

# Evaluating paediatric orthopaedic teleradiology services at a tertiary care centre

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Telehealth services are innovative healthcare strategies that utilize communication technologies to improve healthcare access for patients. Teleradiology is a form of telehealth service that involves the transmission of radiological images, such as x-rays, CTs and MRIs, from one location to another to share patient information with other physicians. The purpose of this study was to assess teleradiology consultations for orthopaedic patients at a paediatric tertiary care centre. A retrospective review was conducted of patients who received teleradiology consultations with a single orthopaedic surgeon from 2015 to 2018 through the paediatric orthopaedic hip clinic at our institution. Teleradiology consultations involved follow-up radiographic imaging at a local community facility for patients who initially received healthcare services at our institution, followed by a telephone consultation to review imaging results and communicate next steps in care. Data collected included patient demographics, imaging type, facility location and distance from our institution. Eighty patients ( $F = 66$ ,  $M = 14$ ) who received teleradiology services were reviewed. Mean age was 3.5 years [95% confidence interval (CI): 2.5–4.4] at

time of imaging. The average distance from community facilities to our institution was 1167 km (95% confidence interval: 920–1414), a measure of the total distance saved in travel for each patient in a single direction. The travel distance saved was substantial. Paediatric orthopaedic teleradiology services provide families specialized consultations and care continuity without costly travel. With increased implementation of teleradiology services, more patients and families can remain in their home communities while receiving the same quality of care. *J Pediatr Orthop B* 31: e69–e74 Copyright © 2020 The Author(s). Published by Wolters Kluwer Health, Inc.

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## Introduction

Modern medical advances have prolonged the lives of our growing population and have resulted in steadily increasing demands on our healthcare system [1]. Dramatically increased life expectancy coupled with population growth expectedly requires additional medical resources [2]; however, capitalist funding models that encourage privatization of care or the minimization of operational and organizational costs are adapting healthcare systems with methods that may not necessarily preserve high levels of quality patient care [3]. Certain healthcare settings, especially those in rural areas, are already experiencing shortages in physicians and nurses such shortages [4]. This, combined with the lack of transport and mobility obstacles often found in rural areas, may serve as additional barriers to accessing high-quality healthcare [4]. To improve healthcare accessibility, advances are being made in telehealth services, an innovative healthcare

strategy that utilizes various communication technologies. These include a range of sophisticated tools such as audio, imaging and video transmission, remote monitoring testing devices and real-time interactive modalities designed to provide patient care that both improves the delivery of healthcare and are also used for educational purposes.

Telemedicine, a subcategory of telehealth, involves the distribution of health-related information and services using telecommunication or electronic technologies. Technology, such as video and web conferencing or other virtual means of communication, can be used in place of in-person visits, allowing for patient–clinician interaction, intervention, education and monitoring over long distances and across multiple health specialties [5]. Telemedicine services have already been implemented in some health centres across Canada to bridge the gap between patients and healthcare professionals. More specifically, for specialities requiring medical imaging, another form of telehealth services, teleradiology, can be utilized. Teleradiology is the transmission of radiological images, such as x-rays, computed tomography (CT) scans,

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and MRIs, from one location to another for the purpose of sharing patient information with other physicians and radiologists. As telehealth services become more widely available, there are more options for patients encountering long wait times and a shortage of available physicians when seeking alternate methods of accessing medical care [6].

Teleradiology services may also have significant clinical implications, such as less crowded waiting rooms and wait times, easing pressure and strain on clinical teams and clerks [7], and may drastically reduce the spread of certain infectious diseases within healthcare settings, as currently seen with SARS-CoV-2, the novel coronavirus causing the COVID-19 pandemic [8]. Use of telehealth and teleradiology services not only minimizes opportunities for infectious disease transmission by reducing the number of patients needing to travel to healthcare centres, but also can be used to ‘forward triage’ patients. Forward triaging is a method that uses webcam-enabled computers so patients may be efficiently screened and assessed while in self-quarantine, thus protecting the health of other patients, clinicians and the greater community [9,10]. Methods like these can be applicable not only to COVID-19, but other infectious diseases like measles and tuberculosis.

