EFFECTIVENESS OF TELEHEALTH FOR TEACHING SPECIALIZED ASSESSMENT TECHNIQUES TO PHYSICAL THERAPISTS

by

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Abstract

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Objective: To determine whether Telehealth is effective in teaching assessment and treatment skills to physical therapists at remote sites.

Methods: A comparison of three educational formats: Teaching via Telehealth (T), Direct Teaching (DT), and Self Study (SS) was completed. Physical therapists in two Northern Ontario cities were rated on their execution of skills before and after education using a global rating scale and a general assessment of competency for each skill. The pre and post tests were completed by an evaluator who was blinded to the type of teaching.

Results: Prior to education there were no differences in performance or competency levels between groups. There was no significant difference between DT and T for the post-test performance and competency scores. However, there was a significant difference in the post-test performance and competency scores between the T and SS groups for all five skills.

Conclusions: It appears that Telehealth is a better teaching tool than self study and is not significantly different from direct teaching as a method for teaching specialized assessment techniques.

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Table of Contents

List of Tables

List of Abbreviations

ANOVA	Analysis of variance
ASHT	American Society of Hand Therapists
CE	Continuing education
DT	Direct teaching
GRIP	Grip strength
GRS	Global rating scale
HSC	Hospital for Sick Children
ICC	Intraclass correlation coefficient
ISDN	Integrated Services Digital Network
LOS	Length of stay
MOBSD3	Mobilization of the long finger
OSCE	Objective structured clinical examination
PI	Primary investigator
PIPJ	Proximal interphalangeal joint
SS	Self study
T	Telehealth
TAMD2	Total active movement of the index finger
2PTDISC	Two point discrimination
VOL	Volumetrics

Introduction

Health care reform has changed the focus of patient care from primarily inpatient to an increased emphasis on outpatient services. The reduction in hospital beds, staff complement and length of inpatient stay has led to an increased need for early referral of patients to the community by many professionals including physical therapists. Unfortunately, a corresponding adjustment to outpatient resources has not occurred, resulting in an imbalance of resources and making accessibility to the appropriate services in the community extremely difficult.[1]

In addition, the vast geographical areas within Canada contribute to inequitable access to health care and clinical information, with large metropolitan centres having a disproportionately large number of health care specialists.[2, 3] This is associated with difficulties in recruiting practitioners to rural areas because of the feeling of professional isolation.[4] This feeling of isolation may be reduced by providing these remote practitioners with improved access via telecommunications to the specialists and educational opportunities available in urban centres. Current telecommunication technology (Telehealth) may provide an economically feasible mechanism to achieve this improved access. Telehealth may also provide an opportunity for continuity of specialist clinical services to rural communities.

Telehealth may be defined as the utilization of telecommunication technology to provide health care services and medical information over distance.[5] Telehealth has the

potential for facilitating equitable and economical health care services to health-care providers and consumers in remote areas.[6]

A broad range of medical specialties have successfully completed studies on the capabilities of Telehealth to assess patients in remote areas using both store and forward techniques (still digital images),[7-15] and real-time interactive tele-conferencing to provide specialty consults.[16-22] Clinical practice using Telehealth techniques at The Hospital for Sick Children in Toronto, has included a number of health care disciplines. On a regular basis, the division of orthopaedic surgery has consultative clinics with cerebral palsy patients in Northern Ontario. General surgical services have completed follow-up clinics with patients in Northern Ontario who have required a variety of surgeries. In both of these specialties, tactile interaction between the patient and physician is critical. Thus, the health care professional at the distant site must be the "physician's hands".

What has not been reported in the literature is the effectiveness of teaching via Telehealth when a "hands on" component is required. This "hands on" interaction is inherent to many specialties especially physical therapy. This domain may challenge the current limitations or applications of Telehealth.

There is a parallel in using Telehealth for the purposes of clinical education. It may be effective for teaching knowledge-based topics, but many health profession domains, such as physical therapy assessment skills, have tactile components that require

measurement and analysis. For example, the capability to feel tissue tension or joint movement. These skills potentially may be learnt through the application of Telehealth, but may not be teachable using this medium because of the need for "hands on" training. This research proposes to determine if physical and tactile assessment skills may be taught through this medium. Exploring the opportunity to utilize Telehealth as an effective teaching tool for rehabilitation assessment techniques may increase the accessibility to health care and education by both the professional and the patient in remote areas. If the use of Telehealth as a teaching tool is to become clinically acceptable, then the results must approximate or improve upon conventional methods.[18]

Although there is an identified need for Telehealth, the assessment of its accuracy in transferring clinical information and meeting teaching requirements must be determined. The presence of available technologies must not by itself be the only criteria for increasing utilization of Telehealth.

HYPOTHESIS

Telehealth is an effective tool for teaching manual specialized assessment techniques; specifically, the teaching of hand assessment techniques to physical therapists.

OBJECTIVES

Primary Objective:

The overall purpose of this research is to determine the effectiveness of Telehealth for teaching specialized assessment skills to physical therapists compared to direct teaching and self study.

Preliminary Objectives:

Prior to the determination of effectiveness, two additional preliminary objectives were required:

1. To survey Northern Ontario physical therapists for the purposes of identifying appropriate subjects for the Telehealth study.

2. To develop a reliable outcome measure to evaluate the competency of a physical therapist in specialized hand assessment techniques.

Literature Review

SCOPE OF THE NEED

From April 1, 1997 to March 31, 1998, 1,402 paediatric* patients with hand trauma have been treated in the province of Ontario.[23] Of this number, 329 were treated by physicians at The Hospital for Sick Children (HSC), Toronto and 99 of these patients required referral for rehabilitation to maximize the restoration of function of the upper extremity.[23, 24] Of these 99 patients 58% came from outside the metropolitan Toronto area but chose to return to HSC for their treatment despite the travel commitment.[24]

In 1994 the average length of stay (LOS) at HSC, for a paediatric plastic surgery patient with a hand injury was 5.16 days.[25] In 1999, the average LOS is 3.10 days.[25] Thus, inpatient rehabilitation has been shortened leading to an increase in need for early referral of complex cases to the community physical therapist.

A physical therapist utilizes clinical techniques to preserve, develop or restore optimal physical function in many areas (*e.g.*, neurology, neurosurgery, orthopaedics and respiratory medicine). Physical therapists achieve this goal by integrating theoretical knowledge and skill performance.[26] In 1999, license renewal application data provided by the College of Physiotherapists of Ontario indicated that there were 4,702 physical therapists registered to practice in Ontario. Of these, 12 currently specialize in hand

* The term 'paediatric' is used to describe the age range from newborn to 18 years of age.

therapy rehabilitation. The practice locations for these 12 physical therapists are unknown but we can assume that most, if not all would be associated with university based hospitals with developed hand surgery programmes. In Northern Ontario physical therapy services are provided by 341 physical therapists. Northern Ontario has been defined by the College of Physiotherapists as the area consisting of the following counties: Algoma, Cochrane, Kenora, Manitoulin, Muskoka, Nipissing, Parry Sound, Rainey River, Sudbury, Sudbury District, Thunder Bay and Timiskaming.

