


Original Article

Current Use and Future Considerations for Concussion Telemedicine Healthcare in Canada

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ABSTRACT: Objective: To examine the use of telemedicine among Canadian concussion providers and clinics before and after the COVID-19 pandemic onset and identify barriers and facilitators for future use. **Methods:** Ninety-nine concussion clinics and healthcare providers across Canada that offered one or more clinical concussion-related service were identified using standardized online searches and approached to complete a cross-sectional online survey. **Results:** Thirty clinics or providers completed the survey and two completed subsections of the survey (response rate of 32.3%). Only 28.1% of respondents indicated that they used telemedicine to provide care prior to the COVID-19 pandemic. Providers most commonly using telemedicine prior to the pandemic were occupational therapists and physicians, while the most commonly used services were in-person videoconferencing and eConsultation. Most respondents (87%) indicated their clinic's use of telemedicine changed following the onset of the COVID-19 pandemic including new use of in-person video-conferencing, telephone calls, and eConsultation. Ninety-three percent indicated that they would consider using telemedicine to provide care to their concussion patients once the pandemic was over. Barriers needed to be overcome to facilitate use or greater use of telemedicine-based services were the inability to conduct a complete physical examination, lack of appropriate reimbursement, lack of start-up, and maintenance funding and medico-legal risk. **Conclusion:** Telemedicine was used by a minority of Canadian concussion clinics and providers prior to the COVID-19 pandemic but was rapidly adopted by many facilities. This study provides important insight into the factors that must be considered to optimize use of telemedicine in concussion care in the future.

RÉSUMÉ : Utilisation actuelle de la télémédecine au Canada dans des cas de commotion cérébrale et considérations futures. Objectif : Se pencher sur l'utilisation de la télémédecine au Canada parmi les prestataires de soins de santé et les cliniques spécialisées dans les commotions cérébrales avant et après le début de la pandémie de COVID-19 ; identifier les obstacles et les éléments facilitateurs en vue d'une utilisation future. **Méthodes :** En tout, ce sont 99 prestataires et cliniques spécialisées dans les commotions cérébrales qui offrent partout au Canada un ou plusieurs services cliniques liés aux commotions cérébrales qui ont été identifiés à l'aide de recherches en ligne normalisées et ensuite contactés pour participer à une enquête transversale en ligne. **Résultats :** Au total, 30 cliniques ou prestataires ont complété notre enquête alors que deux d'entre eux en ont complété les sous-sections (taux de réponse de 32,3 %). Seulement 28,1 % des répondants ont signalé avoir utilisé la télémédecine avant la pandémie de COVID-19 pour prodiguer des soins. À noter que les prestataires qui utilisaient le plus la télémédecine avant la pandémie étaient les ergothérapeutes et les médecins tandis que les services les plus utilisés étaient les vidéoconférences en personne et les consultations en ligne (*eConsultation*). La plupart des répondants (87%) ont par ailleurs indiqué que l'utilisation de la télémédecine par leur clinique avait changé après le début de la pandémie de COVID-19, par exemple en recourant à la vidéoconférence en personne, aux appels téléphoniques et à des consultations en ligne. De plus, 93 % d'entre eux ont indiqué qu'ils envisageraient d'utiliser la télémédecine pour soigner leurs patients souffrant de commotions cérébrales une fois la pandémie terminée. Les obstacles à surmonter pour faciliter l'utilisation ou encourager une plus grande utilisation des services basés sur la télémédecine étaient les suivants : l'incapacité de réaliser un examen physique complet, l'absence de remboursement approprié, le manque de fonds de démarrage et d'entretien ainsi que les risques médico-légaux. **Conclusion :** La télémédecine était utilisée par une minorité de cliniques et de prestataires canadiens de soins liés aux commotions cérébrales avant la pandémie de COVID-19, mais elle a été rapidement adoptée par de nombreux établissements. Cette étude fournit un aperçu important des facteurs qui doivent être pris en compte pour optimiser à l'avenir l'utilisation de la télémédecine dans le traitement des commotions cérébrales.

