped head back. Sharp pain on C5–6 SPs when ax lying on field Fav –Xray, RT – No
8. 18F fell @ cheerleading when held by teammate overhead. Impact back of head. Very sore and limited Fav –Xray, RT – No

Answer tweets

1. 42M Bike accident. Answer: Image, motorized recreational vehicle deemed "dangerous mechanism"
2. 58F Rear end MVA. Answer: No Image, No dangerous mechanism and still at work. Rotation > 45deg to both sides
3. 52M Insidious onset of neck pain. Answer: trick question "Rule not applicable," non-trauma case
4. 23F Hockey player. Answer: No Image
5. 30M Rugby player. Answer: No Image
6. 66F Rear-end MVA. Answer: Image, Age over 65 and paresthesiae into extremities
7. 28M Football player. Answer: Image, midline tenderness and not sitting up/non-ambulatory
8. 38F Cheerleader. Answer: Image, dangerous mechanism – fall from > 3feet

Additional dissemination mechanisms we used were newsletter articles in the PABC Directions newsletter and email alerts sent from PABC and the UBC Department of Physical Therapy, targeted emails to physiotherapist practice leaders in the local regional health authorities, and presentations at annual educational events. To increase awareness of the tool kit we included social media support by running a 6-week Facebook and Twitter campaign through PABC. Physiopedia also highlighted our tool kit using its Twitter and Facebook posts.

With respect to outcomes, as of December 2016, the C-Spine Rule Toolkit collectively, across all three Web sites, had received approximately 18,000 page views, and YouTube video had received more than 2,804 views. More than 60% of the total PABC membership had accessed one or more components of the tool kit. Of the UBC Department of Physiotherapy page views, 80% were generated from the United States, 8% from the United Kingdom, and 5% from Canada. The views of the Physiopedia site originated from 39 countries, with users typically spending 1.5 to 2.5 times longer on these pages than the average time spent on other pages. Unfortunately, we attempted to use feedback buttons on the Physiopedia wiki to enable a more fulsome evaluation of the perceived usefulness of the tool kit but were unable to elicit sufficient engagement from viewers to interpret the findings with any confidence.

In our social media campaign to support the roll out of the C-Spine Rule Toolkit, we included a series of posts on Facebook and Twitter. We posted mini case scenarios on Twitter and quizzed viewers on whether imaging would be appropriate (see Box 3). Tracking the page views before, during, and after the social media campaign

revealed a tripling of views during the social media campaign. We presented the results of the C-Spine survey at the 2014 Canadian Physiotherapy Association Congress, as an example of a grassroots needs assessment initiative.

Our evaluation of the outcomes of the C-Spine Rule Toolkit has been limited to the preceding metrics, primarily reflecting the reach of the tool kit. Although we considered using a randomized controlled trial to demonstrate the effectiveness of eliciting change in practice patterns, given both the imperative to prevent any delay in releasing the tool kit and the challenges involved in ensuring that there would be a control group unexposed to the tool kit, we determined it was not feasible.

Interestingly, however, the effect of a similar tool kit facilitated by the PT KB, the Achilles Tendinopathy Toolkit,⁴⁴ on user-reported clinical practice, has been evaluated and published,⁴⁵ revealing that those who reported familiarity with the tool kit were twice as likely to select evidence-informed interventions for clinical vignettes similar in nature to those used in the survey for the development of the C-Spine Rule Toolkit. Formal evaluation of the impact of tool kits remains a "holy grail" in KT evaluation—indeed, Barac and colleagues recently performed a scoping review of tool kits in health care and found that only 31 of the 89 tool kits reviewed had been evaluated in any way.³⁸

Wiltsey Stirman and colleagues have stated that incorporating strategies to foster the continuation of effective practice is at least as important as planning for effective adoption of these practices.⁴⁶ Therefore, we included strategies in our KT plan for this project that would address the sustainability of the C-Spine Rule Toolkit in physiotherapist practice.

We contacted decision makers to support the sustainability of the tool kit. Our goals were to facilitate having purposefully incorporated it into the curriculum of pre-licensure (specifically the Master of Physical Therapy programme in UBC's Department of Physical Therapy) and post-licensure (the National Orthopaedic Division Manual Therapy Level system) courses. To sustain the awareness of the tool kit, PABC undertakes purposive tweeting to pertinent (i.e., relevant to manual therapy and spinal injury and pathology) and influential Twitter usernames (i.e., those belonging to individuals or organizations with more than 1,000 followers) every month.

This study has several limitations. First, the survey used clinical vignettes to elicit physiotherapists' responses, and they might not reflect clinical practice in real life.

Second, we did not evaluate participants' knowledge or awareness of the NEXUS Criteria, another commonly cited and validated clinical practice rule to determine the need for imaging in patients with acute neck injuries.¹¹ In Clinical Vignette 1, the patient had midline tenderness. According to the C-Spine Rule, as long as one of four other low-risk criteria is present, imaging is not indicated on the basis of midline tenderness alone.¹² However, midline tenderness is one of the criteria for imaging with the NEXUS rule,¹¹ which some physiotherapists may have been aware of or exposed to. Therefore, we are unaware of their reasons for selecting that criterion.