From the total number of Ontario based physical therapists, 210 are located in paediatric facilities throughout Ontario.[27] The number of physical therapists in Ontario who specialize in the rehabilitation of paediatric hand surgery patients is likely less than five. The majority of paediatric physical therapists with a clinical focus of hand therapy are primarily located in the larger urban centres. As a result there is currently an imbalance of accessible specialist rehabilitation services that creates problems when patients require early referral to both urban and rural community specialists for hand rehabilitation therapy.

The rehabilitation of the paediatric plastic surgery patients includes burns, hand surgery, microvascular and craniofacial surgery. The specialty of hand therapy rehabilitation has evolved as a response to more successful and complex surgical procedures.[28] With new surgical techniques surgeons are able to surgically restore a large component of function to an injured hand. However, successful outcomes require involvement of physical therapists experienced in specialized assessment and

rehabilitation techniques.[28] Rehabilitation of a paediatric hand injury differs from that of an adult hand injury. A child must not be viewed as a small adult but as a constantly changing human progressing through a variety of developmental stages.[29] As a result of this added dimension, recommended hand rehabilitation protocols require adjustment to account for the comprehension levels of children and their high activity levels which may jeopardize the surgical repair. Therefore, when treating a paediatric patient the physical therapist must be aware of developmental milestones so that appropriate rehabilitation programmes may be provided.

The training of a physical therapist in assessment techniques requires the utilization of a "hands on" experience with a large component of tactile perception, such as the assessment of tissue tension. This generally requires a physical presence so that the instructor may guide the learner and assist them with integrating the acquired tactile information gained during the completion of the technical skill. Many elements of hand therapy require this type of "hands on" assessment.

In 1985, a survey completed by the American Society of Hand Therapists, identified 17 assessment skills frequently used in the rehabilitation of hand injuries.[28] The five more frequently identified assessment skills were evaluation of:

i) edema,
ii) sensibility,
iii) total active movement,
iv) grip strength,
v) joint mobility.

In the same survey,[28] physical therapists indicated how they acquired these assessment skills. The evaluation of grip strength and sensibility were acquired during the physical therapists' formal education programme. One assessment skill, volumetrics, was acquired on-the-job and the other two, total active movement and joint mobilizations were acquired during continuing education courses.

Continuing education (CE) occurs following initial formal professional education.[30, 31] Generally, the definition of CE is thought to involve structured courses[32] but in actuality CE involves a number of activities such as rounds, reading of journal articles, or discussions with colleagues or perhaps pharmaceutical representatives.[32] The trend towards evidence based practice and maintaining professional competency are two factors that have heightened the importance of CE.[30, 33, 34] Continuing education courses are available to physical therapists after they have graduated and have become licensed physical therapists. In 1994, Tassone and Speechley conducted a survey of Ontario physical therapists which addressed the issue of CE for physical therapists. In this survey the preferred formats for physical therapy continuing education courses were identified as both conferences and workshops.[35] During these two educational sessions information is transmitted by teaching sessions, small group discussions or by practical sessions with direct interaction between the teacher and learner. Therefore, the direct teaching approach using the previously mentioned formats are most often followed for physical therapy CE courses.[35, 36] They are deemed the conventional methods or gold standard. These formats support Graham's[37] findings from her study on the conceptual learning processes undertaken by physical therapy students.

Graham[37] determined that students used an active approach to learning which incorporated their senses (talking, seeing, hearing, and feeling) and their past and current experiences as a context for learning.

Although Tassone and Speechley's[35] survey identified that physical therapists prefer conferences and workshops, physical therapists from the northern portions of the province of Ontario found these methods costly.[35] As a result of economic constraints, 80% of the physical therapists in Ontario most often rely on self study by reviewing journals and other written medical information.[35] Interestingly, in the same 1994 survey, the Northern Ontario physical therapists did express an interest in learning via tele-conferencing.[35] Teleconferencing with the utilization of interactive videoconferencing could attempt to replace the face-to-face aspect of attending conferences or workshops; however, the loss of "hands on" teaching may limit learning opportunities, compared to direct teaching.

In Ontario, CE for any physical therapist is voluntary and there is no compulsory requirement to attend conferences, workshops or other CE educational activities. Physical therapists must renew their professional licenses annually but attendance at CE programmes does not influence their renewal status. Unfortunately, there is limited availability of CE courses and the curriculum of these courses is often restricted to medical specialties. In Ontario, most courses do not concentrate on sub-specialty areas such as paediatrics including paediatric hand injury rehabilitation. Information on hand injuries is offered annually in Toronto at the Upper Extremity Update through the CE

programme at The University of Toronto. This is a general course and is not paediatric based. In the United States, the American Society of Hand Therapists organizes an annual hand therapy meeting but this conference is not specific to paediatric hand injuries. The Philadelphia Hand Therapy group offers a hand rehabilitation course once a year but this is also primarily adult based.

Currently, the availability of CE courses addressing paediatric hand therapy rehabilitation is limited and the courses that are available usually require travel and other expenses which deter participation. As a result, there are a limited number of trained and experienced specialists available to continue the rehabilitation of the paediatric hand therapy patient. Innovative means must be developed to provide the continuity of care for these patients with complex rehabilitation needs and to meet the increasing demands for service as a consequence of earlier discharge from tertiary care hospitals.

One strategy for managing the increasing acuity of referrals and the shortage of trained professionals is to utilize telecommunication technology (Telehealth) to educate and provide consultative services to community physical therapists. This technology also has the potential to provide ongoing continuity between hospital and community physical therapists for specialized rehabilitation programmes.

TELEHEALTH - ORIGINS AND DEFINITION

Telehealth applies utilization of telecommunication technology to health care services and may provide increased accessibility and clinical information to consumers

and providers.[4, 38] Telecommunication technology encompasses everything from the basic telephone, or facsimile, to the sophisticated use of fiberoptics, satellites or a combination of any communication system to transfer information.[39] Broadly, Telehealth may encompass any form of telecommunication technology that links two or more sites that are geographically distant from each other. Generally and in this current research, Telehealth denotes the use of synchronous, two-way interactive technology with both audio and visual capabilities for a multitude of purposes.[40] However, confusion often occurs with the terminology that surrounds Telehealth as there is not an overall generally accepted pattern for use.[4] Telehealth may be applied for consultation (tele-consultation), diagnosis (tele-diagnosis), education (tele-education), or conferencing (tele-conferencing). Contained within each of these applications are more specific functions such as tele-radiology, tele-cardiology, or tele-pathology.[4] The scope of Telehealth is expanding as a result of members of health care disciplines becoming more familiar with the capabilities of Telehealth. For the purposes of this current research, Telehealth was utilized for tele-conferencing and tele-education.