Keywords: Telemedicine; Brain injuries; Concussion; Healthcare; Canada

(Received 2 September 2021; final revisions submitted 25 January 2022; date of acceptance 10 February 2022; First Published online 11 March 2022)

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Cite this article: Ellis MJ, Normand H, Gargaro J, Bayley M, and Russell K. (2023) Current Use and Future Considerations for Concussion Telemedicine Healthcare in Canada. *The Canadian Journal of Neurological Sciences* 50: 257–261, <https://doi.org/10.1017/cjn.2022.18>

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Concussion affects thousands of Canadians annually.¹⁻⁴ Common mechanisms include falls, sports, motor vehicle collisions, and work-related injuries. Harmonized national concussion guidelines recommend that all children and adults with a suspected acute concussion undergo urgent medical assessment, comprehensive follow-up, and medical clearance to return to school, work, and sport-related activities.⁵⁻⁸ It is also recommended that patients who develop persistent post-concussion symptoms (PPCS) be referred to inter-disciplinary concussion clinics that have access to physicians with expertise in traumatic brain injury who work with a team of professionals with expertise in disciplines such as neuropsychology, physiotherapy, neurology, otolaryngology, and psychiatry.

Unfortunately, research suggests that timely access to high-quality primary and specialized concussion healthcare is not universally available throughout Canada. Deficiencies in concussion knowledge have been identified among Canadian primary care and emergency physicians,^{9,10} and research suggests that a significant majority of pediatric concussion patients do not receive appropriate medical follow-up.¹¹ Patients living in remote and isolated regions of Canada face geographic, socioeconomic, and cultural barriers that limit access to primary and specialized healthcare services.¹²⁻¹⁵ Furthermore, there is concern that many concussion clinics in Canada do not have access to physicians or the full complement of physician and allied healthcare professional specialists required to provide comprehensive interdisciplinary care.^{7,16}

In addition, the global COVID-19 pandemic has disrupted access to healthcare services throughout Canada. To limit the initial COVID-19 spread within healthcare facilities and conserve critical supplies of personal protective equipment, regional health authorities recommended limiting nonurgent visits to out-patient clinics and transitioning healthcare delivery to telemedicine wherever possible. These unique circumstances presented an unprecedented challenge for providers and patients, many of whom were forced to interface with models of healthcare delivery that they had limited or no previous experience using.

Over the past decade, telemedicine has emerged as a transformative tool to help overcome disparities in access to specialized healthcare services for patients with a wide range of neurological diseases.¹⁷⁻²³ More recently, a growing body of research has begun to demonstrate that telemedicine is a safe and cost-effective approach to delivering remote care to patients with concussion.²⁴⁻²⁷ Similar to systems of care developed for acute stroke,^{28,29} telemedicine-based networks centered around regional or provincial multi-disciplinary concussion clinics may be a novel approach to expand access to specialized care for patients living in remote, isolated, and medically underserved communities throughout Canada.³⁰ Despite this innovative work, little is known about the use of telemedicine among Canadian concussion care providers and clinics, how use of this technology has changed during the COVID-19 pandemic, and what barriers must be overcome to promote greater adoption and sustainability of telemedicine to manage concussion. Therefore, the objective of this study was to evaluate the use of telemedicine among Canadian concussion healthcare providers and clinics before and after the onset of the COVID-19 pandemic and identify barriers and facilitators that must be considered to optimize its use.

Methods

Study Participants

Institutional ethics approval for this study was obtained from the University of Manitoba.

At present, there is no formal registry or accreditation process for interdisciplinary concussion clinics or providers in Canada. We conducted standardized online searches to identify a generalized sample of Canadian concussion healthcare providers and clinics. We defined a concussion provider or clinic as a facility that advertised providing one or more clinical concussion-related services on their website. Using the Google.ca search engine, we conducted standardized online searches using the terms “concussion clinic” and each Canadian province or territory. For each search, we recorded the top 10 concussion providers and clinics identified within the first 10 pages of Internet searches. To identify any university-based concussion clinics that may not have been identified during the initial online searches, we also completed searches using the terms “concussion clinic” and the name of all Canadian universities with medical school programs. Once the final list was generated, a research assistant searched each individual concussion provider and clinic’s website to identify an appropriate representative to approach to participate in the study (e.g., clinic director, manager) and recorded their contact email. If a contact email was not available, the research assistant telephoned the facility to obtain the email address of an appropriate representative who could be approached to participate in the study. The original online searches for Canadian concussion healthcare providers were completed on May 11, 2020. Additional searches to identify any missed university-based concussion clinics were completed on May 12, 2020.