Recently, increased federal and provincial funding for improved information and communication technologies has resulted in significant growth in Canadian telehealth services, improving access to healthcare across the nation [11]. Stakeholders, such as care providers and health authorities, may wish to evaluate whether clinicians can provide patients with equal or higher standards of care without an in-person examination. Some are concerned that with advancing technologies, opportunities for patient to provider interactions will be missed. More specifically, telemedicine can improve patient care by allowing physicians to provide the same services without conducting an in-person consultation. It allows physicians to adapt existing systems, without drastic changes, to the benefit of both the provider and the patient. Previous studies have suggested no significant difference exists between the quality of care delivered via telemedicine versus traditional on-site, in-person care [12]. Many health centres in Finland, Israel, the Netherlands and Australia have already been optimizing the use of telehealth services, whether it be teleradiology or telemedicine, to provide patient care from concentrated urban regions to decentralized areas [13–15]. Specifically, in Australia, video-conferencing remains the primary method for which telehealth is utilized in rural and remote areas. However, with the occurrence of the current COVID-19 global pandemic, significantly more countries have undergone rapid expansion of their telehealth services [16,17], as recommended by the World Health Organization [18].

Although international studies have sought to understand whether clinicians can provide patients with equal

or higher standards of care without having a physician complete an in-person examination, there is currently no relevant literature related to the evaluation of teleradiology services for paediatric orthopaedics in Canada, which is of special interest to our institution. For the purposes of this study, teleradiology services involved the attainment of radiographs in a community imaging centre or health facility for a current patient at an external institution, the transfer of those images from the centre in which they were obtained to a primary healthcare provider (i.e., orthopaedic surgeon), and assessment and review of the radiographs and subsequent treatment at a different institution using virtual communication means, reducing the need for an in-person consultation (Fig. 1) [19]. The purpose of this pilot study was to assess existing teleradiology services at our institution, a paediatric tertiary care hospital, to determine travel distance saved for patients obtaining radiographic imaging for paediatric orthopaedic conditions and receiving teleradiology consultations in lieu of outpatient clinic visits.