The history of Telehealth dates back to the 1950's when a variety of government departments funded pilot projects designed to determine the effectiveness of assessment and treatment of patients in remote areas.[41] Initially, Telehealth did not demonstrate cost effectiveness and programmes were unable to become self-supporting, resulting in decreased funding and use of Telehealth techniques.[42]

However, over the past decade (1989-1999), renewed interest in Telehealth applications has occurred as a result of a number of factors: advanced new technology, ongoing changes in health care delivery and increasing difficulties in recruiting and retaining specialist health care professionals in rural areas.[3, 6]

CURRENT UTILIZATION OF TELEHEALTH

The rural health care professional has limited access to consultative services with specialists and faces barriers when attempting to continue professional education.[20] Hassol *et al.*[43] suggested that these problems may be resolved by using Telehealth technology.

Currently, the primary professional benefits of Telehealth are patient consultation and continuing education programmes between rural communities and larger medical facilities.[39] The initial studies involving Telehealth utilized the store and forward technique for the purposes of tele-consulting and tele-diagnosis. This method is not based on real time evaluation but captures and stores clinical information for later elective transmission and evaluation. Generally, there is little to no direct contact with the patient by the consultant. The advantage of this technique is that both parties do not need to be available simultaneously.[42]

A number of medical specialties such as pathology, radiology and dermatology evaluated Telehealth using the store and forward technique, and demonstrated diagnostic accuracy in these specialties.[7-15, 44] More recent studies including Telehealth

applications in neonatal intensive care, confirmed these earlier results.[20, 45-47] In 1999, Scerri and Vassallo[48] reported that high-resolution digital pictures could be successfully transmitted as an electronic mail attachment from a British military hospital in Sipovo, Bosnia to specialists located in the United Kingdom to obtain their opinions in plastic surgery, radiology, dermatology, orthopaedics, urology, ophthalmology, general medicine, maxillofacial surgery and pathology. The two primary goals of this recent work was to provide diagnostic and treatment support to isolated physicians and to prevent unnecessary evacuation of personnel during operational deployment.[48] It is not surprising that Telehealth is effective when utilizing the store and forward format as this technique allows the transmission of high resolution images required for quality diagnostic analysis when "hands on" clinical techniques or direct patient contact is not required.

With the development of increasingly sophisticated technology, the potential applications of Telehealth have increased. Real time evaluation provides live interaction between the patient and the consultant. This development allows disciplines, previously limited by the store and forward technique, to expand their use of Telehealth. Investigators from a number of other specialties became aware of and started to evaluate new clinical applications.[16-22]

For example, extensive work in cardiology involving transmissions and evaluations of real time echocardiograms have been completed.[21, 22] These studies demonstrated that accurate diagnosis and subsequent management of the cardiac defects

could be successfully completed providing cardiac consultations to areas that would otherwise not have these services.[21, 22] In addition to echocardiography, Mattioli *et al.*[49] reported good sensitivity and specificity with remote auscultation of paediatric cardiology patients using an electronic stethoscope compared to conventional auscultation. This study's sample size was small (n = 7), thus prompting Belmont *et al.*[50] to continue to evaluate the use of remote stethoscopy for pediatric tele-cardiology. The purpose of that study was to determine if the use of an electronic stethoscope for remote assessment was as reliable as conventional auscultation in providing similar clinical information. Reliability was established but lower diagnostic validity was reported when compared to conventional auscultation. This discrepancy was attributed to a flaw in the study design because the consultant was unable to request the readjustment of the location or the pressure of the stethoscope, which can easily be done during conventional auscultation and could be done by directing the remote site assistant. During a routine Telehealth session these limitations would be addressed and altered accordingly.

The Ottawa Telehealth Project[1] continued investigating tele-cardiology applications and also addressed the issue of patient satisfaction and cost effectiveness. These results confirmed previous reliability of tele-cardiology diagnostic techniques. All patients (n = 19) who were first time users of Telehealth were satisfied with their consultation and the advice given. No patient had difficulties communicating their clinical history via Telehealth and all were pleased to avoid travel in order to visit the consultant in person. Significant monetary savings to the government and to the patients were projected.[1]

To further evaluate the application of real time Telehealth, Pacht *et al.*,[19] studied this application on ambulatory pulmonary patients. They demonstrated that this method could be effectively utilized in an outpatient pulmonary clinic and showed that an accurate history, a precise physical examination including auscultation, a diagnosis and the establishment of a treatment plan could all be completed via Telehealth. In addition, orthopaedic and dental surgeons have confirmed the clinical effectiveness in real time Telehealth assessment and diagnosis.[16, 17]

Reid *et al.*[20] demonstrated patient and physician satisfaction with Telehealth techniques. Consulting physicians reported that Telehealth did not interfere with satisfactory patient clinical assessments, the referring physicians felt that Telehealth was dependable and patients were highly satisfied. All participating patients agreed that Telehealth was valuable to their community. The greatest benefit of Telehealth was accessibility for expert consultation thereby deferring the need for transportation of the patient.[20] In 1999, the Telehealth group from the Hospital for Sick Children, Toronto, published results from a survey which was completed at the end of each Telehealth session by all of the families who utilized Telehealth between February 1996 to September 1997. Dick *et al.*[51] reported high satisfaction with the use of Telehealth for consultative purposes but clearly identified that issues of patient privacy and consultant camera discomfort remain unresolved.

The only identified study involving physical therapy and Telehealth was completed at the Louisiana State University School of Medicine by Nitzkin *et al.*[18] During this study four physical therapists were required to complete clinical assessments by conventional "hands on" examination and via Telehealth of the function of the knee, cervical and lumbar spine range of motion or alignment on four patients. All four patients were assessed using both methods during the same session. Half of the subjects were assessed first by conventional methods and the other half underwent remote assessment first. These examinations resulted in 512 matched pairs of observations. The Telehealth sessions were done between two adjacent hospital rooms. All four physical therapists were involved simultaneously to minimize the length of time required for each assessment. One of the physical therapists guided the remote assistant to perform the required assessment. No discussion occurred between the therapists. At the completion of the assessments, each physical therapist was given an opportunity to request an additional view. Both the conventional and Telehealth findings were compared to criterion established by the researcher. The physical therapists who participated in the study were not aware of the established criteria during the testing time. The conventional assessment scores had a 91% agreement with the criterion and the Telehealth findings an 86% agreement. The reliability of the Telehealth examinations increased with continued use of the equipment. Although these results are encouraging, a small sample size and the potential effect of memory bias should be addressed in future work.