Online Telemedicine Survey

Using Survey Monkey, we developed an electronic survey composed in the English language that collected provider or clinic information, multiple choice and open-ended questions that assessed the use of telemedicine prior to and after the onset of the COVID-19 pandemic, the types of telemedicine services used and which healthcare providers at these facilities used telemedicine and for what purposes (see PDF, supplemental digital content 1, to view survey). The survey included questions addressing limitations, barriers, and concerns that must be considered to facilitate the use of telemedicine in the future. Prior to completing the survey, all participants provided informed consent and were ensured that data collected from the study would be presented in a de-identified fashion. The electronic survey was emailed to the identified representative from each concussion healthcare provider or clinic. If a response was not received after three email attempts, the research assistant telephoned the representative to inquire about whether they were interested in participating in the study. Provider and clinic representatives were recruited to participate in the study starting on May 22, 2020, and reminders were sent in four- to five-week intervals until August 7, 2020.

Statistical Analysis

The results of the surveys were downloaded from Survey Monkey and imported into an Excel spreadsheet for analysis. Survey responses were tabulated and proportions were calculated.

Table 1: Characteristics of survey respondents (N = 32)

	N (%)
Respondent	
Physiotherapists	9 (28.1)
Physicians	7 (21.8)
Clinic administrators	5 (15.6)
Nurse	1 (3.1)
Other	9 (28.1)
Did not respond	1 (3.1)
Province	
Ontario	6 (18.8)
British Columbia	6 (18.8)
Alberta	5 (15.6)
Nova Scotia	4 (12.5)
New Brunswick	4 (12.5)
Manitoba	3 (9.4)
Newfoundland	2 (6.3)
Prince Edward Island	1 (3.1)
Quebec	1 (3.1)

Results

Overall, 106 individual concussion healthcare providers or clinics were identified. For 99 (93.4%) of these facilities, an appropriate representative was identified and invited to participate. Of the 99 eligible representatives, 30 returned fully completed surveys and two participants completed only subsections of the survey but were included in the final analysis. Three representatives declined to participate. The overall response rate was 32.3%, and the characteristics of respondents appear in Table 1. Among participants, 59.3% indicated they had on-site access to a physician with expertise in concussion, 75.0% had access to two or more other multidisciplinary professionals, 96.9% followed national concussion management guidelines, and one representative did not respond to any of these questions. Overall, 62.5% indicated they provided care to patients living in rural and remote northern communities in Canada and 34.3% indicated they provided care to patients living outside the province or territory in which they reside (one representative did not respond).

Nine of the 32 (28.1%) representatives indicated that they used telemedicine to provide care prior to the COVID-19 pandemic: seven (77.8%) offered telemedicine-based services to patients who lived outside their province or territory and two (22.2%) had established a formal telemedicine program or network. Telemedicine-based services included in-person videoconferencing only (44.4%), in-person videoconferencing and eConsultation (22.2%), telephone only (11.1%), Ontario Telemedicine Network only (11.1%), and one program used in-person videoconferencing, eConsultation, and telephone follow-up (11.1%). Prior to the COVID-19 pandemic, all nine facilities had at least two healthcare providers who were using telemedicine-based services to provide clinical care including: physician (77.8%; three of which were psychiatrists), occupational therapist (66.7%), physiotherapist (33.3%), neuropsychologist (22.2%), athletic therapist (22.2%), social worker (11.1%), counselor (11.1%), nurse practitioner (11.1%), lead clinician (11.1%), qEEG technician (11.1%), and health coach

Table 2: Most common potential barriers to increasing telemedicine-based services (N = 30)

Barriers	N (%)
Inability to conduct a complete physical examination	23 (76.7)
Lack of appropriate reimbursement	14 (46.7)
Lack of start-up and maintenance funding	12 (40.0)
Medico-legal risk	11 (36.7)

(11.1%). The most commonly indicated motivating factors for using telemedicine were to improve access to care for patients living in remote and underserved communities (100%), decrease travel time for patients (88.9%), improving clinical outcomes (66.7%), and ensure greater clinical coverage for clinic catchment area (55.5%).