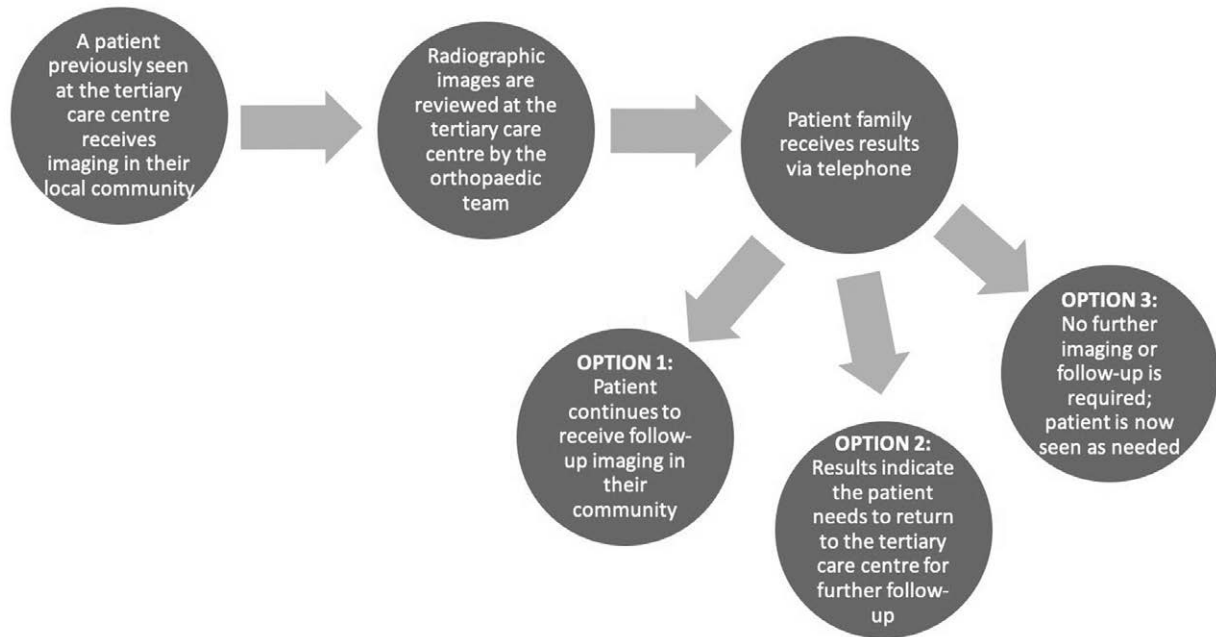
## Methods

A retrospective review was conducted of patients who received teleradiology consultations with a single orthopaedic surgeon from 2015 to 2018 through the paediatric orthopaedic hip clinic at our tertiary care centre. Any patient who received radiographic imaging at a hospital, clinic or facility in their home community to be subsequently used for an orthopaedic teleradiology consultation was included in this review. Teleradiology consultations at our tertiary care centre involved the arrangement for follow-up radiographic imaging at a local community facility for patients who had previously received orthopaedic outpatient services at our institution. The use of teleradiology enabled the surgeon to provide the same services to their patient without having to be at the same location of the patient.

A patient who had previously undergone corrective hip surgery, received a Spica cast or was routinely being monitored for development dysplasia of the hip (DDH) in our clinic, was given the option to receive their imaging closer to home using teleradiology services. Instead of booking an outpatient follow-up appointment at our centre, the nurse clinician provided patients with an imaging requisition form and time-frame appropriate for the patient’s orthopaedic needs to obtain their imaging at a facility closer to home. After receiving their imaging, an orthopaedic follow-up teleradiology appointment would be scheduled with the patient family and our institution.

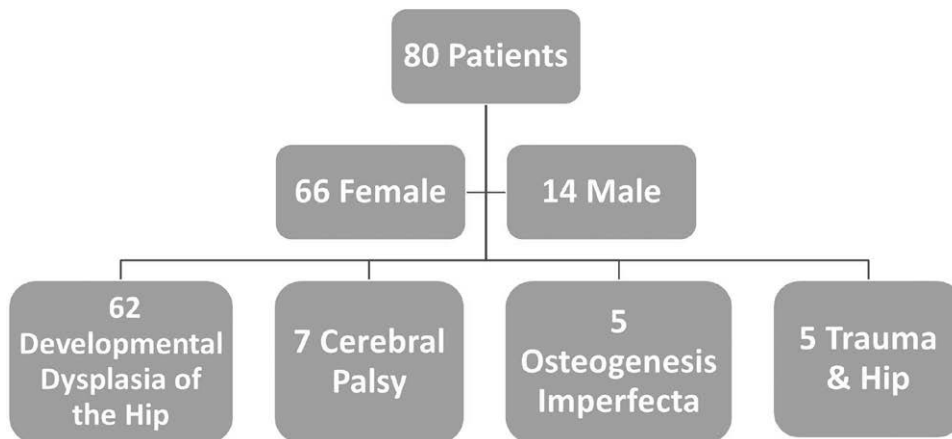
Radiograph results were reviewed by the orthopaedic surgeon as with any other patient using the province-wide electronic imaging viewer accessible to physicians and clinicians, with support from the nurse clinician prior to consultations. Subsequently, a telephone consultation was conducted with the orthopaedic surgeon, nurse clinician and patient family to review the imaging results

Fig. 1



Teleradiology services at a Canadian provincial tertiary care hospital.

Fig. 2



Patient demographics.

obtained from the external centre. The findings and recommendations for the next steps in the child's care were then communicated to the patient's family. These recommendations may include repeat radiography at a later date for continued monitoring, a request for the patient to return to the orthopaedic outpatient clinic at our institution for an in-person appointment and further investigation or a change in treatment plans such as weaning a brace worn by a DDH patient or no further imaging required (Fig. 1). Data collected included basic patient demographics, imaging type, facility location and

distance from our institution were collected and basic descriptive statistical analyses were conducted.