TELEHEALTH AS AN EDUCATIONAL TOOL

The use of Telehealth has also been evaluated for its effectiveness when used for CE. It is essential that education be continued beyond basic professional training to allow the practitioners to accommodate to constant change in new health care practises.[31, 52] Tele-conferencing, which is the simultaneous use of telecommunication technology by geographically isolated professionals,[4] has been used for CE by physicians,[20, 53] by nurses[54, 55] and by allied health professionals.[56]

In the studies involving physicians, the CE services were highly accepted by rural physicians and a feeling of reduced isolation was reported.[20, 57] Reid *et al.*[20] reported that even the urban physicians found tele-conferencing valuable.

Fogel Keck[58] completed a study involving graduate nursing students comparing learning outcomes of students who received instruction via tele-education and those in traditional classrooms. No significant differences between traditional and tele-education students' grades were identified.[58] Fogel Keck's[58] study supported the findings of Barron[59] and Wergin[60] who had previously investigated the use of transmitting graduate courses by television. Barron[59] established that academic quality and accessibility were acceptable suggesting that the use of telecommunication technology was a viable alternative for teaching library and information science courses. Wergin[60] found no statistical significant difference for grade point averages in six out of 10 graduate courses in mechanical engineering when telecommunication equipment was used as the medium for continuing education.

In the mid 1990's more recent utilization of interactive videoconferencing has been completed by the University of Toronto's Engineering and Law faculties. The engineering faculty in conjunction with McMaster University, Hamilton, Ontario and Waterloo University, Waterloo, Ontario, used a synchronous, interactive audio-visual system for the purposes of offering both graduate courses and a select number of undergraduate courses to students not located at the respective campuses. No formal analysis has been recorded to date but during informal discussions with a faculty member interactive videoconferencing was viewed as successful as it provided courses that would otherwise not have been available to the distant learner.[61] Although no formal cost analysis has been reported the faculty reports that utilizing videoconferencing techniques was equivalent in cost to having a professor travel to and from remote sites.[61]

In a study conducted by Daly *et al.*,[62] the academic performance of nursing students in satellite centres and on campus were compared. In both settings the format of teaching was lecture based and was not used to teach "hands on" skills. The traditional classroom format was compared to satellite locations which used a variety of telecommunication strategies to teach the course material. Stored audiotaped lectures and also live two-way interactive audio lectures were primarily used in the satellite centres. There was no statistically significant difference for grade point average between the classroom and satellite settings suggesting that sites and method of delivery of the information did not affect learning.[62] However, it remains unclear whether it is as effective in teaching "hands on" skills.

In Canada, Jennett *et al.*[63] confirmed that the majority of medical learning programmes using telecommunications technology by medical practitioners is via two-way audiovisual conferencing. Increased accessibility and reduced cost of CE by this technique has also been demonstrated in Canada.[20]

In an attempt to decrease the disparity in access to education programmes between rural and urban centres, a study of Telehealth techniques involving CE is presently being conducted in Australia.[64] This study will compare weekly videoconferencing sessions to the same information provided on a compact disc and distributed to participating sites. The researchers hope to determine the preferred method of receiving CE and establish the cost-effectiveness for each of these methods. In addition to providing educational support to rural health care providers, the researchers hope that this may result in improved health of local patients.

No published studies comparing effectiveness of learning "hands on" techniques via telehealth when compared to traditional methods were located.

TELEHEALTH AND PHYSICAL THERAPY AT THE HOSPITAL FOR CHILDREN

The Hospital for Sick Children (HSC) established a formal Telehealth programme in February 1996 using high band width synchronous videoconferencing. Prior to mid

July 1999, 518 Telehealth sessions were completed at HSC by a variety of health care professionals.[65] Physical therapy completed 14 Telehealth sessions for the purpose of pre-discharge teaching and follow-up assessments.[65] The majority of the physical therapy patients were from Northern Ontario with the exception of one international patient. The community physical therapists had little or no experience in rehabilitating the paediatric patient. Most (60%) of the HSC's physical therapy Telehealth sessions involved paediatric plastic surgery patients and only one involved teaching of assessment and treatment skills for the hand injured patient.

Until the early 1990's at The Hospital for Sick Children, when patients with complex hand injuries were referred back to their community, the tertiary acute care physical therapist often accompanied the child to the home and provided direct teaching to the community physical therapist. This was expensive and time consuming. This practice is no longer feasible due to shrinking human and financial resources. In order to provide continuous specialized complex care of the paediatric plastic surgery patients requiring rehabilitation, community physical therapists must increase their experience and knowledge. In addition, professional support to the community physical therapist must be provided through a direct link with those who have expertise. This link may be achieved through the use of Telehealth communication technology. If both the community rehabilitation professionals and the paediatric specialists find it to be effective and appropriate, then the rate of utilization would increase and Telehealth sites would become increasingly cost effective.

From studies so far, it is evident that Telehealth may be effectively used for store and forward evaluations, real time assessment and diagnosis, and continuing education in a number of healthcare specialties. However, in reviewing the literature, the effectiveness of Telehealth for teaching specialized clinical assessment techniques such as those required in the rehabilitation of the paediatric plastic surgery hand injury patient has not been clearly established. This process of learning is not purely didactic but has a large component of "hands on" interactive work in which clinical skills, not concepts, are being conveyed.

GLOBAL RATING SCALES

When examining the ability to complete a clinical skill, competency must be measured. The ability to perform a clinical skill constitutes a large portion of a clinicians' overall clinical competence.[66] Thus, an appropriate outcome measure to evaluate the level of competency must be identified. The advantage of using an outcome measure is that it allows the outcomes to be quantified, allowing mathematical calculations to be completed and comparisons made.[67]