The third limitation pertains to the language used in our survey. In reference to the clinical vignettes, we specifically asked whether the patient should "see a physician for referral for cervical X-ray imaging" (see the online Appendix). There was controversy at the time the NEXUS Criteria and C-Spine Rule were developed about the best imaging modality to choose to screen for serious injury because of costs, delays in treatment, sensitivity, and associated radiation dose.⁴⁷⁻⁵³ However, the most recent imaging guidelines recommend a CT scan, when available and safe, as the initial imaging modality for adult patients (aged 16 years or older) with acute injury who have sustained blunt neck trauma.^{13,54} The debate swirling around the optimal choice of follow-up imaging modality in emergency department settings continues.^{13,30,54,55} In light of these changes, it would have been preferable for us to have used more inclusive terminology such as radiography or diagnostic imaging.

Another limitation of our study is that we developed the resources in the tool kit to address the barriers reported by Canadian physiotherapists in a single province, and thus they may not apply to the practice needs of therapists either nationally or internationally. Physiotherapists accessing the tool kit and the C-Spine Rule information should take into account the culture, policies, and availability of X-rays and CT scans in their region. That being said, both the 2012 American College of Radiology Appropriateness Criteria¹³ and the 2016 National Institute for Health and Care Excellence Spinal Injury

UK clinical practice guideline⁵⁴ endorse using the C-Spine Rule to determine whether imaging is indicated in acute management of alert and cooperative patients after blunt cervical trauma.

In addition, although it was desirable, we found it was not feasible for us to measure the impact of the tool kit on clinical practice to determine how many patients had received management based on its contents or, perhaps more important, how physiotherapists may have changed their practice after being exposed to the tool kit. We attempted to recruit a physiotherapist to evaluate the effect of the tool kit on clinical practice as a funded master's degree project but were unsuccessful.

Finally, although the C-Spine Rule has not been validated for use by physiotherapists, our findings suggest that this tool, combined with clinical judgment, could help physiotherapists determine the need for imaging in patients who have recently sustained blunt cervical trauma. Rebbeck and Liebert⁵⁶ published a case study in which all of the appropriate imaging was done, but a spina bifida atlanto with associated transient cord compression was missed. They reinforced the importance of combining all the available evidence with clinical judgment to effect the best outcome for a patient. The C-Spine Rule can facilitate that process.

CONCLUSION

Not every patient requires imaging after cervical spine trauma. Physiotherapists should use the C-Spine Rule to evaluate alert and medically stable patients with acute blunt neck trauma to determine the need for imaging. It can be easily incorporated into the physiotherapy evaluation without adding undue time to the process or requiring a therapist to learn new skills.

In this article we provided a description of

1. The results of our survey exploring physiotherapists in British Columbia regarding decision making about which patients who had sustained traumatic neck trauma should follow up with a physician about the need for radiological imaging, awareness and knowledge of the Canadian C-Spine Rule, and perceived barriers to and facilitators of integration of the C-Spine Rule into their clinical practice.
2. Our development and dissemination of resources to support this aspect of practice.

Our initiative was guided by KT theory and science and used the KTA Process Model. The resulting tool kit received more than 18,000 page views from around the world, but we were unable to ascertain its direct impact on clinical practice. On the basis of our review of the literature, our involvement in a formal KT course, and our experience, we endorse the necessity and benefits of following a framework, such as the KTA Process, to guide a KT initiative.

KEY MESSAGES

What is already known on this topic

The Canadian Cervical Spine Rule (C-Spine Rule) has been validated in multiple acute care settings by several types of health care providers (paramedics, physicians, and nurses).^{12–22} Although physiotherapists possess the skills to use the rule, there was no literature describing its use by physiotherapists.

There is a plethora of literature illuminating the barriers to adopting evidence-informed practice. Implementation science has focused on evaluating the process and outcomes of complex health service interventions; however, there is limited documentation of how grassroots efforts can be leveraged to implement best practices.

What this study adds

In many jurisdictions, including Canada, physiotherapists are primary care practitioners. Although the scope of physiotherapy practice in many places in the world does not currently include ordering imaging, identifying those patients with cervical trauma who are most likely to require imaging to rule out clinically important injuries is clearly critical to safe practice.

This article describes a project undertaken to evaluate, describe, and address a gap in knowledge for physiotherapists in British Columbia about which patients who had sustained blunt neck trauma required follow-up with a physician for radiography to rule out significant injury. We used an online survey to evaluate whether there was a knowledge gap, at the same time incorporating evaluation of facilitators and barriers to use of the C-Spine Rule in clinical practice.

Our survey determined, that only 42.2% (193 of 457) of British Columbia physiotherapists surveyed, most of whom worked in private practice as primary care practitioners, had heard of the C-Spine Rule. However, after survey respondents had been exposed to the C-Spine Rule and our FAQs, 97.4% indicated that they would consider using the rule in their practice in the future. Although 89.1% indicated that they did not foresee any barriers to incorporating the rule into their clinical practice, 10.7% (49 of 457) identified specific barriers and the majority indicated tools and methods that would facilitate their use of the rule.

We used the findings from our survey to develop a tool kit and disseminated the tool kit and our survey findings using multiple strategies. The article provides an example of a process that can inform teams wanting to undertake similar initiatives. One of our objectives is to encourage teams of clinicians and researchers to improve on this process and publish their work so that we can all move forward the practice of KT in the physiotherapy profession.

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