## Results

A total of 80 patients (66 women, 14 men) who received teleradiology services were reviewed. Of these patients, 62 were diagnosed with DDH, seven with cerebral palsy, five with osteogenesis imperfecta, three with other hip disorders and two with traumatic injuries (Fig. 2). Mean age was 3.5 years [95% confidence interval (CI): 2.5–4.4] at the time of imaging, and 40% of patients had previously

**Table 1 Patient demographics**

Patient demographics	
Age [mean, (95% CI)]	3.5 years (2.5, 4.4)
Sex [number (%)]	Men: 14 (17.5) Women: 66 (82.5)
Previous surgical intervention [number (%)]	32 (77.5)
Average distance from community facility to BCCH [mean, (95% CI)]	1167 km (920, 1414)

BCCH, British Columbia Children's Hospital; CI, confidence interval.

undergone some form of surgical intervention (Table 1). All patients had an anteroposterior X-ray film of the relevant anatomical location taken, and eight patients had additional views taken for better visualization. The average distance from community facilities to our institution was 1167 km (95% CI: 920–1414), a measure of the total distance saved in travel for each patient in a single direction. The closest imaging facility to our institution was 19 km away, and the furthest imaging facility was 2927 km away.

## Discussion

Prior to incorporating teleradiology services, all patients and families were expected to travel to our outpatient clinic to obtain their medical imaging and follow-up consultation with the orthopaedic surgeon, regardless of where they lived. The implementation of teleradiology in the orthopaedic clinic at our institution resulted in substantial savings in travel distance for patients and families. These savings could be especially beneficial for patients being monitored that no longer require extensive treatment or intervention (e.g., surgery) as part of their care. For example, it is not necessary for a child with DDH (Fig. 3) who no longer requires bracing or has been postoperatively stable to return to a tertiary care centre if simple radiologic follow-up will suffice. For patients living outside of the region and elsewhere within the vast province, a trip to our institution for specialist care can mean significant travel and associated costs. These may include flights and accommodation, additional expenses related to missed work and taking unpaid leave and disruption for the entire household if needing to provide care for other family members. There are times when travel is cancelled due to poor weather conditions, last-minute appointment cancellations occur or care cannot be arranged for other children in the family. Additionally, if time is dedicated to extensive travel, this may negatively impact a child's quality of life, especially if there are limitations associated with their condition. For example, many children with cerebral palsy experience mobility limitations and require ambulatory aids or wheelchairs. Paediatric orthopaedic teleradiology services provide families the opportunity for care continuity with specialized consultation, without the need for costly travel or time away from work.

One of the major barriers with healthcare as a sector is that it that has been very conservative in terms of technology

**Fig. 3**

An anteroposterior pelvis radiograph of a 2-year-old woman with developmental dysplasia of the hip, assessed at a community facility. She received 6 months of brace treatment beginning at 3 months of age.

uptake and lags behind other sectors. On a global scale, new technology and clinical workflows have already been adapted to support alternative care delivery. Small, simple changes within existing health services and structures that do not require extensive transformations to operations are both time and cost-effective. The need for improved solutions and better alternatives to antiquated health systems became apparent with the COVID-19 world outbreak. The COVID-19 global pandemic has greatly accelerated the use of telehealth services and demonstrated that political, security and financial barriers should no longer limit the healthcare system in providing more technologically advanced health services. One can only wonder how some countries would have better fared in their pandemic response had simple virtual technologies such as teleradiology services already been in place. Nevertheless, expansion and improvement in telehealth services will be crucial in protecting patients against existing and other future infectious diseases.

As many surgical procedures in the orthopaedic field, such as those for hip reconstruction or scoliosis surgery, can result in large surgical incisions, frequent postoperative wound assessments are required. However, telemedicine methods, like secure transmission of photos and videos to clinicians by patients, can be used to examine postoperative wounds without the need for an in-person visit and may even result in early detection of postoperative complications [20]. Reduction of in-person visits, like those for wound assessment, will also minimize the use of personal protective equipment within healthcare centres [21] and reduce the opportunity for viral transmission between patients and families and healthcare workers. As a COVID-19 resurgence is expected [22] and

the emergence of future novel infections are predicted to occur, it will be important to ensure current telehealth services are sufficiently prepared for such events.