Most (86.7%) of respondents indicated their clinic's use of telemedicine changed since the onset of the COVID-19 pandemic and two respondents did not answer. Among the 26 clinics that changed their telemedicine services during the COVID-19 pandemic, the most common additions were the use of in-person videoconferencing (69.2%), telephone call appointments (65.4%), eConsultation (19.2%), and other (11.5%). Ninety percent of the 29 respondents indicated that telemedicine had helped provide care to their patients during the pandemic and 13 of 28 respondents (46.4%) indicated that new tariffs or billing codes were introduced in their province or territory to allow providers to bill for telemedicine-based services that were previously unavailable prior to the pandemic. The potential barriers to increase the use of telemedicine-based services appear in Table 2. While 8.3% were unsure, most (22/24; 91.7%) indicated that with appropriate training, equipment, financial support, and supportive evidence they would be open to using telemedicine to assist with the care of select concussion patients in the future. Ninety-three percent of the 30 respondents indicated that they would consider using telemedicine to provide care to their concussion patients once the COVID-19 pandemic crisis was over, and two respondents did not indicate their future plans.

Discussion

This is the first study to examine the use of telemedicine among Canadian concussion clinics and providers. Only 28% of respondents indicated they used telemedicine to deliver clinical care prior to the COVID-19 pandemic. Among the participating clinics and providers, telemedicine was most commonly used by physicians and occupational therapists and the most common service was in-person videoconferencing. The results also suggested that providers were predominantly using this technology to provide follow-up care of patients who had previously undergone in-person assessment with a smaller proportion using it to conduct initial assessments of concussion patients. Overall, these findings are consistent with the preliminary reported literature that examined the use of telemedicine to deliver primary and multidisciplinary concussion care.

To date, research suggests that telemedicine, including the use of in-person videoconferencing, is a safe, feasible, and cost-effective approach for physicians to provide initial medical assessment and follow-up care of carefully selected pediatric concussion patients living in rural and remote underserved regions.^{24,26}

The role of occupational therapists in concussion management continues to expand^{31,32} as does the literature suggesting a role for virtual delivery of out-patient rehabilitation to patients with neurological disorders.³³ There is also a strong body of evidence to support the delivery of virtual psychiatric services.¹⁹ Recent work has suggested that the development of formal hub-and-spoke type telemedicine-based networks composed of provincial or regional multidisciplinary concussion clinics linked to multiple hospitals and healthcare centres within rural and remote communities may be a novel approach to expand access to concussion care in Canada.³⁰ Very few study respondents indicated they had established formal telemedicine networks, however nearly all felt these networks could improve access to primary and specialized concussion care in Canada. The most common motivating factors for using telemedicine prior to the COVID-19 pandemic were improving access to care for patients living in remote and underserved communities, decreasing travel time for patients, improving clinical outcomes, and ensuring greater clinical coverage for clinic catchment area. Despite few Canadian concussion healthcare providers using telemedicine prior to the COVID-19 pandemic, the vast majority felt their patients could benefit from the adoption of these services.

The results of this study suggest COVID-19 pandemic increased the use of telemedicine among Canadian concussion providers and clinics. The evolving pandemic likely led practitioners to rapidly modify their practices and begin using telemedicine-based platforms they had never used previously. Furthermore, many provincial health care systems quickly developed payment structures for telemedicine. Indeed, 87% of respondents indicated their clinic began to use services such as in-person video-conferencing, telephone call appointments, eConsultation after the onset of the COVID-19 pandemic. Almost all of respondents indicated that telemedicine helped provide care and 93% indicated they would consider using telemedicine to provide concussion care once the pandemic was over.