Competency is the ability to perform a clinical task or fulfill a role satisfactorily.[26, 68] Loomis[69] outlined that knowledge, skills, judgements and attitudes were essential components to competent performance. One method to measure the level of competency of clinical skills is through the use of an Objective Structured Clinical Examination (OSCE).[70, 71] The OSCE was first described by Harden *et al.*[70] During an OSCE the subject rotates through a number of timed stations and completes the specified

task which is assessed by a rater using an objective binary checklist.[70] The checklists consist of items that are required for a complete and competent performance of that specific skill. With increased use of the OSCE, researchers further examined the reliability and validity of the checklist as an indication of competence. A study completed by Hodges *et al.*[72] revealed that when medical students were evaluated using a checklist they achieved higher scores than residents. A possible explanation for this is that experts are able to correctly solve problems with minimal information whereas the novice generally requires a much more detailed repertoire.[73, 74] Thus, the checklist may not accurately reflect a level of competence but rather a level of thoroughness.[72, 74] To overcome the limitations of the checklist approach, researchers have introduced the use of the Global Rating Scale (GRS).[74, 75] The GRS is a measurement instrument which allows evaluation of a clinical skill.[74-76] The GRS generally consists of a number of categories per skill. Each category is defined and has an associated scale allowing the evaluator to determine the extent of the quality of the performance.[75] Three to seven points on the scale is recommended but the number of rating points is determined by the specificity of the required judgement.[75] If a gross judgement is necessary a scale with few points is appropriate but if a more precise evaluation is needed the number of points on the scale is increased. However, more than seven rating points is generally no more effective because discrimination by the evaluator becomes increasingly challenging.[75, 76] The presence of anchor points at the beginning and the end of the scale often indicate the best or worst performances.[75] The GRS is particularly useful when a trait or action requires a more extensive evaluation beyond the yes/no or present/absent paradigms.[75] This feature is the major difference between the GRS and the checklist. Numerous studies

have been completed assessing and confirming the reliability and validity of the GRS for assessing the performance of clinical skills.[72, 74, 77] Regehr *et al.*[74] completed a study on general surgery residents performing technical skills and compared what method of evaluation was most effective - the checklist, the GRS or a combination of both. The residents were assessed by one evaluator using both the checklist and GRS, and by a second evaluator using only the GRS. They determined that when the GRS was used by the expert evaluators higher inter-station reliability, and better construct and concurrent validity were established when compared to the checklist. When the two evaluative methods were used simultaneously there was no improvement in the reliability or validity of the GRS. These results suggested that the use of the GRS alone represents the performance scores appropriately.

SCOPE OF THE PROBLEM

In summary, as a result of early discharge of the acute patient, the lack of available continuing education courses and the inequitable distribution of specialized health care professionals, there is an obvious need to provide support and training to the community based physical therapist. It is evident that new communication technologies are potentially able to fill the gaps where health care services are not easily available or accessible. One of the potential solutions is the use of Telehealth. However, questions remain regarding the abilities of this technology to meet and fulfill the need. With the lack of evidence in the literature supporting the use of telecommunication technology to teach "hands on" technical skills, it is necessary that further work be completed to determine if Telehealth has this capability. Therefore, the purpose of this study was to

determine if Telehealth may be used effectively to teach specialized assessment techniques to physical therapists and to determine if Telehealth is effective. Effectiveness of Telehealth may be established by comparing the accuracy of Telehealth to conventional methods.[78] This study was designed to assess a change in the performance and competency scores of those receiving three different types (T, DT and SS) of instruction in order to determine if Telehealth is effective and therefore empirically justified. [79]

Methods

The purpose of this study was to evaluate the effectiveness of teaching hand assessment skills via Telehealth compared to two other educational formats; self study and direct face-to-face teaching. Direct teaching was deemed the optimal method of teaching clinical and assessment and treatment techniques and self study was deemed the current standard of practice.

The study required two preliminary studies be conducted in preparation for the primary study: an initial survey and the development of a measurement tool. The survey was required to identify potential subjects for the primary study. The measurement tool was required to assess the primary outcome: the subjects' skills while performing specified components of a hand assessment. An appropriate measurement tool could not be found in the literature.

(1) PHYSICAL THERAPIST SURVEY

Design

The objective of the first component of this study was to determine the size of the pool of physical therapists who would be eligible for the intervention component of the study and their willingness to participate. This objective was addressed by a mail survey to all of the physical therapists in Northern Ontario. In addition, the survey was to develop a profile of the potential sample population who would meet the criteria for the intervention study.

Subjects

The targeted population was physical therapists in Northern Ontario. To identify the target population, a comprehensive list of physical therapists, licensed to practice in Ontario as of June 1, 1998, was obtained from the College of Physiotherapists of Ontario. The registry is updated yearly as part of the annual process for a physical therapist to obtain a license to practise in the province of Ontario. Information was requested for physical therapists practising in Northern Ontario. Since the target population was small, (n = 343), all were selected to participate and were sent a survey instrument. This population was selected on the basis of: geographical isolation; scarcity of academic resources and decreased access to experts. Furthermore, subjects for the intervention study were selected based on the willingness of the physical therapist to participate and the proximity of the physical therapist to existing Telehealth sites in Thunder Bay and Sault Ste Marie.

Survey Instrument

The survey (see Appendix 1) consisted of 31 closed-ended questions. It was developed by following the guidelines recommended by Aday.[80] The items for the survey were generated by outlining the information that needed to be collected to identify the subjects who fulfilled the criteria for the primary study. The first section of the survey contained questions regarding the physical therapists' level of awareness and utilization of Telehealth. Next, the physical therapists' paediatric and hand clinical experience was assessed. If the physical therapist was available to participate in the Telehealth

component of the study they were asked to complete the final section. This section consisted of demographic questions.

Once the development of the survey was initially completed, it was reviewed to address face and content validity by three individuals who were experts in the development and utilization of surveys.[♣] Suggestions and recommendations were integrated into the survey prior to the pre-test.

Prior to mailing the survey to the target population a pre-test of the survey to identify missing or ambiguous questions and formatting difficulties was completed in July 1998 using a convenience sample of fifteen physical therapists from Barrie, Ontario. This population was chosen as they were somewhat geographically isolated but did not impinge on the target population of Northern Ontario. These physical therapists may or may not have had clinical experience in rehabilitating the plastic surgery patient. A cover letter and a copy of the survey was sent to the convenience sample asking for their assessment of the survey tool. The revised survey was then prepared for mailing.

Data Collection

The distribution of the survey to the target population was initiated following the guidelines established by Salant & Dillman[81] and Aday[80] to ensure the best possible response rate. One month prior to mailing the survey, a pre-announcement letter was sent

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to the target population. As suggested by Aday,[80] contacting the responder prior to the survey tends to produce a more co-operative responder. This produces a situation known as a "warm contact".[80] This announcement explained the reason for the survey and how it would help develop the next stage of the Telehealth research project. Also, a statement attempting to elicit their participation was included.