In 2017, ChildHealthBC launched its first telepaediatric intensive care service (Tele-PICU) to provide children with greater access to specialized care closer to their home communities throughout British Columbia using telemedicine [23]. Tele-PICU allows healthcare teams to assess children in their community through live, two-way videoconferencing between Vancouver and Victoria. As a result, intensive care units can collaborate with healthcare providers in communities across British Columbia to help children receive diagnosis and treatment earlier and without leaving their community. When a child does not need to be transferred from one care facility to another, families face fewer burdens with reduced travel costs and less time away from work; therefore, they are able to stay better connected with their home-based support networks throughout the care process [23]. These types of organized and collaborative approaches provide opportunities for optimizing healthcare provincially, nationally and internationally. Increased availability of teleradiology services can diversify the geographic access to patients so that at regional, provincial and national levels, more health services and programs are better integrated.

While telehealth services have received considerable attention, there is a paucity of literature or evidence on the specific topic of teleradiology. Hesitation surrounding the use of telemedicine in Canada persists due to its unfamiliarity, so the country lags behind other nations in implementing these services [6]. Most concerns are due to the privatization associated with virtual telemedicine, as technology companies often design telemedicine applications with profit-seeking models to meet the demands of long wait times and practitioner shortages. Furthermore, centres are hesitant to implement telehealth services due to costs associated with implementation procedures and infrastructure for operations, but less expensive methods of telehealth services can still be optimized. Namely, the use of teleradiology consultations, like the ones conducted at our institution, can be implemented at other centres nationally and internationally, without the need for sophisticated or complex use of technology such as videoconferencing. While nursing resources may be needed to conduct teleradiology consults and are maybe an additional expense for these services, other costs to develop a program like this would be minimal as it can simply be booked as a regular patient appointment but provided virtually. These patients would fall under existing nursing workloads and may even potentially free up time for additional patients or longer visits with patients requiring more in-depth care.

Conducting orthopaedic consultations using teleradiology services has great potential to improve access to care for patients without diminishing the quality of care

received. Increased implementation of teleradiology services allows patients and families to remain in their home communities, potentially reducing wait times for those referred for specialist care. This also allows for better allocation of resources and services to reduce the burden on health professionals, especially front desk staff who interact first-hand with frustrated patient families. Our program is an example of how other departments across Canada and internationally can make minor modifications within existing programs to better serve the needs of their patients and staff when barriers telehealth or virtual care services persist. More teleradiology programs like this will enable health organizations around the world to provide alternative yet complementary patient interactions to face to face patient–physician ones while also mitigating inequalities in access to rural areas.

There are a number of limitations to this study. The retrospective design prevented the evaluation of participant experiences with teleradiology services. The authors attempted to include a variety of patients in the study, but the majority of cases had DDH as their primary diagnosis. However, it is important to include other patient types to demonstrate the wide range of patients that can receive and benefit from teleradiology consultations. Additionally, the definitions of telehealth, teleradiology and telemedicine are often subjective and vary from centre to centre and physician to physician, making comparisons to other studies or existing services challenging. We have attempted to define and clarify these differences. There are also financial limitations to conducting full-scale studies on telehealth or teleradiology services since advanced technology may require additional funding and staffing resources to implement innovative projects. Costs may vary based on the geographic setting and availability of technology and applications for telehealth services. Still, optimizing existing services rather than making radical changes to the standard of care can minimize financial barriers. Finally, in the event that a teleradiology consultation determines that patient does, in fact, require further follow up in-person, this is an additional visit in care, but nevertheless does increase patient-to-provider contact.

To determine whether conducting orthopaedic teleradiology consultations can improve access to care for patients without diminishing the quality of care received, a quality improvement project for teleradiology services at our institution in the paediatric orthopaedic hip clinic is being developed. Eligible participants include families receiving care in-person at our institution and those obtaining imaging at facilities in their communities. To better understand costs associated with clinic visits and the effectiveness of implementing teleradiology services for all surgeons in the orthopaedic department, patient satisfaction surveys will be administered to both cohorts to measure patient

experiences using teleradiology services and receiving clinical care at our institution. This project may provide rationale for funding to collaborate with ChildHealthBC's initiative and to implement full-scale teleradiology services for orthopaedic patients' nationwide.

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### Conflicts of interest

K.M. has received research support from I'm a HIPpy Foundation, Allergan, Pega Medical and Depuy Synthes (Johnson & Johnson). None are directly relevant to the work in this article. For the remaining authors, there are no conflicts of interest.

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