This study identified a number of key barriers that must be overcome to promote use or greater use of telemedicine among Canadian concussion providers and clinics. The barriers were consistent with the published literature on teleneurology.^{23,34} First, survey respondents identified the inability to perform a comprehensive physical exam was a barrier. Canadian national concussion guidelines suggest that all children and adults with a suspected concussion undergo a medical assessment performed by a physician or nurse practitioner that includes a clinical history and physical examination.^{5,6,8} A comprehensive physical examination should ideally include assessment of mental status, speech and communication, as well as objective testing of cranial nerve, motor, sensory, cerebellar, balance, vestibulo-ocular, and cervical spine functioning. The comprehensive testing of vision, motor, and sensory functioning as well as palpation of the cervical spine and tests to evaluate peripheral vestibular functioning cannot be performed without the assistance of a trained telepresenter. Nonetheless, a study by Ellis et al.²⁴ suggested that carefully selected pediatric concussion patients living in remote communities who have undergone a previous medical assessment can be managed safely and exclusively through telemedicine. The same authors introduced a preliminary clinical algorithm and adapted physical examination as well as standardized resources to guide the remote medical assessment and longitudinal care of pediatric patients living in remote and isolated communities in northern Canada.²⁵

A second barrier was the lack of appropriate reimbursement; however, the COVID-19 pandemic has helped to address concerns

about provider remuneration and licensing. As demonstrated here, many concussion healthcare providers and clinics benefitted from the regional development of new tariffs and billing codes created during the COVID-19 pandemic that allowed providers to be reimbursed for certain telemedicine-based services.

Other barriers included concerns related to lack of start-up and maintenance funding and medico-legal risk. Despite the recent advances in the use of telemedicine for concussion care, long-term solutions are needed to address concerns related to funding and medico-legal risk. The results of this study provide strong support for developing a national working group to help address these challenges. Indeed during the COVID-19 pandemic, the Living Guideline on Pediatric Concussion Care published a domain that describes evidence-based and expert consensus recommendations and guidelines for the use of telemedicine in concussion.⁶ Medico-legal risks include risk of malpractice allegations because of inability to perform clinical examinations, risk of injury during remote examinations, and challenges of developing therapeutic rapport over videoconference could be addressed by establishing standards for telehealth examinations and ensuring informed consent from patients regarding the limitations of telehealth.

To date there is minimal evidence regarding patient satisfaction of virtual concussion care. However, a small randomized controlled trial comparing in-person versus telehealth concussion care among pediatric athletes found that patient satisfaction was similar between both treatment options.³⁵ Moving forward, there is a need to build a strong foundation of evidence that evaluates patient satisfaction with virtual care, examines the societal and economic benefits of this approach, and addresses the extent to which concussion-related healthcare services (i.e. cervical spine and vestibular physiotherapy, neuropsychological testing, occupational therapy) can be safely and cost-effectively delivered via telemedicine to patients living in medically underserved communities.

This study has several important limitations. First, the response rate for this survey study was 32.3%. Although the authors used multiple strategies to contact the identified concussion healthcare clinics and providers, many chose not to participate. The survey was received when many aspects of professional and personal lives were moved online and people were experiencing screen and computer fatigue which may have decreased participation. Also, it is possible that those clinics and providers who were not using telemedicine to deliver concussion care were more likely to decline participating in the study if they did not perceive that the survey was relevant to their current practice. Second, this study was conducted during the COVID-19 pandemic, which may have impacted survey responses. Many clinicians were logistically unable to provide in-person care and were forced to adopt virtual models of concussion care delivery. Given these evolving circumstances, this may have led to an overestimation of the use of telemedicine prior to the COVID-19 pandemic among those who anticipated the impact of this looming public health crisis and therefore chose to adopt these practices immediately prior to regional recommendations to limit in-person patient visits. Third, the survey was not translated into French, and this may have resulted in fewer responses from Quebec. Future research is needed to evaluate whether the increased use of telemedicine-based services translates into the long-term adoption and sustainability of these practices moving forward.

In conclusion, telemedicine was used by a minority of Canadian concussion clinics prior to the COVID-19 pandemic and mostly used by occupational therapists and physicians. Although telemedicine increased following the onset of the COVID-19 pandemic,

several barriers must be addressed to facilitate increased adoption of telemedicine-based services and virtual care into the routine clinical practice of interdisciplinary providers in the future.