The first mailing of the survey to the target population was September 1998. A package containing a cover letter, the survey, a pre-stamped reply card and a pre-stamped, pre-addressed envelope for returning the survey was sent to all physical therapists in Northern Ontario. This method of providing the above items to the physical therapists was followed to maximize the convenience of the survey thus contributing to the best possible response rate.[81]

The cover letter (see Appendix 2) was personalized and clearly emphasized the benefits of completing the survey and that the subject may be selected to participate in the next stage of the research. Being selected to participate in the next stage was worthwhile to the subject as they would receive specialized training from a certified hand therapist without incurring any personal cost. The cover letter also informed the recipients that the results of the survey would be published in a peer reviewed journal.

Each survey was assigned a number corresponding to the subject's name. This was completed so that if the subject was available to participate in the final stage of the

research their profile from the survey could determine if they were a suitable candidate. The numbering of the surveys also allowed identification of the respondents' name and address.

Although this survey did not involve harmful or threatening questions, confidentiality was possible and adhered to using this technique. Implied consent was provided by the subjects upon their return of the completed survey.

One week after the initial mailing of the survey package, a reminder card was sent out to those who had not responded. At three weeks after the initial mailing, an additional survey and pre-stamped envelope with a new cover letter explaining that the survey had not yet been received was sent to the non-responders. All surveys received within three months of the initial mailing were included in the data analysis.

The respondent who indicated that they were interested in being selected to participate in the final stage of the Telehealth study were contacted by phone to confirm their availability to participate as a subject in February or March 1999. All positive responses were placed in the subject pool for later allocation to the educational groups.

Analyses

Responses to the survey were entered into an Excel database. The response rate was determined by dividing the number of useable responses by the number of surveys

originally sent out. Descriptive statistics expressed the demographic characteristics, the level of awareness and utilization of Telehealth, the paediatric clinical experience, the level of hand training and the availability of the subjects to participate in the final stage of the research. Chi-square statistical analyses were used to determine if there was a significant relationship between the utilization of Telehealth and either paediatric experience or the availability to participate in the study.

(2) MEASUREMENT TOOL DEVELOPMENT

The primary purpose of developing a new measurement tool was to allow the accurate evaluation of a physical therapists' skill while performing components of a hand assessment. This component of the preliminary work was completed to develop and assess the reliability and validity of the measurement tool so that it could then be used during the primary intervention study.

The Tool

This measurement tool was designed on the basis of a global rating scale (GRS). A GRS consists of two parts: attributes of the skill that is being assessed and a scale which allows the evaluator to determine how well the attributes are being performed.[75] The scale was developed by: reviewing the related literature on global rating scales and the technical guidelines for performing hand assessment skills established by the American Society for Hand Therapists (ASHT).[82] Upon completing the review, four dimensions were selected as the attributes to be examined because they were identified as

the most relevant to skill execution. These four dimensions were: *the knowledge of the technique; the ability to perform the technique; instrument handling and organizational skills*. Each dimension was graded on a five point scale ranging from one to five with an overall minimum score of four and a maximum possible total score of 20 for each skill performed. Descriptors were provided at points one, three and five to provide guidelines for the evaluators. The score utilized for the analysis was the sum of the four dimensions. Once developed, the proposed measurement tool was reviewed by three clinicians who have experience with the development and utilization of GRS.♥

Subjects

According to the estimates provided by Donner and Eliasziw[83], 30 subjects are sufficient to demonstrate inter-rater reliability of 0.6 or greater. With 30 people, assuming the true population inter-rater reliability is ≥ 0.8, there is a 95% probability that the obtained inter-rater reliability for this sample will be > 0.6. An obtained intraclass correlation coefficient (ICC) value of < 0.6 would indicate problems with the inter-rater reliability of the measure.

A convenience sample of thirty rehabilitation therapists were selected from the University of Toronto's teaching hospitals to participate as subjects. The levels of experience in hand assessment skills ranged from the neophyte, to moderate experience, to the certified hand therapist. This heterogeneous population was representative of the

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range of expected abilities that the measurement tool would be applied to.

Examiners

Two hand therapists associated with the University of Toronto and its hospitals served as the examiners. Both are considered to be experts in the field of rehabilitation of the hand. During the training of the examiners for this study, both hand therapists reviewed the measurement tool and the guidelines for performing the five hand assessment techniques as described in *ASHT: Clinical Assessment Recommendations.*[82] This established a common baseline between the two examiners to decrease the inter-rater variability associated with the execution of the assessment techniques. They were then instructed not to converse with each other about the study during or between the examination days in order to avoid influencing each others' evaluation results.

Skills Trained

The five skills that were chosen for the study were selected from a 1985 survey conducted by the ASHT.[28] These five skills were identified in the top ten assessment and treatment techniques used in hand rehabilitation.[28] These five particular skills were selected because each of the skills were relevant to clinical practice and possessed characteristics that would challenge the transmission of information via the three educational formats used in the final stage of the study. The skills were volumetrics of the hand (VOL); total active movement of the index finger (TAMD2); joint mobilization

of the proximal interphalangeal joint of the long finger (MOBSD3); grip strength (GRIP) and two point discrimination of the ulnar nerve (2PTDISC).

Volumetrics required the subject to be familiar with the theory of displacement of water. The subject had to ensure that the standardized patient's skin integrity was amenable to being submerged in water, the volumeter filled to the point of having a meniscus, the upper extremity lowered in the correct position and the overflowing water correctly collected and interpreted.

Grip strength required that the subject place the hand held dynamometer's grip on level two, the standardized patient instructed to keep their elbow adducted to their torso with the elbow held at ninety degrees in a neutral position and an average of three repetitions was used to calculate the standardized patient's grip strength.

A finger goniometer was required to determine total active movement. The subject was required to have correct alignment of the goniometer on the dorsum of the index finger and measure both active composite flexion and composite extension. A mathematical calculation was required to be completed to determine total active movement.

For joint mobilization of the proximal interphalangeal joint (PIPJ) of the long finger it was necessary for the subject to use both visual and tactile senses. The subject learned the correct placement of their hands on the standardized patients' hands plus

learned the feeling of distracting the PIPJ and then mobilizing the joint in the correct anterior/posterior motion to the limit of the joint capsule.

Two point discrimination is a sensibility test that is not frequently used by physical therapists because this test generally is most often used by occupational therapists for rehabilitation following nerve injury. Two point discrimination also requires both visual and tactile learning. The subject was required to learn how to use the tool correctly plus learn the amount of pressure that was required to determine the static two point discrimination of ulnar nerve function.

Test Format

The format of the evaluation of the measurement tool was based on the principles of an Objective Structured Clinical Examination (OSCE) which is an evaluation tool for assessing clinical skills.[70] It is expected that during an OSCE the subject will perform a specified task within a certain time frame while being evaluated by an examiner. For this study a five-station examination was designed. Each station consisted of a hand assessment skill which was to be performed by each subject on a standardized patient within a five minute time frame. The standardized patient had been previously informed of the injury they were to portray. The overall testing time per subject was thirty minutes allowing five minutes for signing of the consent form and changing of the stations.