Supplementary Material. To view supplementary material for this article, please visit <https://doi.org/10.1017/cjn.2022.18>

Disclosures. Judith Gargaro was an employee of ONF and contributed to the development of the ONF guidelines for concussion and mild TBI. Dr Bayley received funding for development of the ONF guidelines.

Authorship Confirmation Statement. All authors have made substantial contributions to the conception or design of the work and/or the acquisition, analysis, or interpretation of data for the work and have been involved in the drafting the work or revising it critically for important intellectual content. All authors provide final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Authorship Disclosure Statement. Authors Michael Ellis, Judith Gargaro, Mark Bayley, and Kelly Russell have contributed to the development of Ontario Neurotrauma Foundation guidelines for concussion and mild traumatic brain injury. Michael Ellis and Kelly Russell specifically contributed to the Telemedicine and Virtual Concussion Care guidelines. Michael Ellis served as the co-chair of the expert advisory committee for Parachute expert advisory committee on concussion that was responsible for developing the Canadian Guideline on Concussion in Sport.

References

- Gordon KE, Kuhle S. Canadians reporting sport-related concussions: increasing and now stabilizing. *Clin J Sport Med.* 2020. DOI [10.1097/JSM.0000000000000888](https://doi.org/10.1097/JSM.0000000000000888).
- Gordon KE, Kuhle S. 'Reported concussion' time trends within two national health surveys over two decades. *Brain Inj.* 2018;32:843–9.
- Langer L, Levy C, Bayley M. Increasing incidence of concussion: true epidemic or better recognition? *J Head Trauma Rehabil.* 2020;35:E60–6.
- Zemek RL, Grool AM, Rodriguez Duque D, et al. Annual and seasonal trends in ambulatory visits for pediatric concussion in Ontario between 2003 and 2013. *J Pediatr.* 2017;181:222–8.e2.
- Marshall S, Bayley M, Berrigan L, et al. Guideline for Concussion/Mild Traumatic Brain Injury & Prolonged Symptoms: 3rd Edition (for Adults 18+ years of age); 2018. Available at: http://braininjuryguidelines.org/concussion/fileadmin/pdf/Concussion_guideline_3rd_edition_final.pdf
- Reed N, Zemek R, Dawson J, et al. Living Guideline for Pediatric Concussion Care; 2021. Available at: <https://www.pedsconcussion.com/wp-content/uploads/2021/01/Living-Guideline-for-Diagnosing-and-Managing-Pediatric-Concussion.pdf>
- Foundation ON. Standards for Post-Concussion Care: from diagnosis to the interdisciplinary concussion clinic; 2017. Available at: <https://concussionsontario.org/wp-content/uploads/2017/06/ONF-Standards-for-Post-Concussion-Care-June-8-2017.pdf>; accessed January 2, 2021.
- Parachute. Canadian Guideline on Concussion in Sport; 2017. Available at: www.parachutecanada.org; accessed January 2, 2021.
- Stoller J, Carson JD, Garel A, et al. Do family physicians, emergency department physicians, and pediatricians give consistent sport-related concussion management advice? *Can Fam Physician.* 2014;60:50–2.
- Zemek R, Eady K, Moreau K, et al. Knowledge of paediatric concussion among front-line primary care providers. *Paediatr Child Health.* 2014;19:475–80.
- Fridman L, Scolnik M, Macpherson A, et al. Annual trends in follow-up visits for pediatric concussion in emergency departments and physicians' offices. *J Pediatr.* 2018;192:184–8.
- Huot S, Ho H, Ko A, et al. Identifying barriers to healthcare delivery and access in the Circumpolar North: important insights for health professionals. *Int J Circumpolar Health.* 2019;78:1571385.
- Marrone S. Understanding barriers to health care: a review of disparities in health care services among indigenous populations. *Int J Circumpolar Health.* 2007;66:188–98.
- Health NCCfI. Access to health services as a social determinant of First Nations, Inuit and Métis health; 2019. Available at: <https://www.nccih.ca/docs/determinants/FS-AccessHealthServicesSDOH-2019-EN.pdf>; accessed January 2, 2021.
- Oosterveer TM, Young TK. Primary health care accessibility challenges in remote indigenous communities in Canada's North. *Int J Circumpolar Health.* 2015;74:29576.
- Ellis MJ, Ritchie L, Selci E, Chu S, McDonald P, Russell K. Googling concussion care: a critical appraisal of online concussion healthcare providers and practices in Canada. *Clin J Sport Med.* 2017;27:179–82.
- Dorsey ER, Glidden AM, Holloway MR, Birbeck GL, Schwamm LH. Telemedicine and mobile technologies: the future of neurological care. *Nat Rev Neurol.* 2018;14:285–97.
- Dumitrascu OM, Demaerschalk BM. Telestroke. *Curr Cardiol Rep.* 2017;19:85.
- Hubley S, Lynch SB, Schneck C, Thomas M, Shore J. Review of key telepsychiatry outcomes. *World J Psychiatry.* 2016;6:269–82.
- Larner AJ. Telemedicine: an overview of current status. *Pract Neurol.* 2011;11:283–8.
- Lo MD, Gospe SM Jr. Telemedicine and child neurology. *J Child Neurol.* 2019;34:22–6.
- Vierhile A, Tuttle J, Adams H, tenHooft C, Baylor E. Feasibility of providing pediatric neurology telemedicine care to youth with headache. *J Pediatr Health Care.* 2018;32:500–6.
- Wechsler LR, Tsao JW, Levine SR, et al. Telemedicine applications: report of the telemedicine work group of the American Academy of Neurology. *Neurology.* 2013;80:670–6.
- Ellis MJ, Boles S, Derksen V, et al. Evaluation of a pilot paediatric concussion telemedicine programme for northern communities in Manitoba. *Int J Circumpolar Health.* 2019;78:1573163.
- Ellis MJ, Mendez I, Russell K. Preliminary clinical algorithm to optimise remote delivery of paediatric concussion care in Canada's North. *Int J Circumpolar Health.* 2020;79:1832390.
- Vargas BB, Channer DD, Dodick DW, Demaerschalk BM. Teleconcussion: an innovative approach to screening, diagnosis, and management of mild traumatic brain injury. *Telemed J E Health.* 2012;18:803–6.
- Vargas BB, Shepard M, Hentz JG, Kuttyreff C, Hershey LG, Starling AJ. Feasibility and accuracy of teleconcussion for acute evaluation of suspected concussion. *Neurology.* 2017;88:1580–3.
- Adeoye O, Nystrom KV, Yavagal DR, et al. Recommendations for the establishment of stroke systems of care: a 2019 update: a policy statement from the American Stroke Association. *Stroke.* 2019;50:e187–210.
- Demaerschalk BM, Berg J, Chong BW, et al. American Telemedicine Association: telestroke guidelines. *Telemed J E Health.* 2017;23:376–89.
- Ellis MJ, Russell K. The potential of telemedicine to improve pediatric concussion care in rural and remote communities in Canada. *Front Neurol.* 2019;10:840.
- Harris MB, Rafeedie S, McArthur D, et al. Addition of occupational therapy to an interdisciplinary concussion clinic improves identification of functional impairments. *J Head Trauma Rehabil.* 2019;34:425–32.
- Reed N. Sport-related concussion and occupational therapy: expanding the scope of practice. *Phys Occup Ther Pediatr.* 2011;31:222–4.
- Tenforde AS, Hefner JE, Kodish-Wachs JE, Iaccarino MA, Paganoni S. Telehealth in physical medicine and rehabilitation: a narrative review. *PM R.* 2017;9:S51–8.
- Wechsler LR. Advantages and limitations of telemedicine. *JAMA Neurol.* 2015;72:349–54.
- Elbin RJ, Stephenson K, Lipinski D, et al. In-person versus telehealth for concussion clinical care in adolescents: a pilot study of therapeutic alliance and patient satisfaction. *J Head Trauma Rehabil.* 2021. DOI [10.1097/HTR.0000000000000707](https://doi.org/10.1097/HTR.0000000000000707).