The subject's performance at each station was evaluated independently by the two examiners. Each skill was evaluated using the new measure (see Appendix 3).

Procedures

Three evaluation sessions were organized to accommodate the schedules and the locations of the thirty subjects participating in the study. The subjects were required to attend only one, thirty minute testing session. Three teaching hospitals; The Hospital for Sick Children, The Toronto Hospital - Western Division and York County Hospital, all with similar environmental conditions were utilized. This schedule was also developed to minimize the fatigue and to maximize the accuracy of the evaluators. Each subject was requested not to interact with other subjects about the study to avoid bias.

Prior to the examination each subject signed a consent form (see Appendix 4) for participating in this study and was also asked to provide consent (see Appendix 5) for being videotaped so future evaluation of their performance might be completed to determine intra-rater reliability of the measurement tool. The subjects were also requested to fill a questionnaire (see Appendix 6) providing information regarding their years of experience as a physical therapist and their experience in treating hand injuries The information from the questionnaire was used during the analysis to determine the validity of the scale.

Upon arriving at each station, the subject was provided with a written scenario detailing the skills to be performed on the standardized patient. All required equipment was located at the station for each skill. The subject was informed when to begin and when to end each station. The subject was independently rated by two evaluators using the measurement tool. Once all five skills had been performed, the subject was once again reminded not to discuss the elements of the study with other subjects.

Analyses

The four domains of the measurement tool - knowledge of the technique, the ability to perform the technique, instrument handling and organizational skills - assessed the underlying characteristic of performance in an equal manner precluding the need to weight the items. Thus, the four domain scores were then aggregated into one total score for each of the five skills.[84]

Inter-rater reliability of the measurement tool for each skill was calculated using the intraclass correlation coefficient (ICC) random effects model (2,1)[85] based on a repeated measures analysis of variance on the total score for each skill. This ICC model was chosen because all of the subjects were measured by both of the evaluators permitting extrapolation to other examiners. The second set of analyses assessed the construct validity of the measurement tool using a one-way analysis of variance with years of experience as the independent variable and the summary score as the outcome (dependent variable).

(3) PRIMARY STUDY - EFFECTIVENESS OF TEACHING VIA TELEHEALTH

The final phase of the research addressed the primary objective - to determine the effectiveness of Telehealth as a tool for teaching specialized rehabilitation assessment techniques. Three educational formats, (A) teaching via Telehealth, (B) direct, face-to-face teaching, and (C) self study were used to teach five hand assessment skills. A comparison was completed to determine whether or not Telehealth was significantly different from the other two methods for teaching hand skills.

Location

Thunder Bay and Sault Ste Marie were selected as the two testing locations. Both cities had developed, functioning Telehealth sites that were readily available to the principal investigator. The majority of physical therapists from Northern Ontario who were willing to participate in the study were also within driving distance of these two cities. The study was conducted in February 1999 in Thunder Bay and in March 1999 in Sault Ste Marie. The design of the study was stratified by city such that members of each city were recruited and placed into one of the three educational interventions.

Subjects

Of the 89 physical therapists who indicated an interest in participating, 42 physical therapists were located close to one of the two testing sites and consented to participate. As will be seen in the results of the measurement tool analysis, neophytes obtain an average score of approximately 8.00 across the five skills. Given that 12.00 is considered the clinically effective performance level, an increase of approximately four points on the scale will be deemed clinically important for the main study. Also, to be seen in the results of the measurement tool analysis, the pooled standard deviation across all levels and across all five skills is approximately 3.27. Thus, our best estimate of a clinically relevant effects size is 4/3.27 or 1.22 standard deviations. Conservatively accepting an effect size of 1.00 the sample size required to prove effectiveness in a repeated measures design when five techniques were measured with an alpha level of 0.05 and beta level of 0.2 was eight subjects per group.[86, 87] Since there were three

intervention groups, 24 physical therapists were required to meet the sample size requirements. Additional subjects were allocated to each group to accommodate for unexpected attrition.

Within each city, the profiles of the subjects, obtained from the survey were reviewed. There were a large number of variables that could potentially effect the outcome measure, so we wanted to equate groups on these variables. The large number of relevant variables that needed to be controlled relative to the number of subjects available for the study raised doubt regarding the use of randomization as an equating procedure. Instead, subjects were systematically allocated to ensure that the three educational groups were balanced according to age of the subjects, graduation year, type of educational format utilized at the university where each subject trained, prior hand therapy experience, prior Telehealth experience and type of current clinical practice with equal numbers in each group (14 per educational format).

Examiners

The same two hand therapists who were previously involved in the development of the measurement tool traveled to the two Northern Ontario cities with the primary investigator (PI). One hand therapist was the pre-/post-test evaluator and the other hand therapist was the instructor for the educational sessions. The evaluator was blinded to the educational format to which each subject had been assigned. The instructor had no

discussions with the evaluator regarding the abilities of the subjects. These two precautions were taken to minimize any potential bias.

Skills Trained

The same five skills that were used to determine the reliability and validity of the measurement tool were again used during each educational format. The skills were volumetrics of the hand (VOL); total active movement of the index finger (TAMD2); joint mobilization of the proximal interphalangeal joint of the long finger (MOBSD3); grip strength (GRIP) and two point discrimination of the ulnar nerve (2PTDISC).

Interventions

(A) Telehealth Teaching:

Teaching via Telehealth was completed using an intra-city link between two facilities who housed compatible videoconferencing equipment. In Thunder Bay the link occurred between the Health Sciences North facility and a private company, Abend Solutions. The Health Sciences North facility's videoconferencing equipment was the Picturetel Concord 4500 model which transmitted the information via four centrex lines at 224 kilobytes. Abend Solutions used the 3M VCS 3100 model which transmitted the information via two Integrated Services Digital Network (ISDN) lines at 224 kilobytes. It was important to have similar bandwidths so that the clarity of the transmission was equivalent at both sites. The instructor was located at the Abend Solution site and the subjects were located at the Health Sciences North site.

The Telehealth session lasted three and half hours. It was organized such that the instructor taught each skill for fifteen minutes and within this time frame also demonstrated the skill using a standardized patient. The information that was transmitted was the same as that given to all education formats. Immediately following the teaching and demonstration of each skill, the subjects practised in pairs using each other as the "patient" with the expectations that when they were not interacting with the instructor they would exchange ideas to problem solve and to perfect their performances. Each pair also received five minutes of interactive feedback from the instructor via Telehealth. During this interactive session each subject demonstrated the skill and immediate feedback was provided from the instructor. The videoconferencing equipment permitted the instructor to control the camera so that wide angle views or close up views were possible. This format was followed for each of the five skills. At the completion of this educational session, the subjects were reminded of the time and location for the post-testing phase.

One month later an intra-city link was established in Sault Ste Marie and this session lasted two and a half hours. The format and schedule that was followed in Thunder Bay was strictly adhered to in Sault Ste Marie.

The two videoconferencing sites were located at Sault College but were geographically distant from each other within the college. One location contained the Picturetel Venue 2000 with 2 ISDN lines which transmitted at 224 kilobytes and the other site used the Picturetel 4000 Ex which had a Centrex line which transmitted at 112 kilobytes. Having the same line configuration at both locations was not possible but in

pre-testing the equipment it was apparent that the quality of the transmission was acceptable for the purpose of the research. However, with the disparity in the line configurations, there was the potential to reduce the effectiveness of teaching via Telehealth.

Utilizing this method of teaching allowed the transmission of information from person-to-camera-to-person.

(B) Direct, face-to-face teaching:

For the direct, face-to-face teaching session, initially in Thunder Bay and then one month later in Sault Ste Marie, the instructor and the subjects were in the same room. The session in Thunder Bay took three hours and the session in Sault Ste Marie lasted two and a half hours. The same format that was utilized during the Telehealth sessions was followed exactly such that the same instructor demonstrated and taught each skill for fifteen minutes and then provided each pair of subjects with feedback for five minutes. The instructor had documented information on each skill which was conveyed to both groups. Again the subjects were expected to interact and practise with each other to problem solve when not interacting with the instructor. At the completion of this educational session the subjects were reminded of the time and location for the post-testing phase.

The primary difference between the Telehealth session and this session was that the instructor and the subjects were in the same room allowing physical interaction not

just visual and verbal interaction. This method of teaching is the previous standard for educating rural physical therapists and is considered the ideal method.

(C) Self Study:

The subjects assigned to the self study group were provided with a package containing written information at the end of their pre-test. This material outlined how to correctly perform each hand assessment skill. The package contained the same information that the instructor transmitted via Telehealth and during the direct, face-to-face teaching sessions. These subjects were expected to learn the material independently in the same manner as they would normally do. They were not given any suggestions on how they should approach this task but if a subject raised a question for example: "may I go to my department and practise on the appropriate equipment?" They were guided with the response, "if you would normally do this then it is acceptable". This approach was taken to attempt to capture the normal routine that a physical therapist may follow when faced with learning a new technique. This method is consistent with the way information is currently shared with rural physical therapists.

Evaluation of Outcomes

All subjects prior to and after the educational sessions were rated by the evaluator on their ability to perform each hand assessment technique. Both pre-test and post-test used the same format that was used during the development of the measurement tool. It was based on the structure of an OSCE utilizing the same five scenarios and hand assessment skills. Each subject was evaluated by the evaluator using the GRS with the

binary question addressing competency. (see Appendix 7) Each subject was allocated to a thirty minute time slot which allowed five minutes for each skill and five minutes for instructions.

Procedures

Potential subjects identified by the survey were contacted by phone in January 1999. They were informed about the purpose and design of the study but were not informed what the five skills would be, nor were they informed about which educational group they had been assigned to. This was done to minimize the subjects' desire to study or review the skills prior to the pre-test and to also minimize the potential drop out rate if they had been allocated to an undesirable educational format. A written document confirming the time and location of the pre-testing, and the post-testing was sent to each participant.

The pre-testing sessions occurred in the respective cities one or two days prior to the educational intervention. At the completion of the subjects' performance, each subject was informed of which educational format they were required to attend and the time of day. It was at this time that the self study subjects received their literature. The subjects who had been assigned to the Telehealth and direct teaching groups were instructed not to review the techniques prior to the educational sessions so that a pure evaluation of the sessions could be achieved.

Teaching via Telehealth occurred in the morning and direct teaching in the afternoon. The same instructor taught both sessions.

All subjects from each of the three groups were reassessed in their respective cities two or three days following the educational sessions. The pre/post testing time frame was standardized so that the subjects tested on the first day of pre-testing were tested on the first day of post-testing and the same applied to the physical therapists tested on the second day of pre-testing. At the completion of the post-test each subject was given a $40.00 honorarium for expenses in participating in the study.

Analyses

The data were entered onto an Excel spread sheet and then imported into SPSS statistical programme. The data were reviewed and no missing or incorrect data were found. Descriptive statistics outline the mean score and standard deviation for each educational format per skill.

Performance Scores:

For each of the five skills, a two way analysis of variance with time (pre vs post) as the within subject factor and the educational intervention (TH vs DT vs SS) as the between subject factor was utilized. Critically, a two way interaction was taken as preliminary evidence that there was a difference in the amount learned by the groups, and

a series of subsequent analyses was used to establish the nature of the two way interaction.

To do this a one way analysis of variance comparing all three groups was completed on the pre-test performance scores to ensure that all three groups were similar prior to the educational interventions (suggesting that the groups were balanced).

Secondly, a one way analysis of variance was performed comparing the three groups on the post-test performance results. Assuming a significant difference in post-test scores would be found, a series of *post hoc* Tukey's tests were completed to identify the differences.

Finally, speculating that the amount of learning would be lower in the self study group a series of paired t-tests comparing pre and post scores on each skill were completed to determine if learning by this method is worthwhile in the absence of other teaching tools.

Competency Scores:

Descriptive statistics outline the per cent competent during both the pre-test and the post-test.

Again, for each of the five skills, a 2 × 3 chi square analysis (competent vs incompetent by intervention group) was performed of both pre-test and post-test competency scores. No differences were expected on the pre-test but assuming that there

would be a significant effect in post-test scores, a set of *post hoc* 2 × 2 chi square analyses were performed to determine which pair of training conditions were different.

Assuming again that self study would have the lowest increase in competency levels, a set of McNemar's tests were completed (on each skill) to determine if this method was able to help participants develop competency.

RESULTS

(1) PHYSICAL THERAPIST SURVEY

Response Rates

Three hundred and forty-three questionnaires were mailed in September 1998. Three were returned unopened because of a change in the recipient's address. One questionnaire was returned not completed with a letter attached from the responder explaining that she felt she was too old to fill out the questionnaire. Of the remaining 339 questionnaires, 241 (71%) were received within the three month time frame (see Appendix 8). From the overall possible data entries 2% were missing. In reviewing the data there was not any pattern in the missed data.

Survey Findings (Frequencies)

From the 241 returned surveys, 89 respondent (37%) indicated interest in being contacted to participate in the primary intervention study. Of the 89, 46 (52%) were from Thunder Bay and vicinity and 43 (48%) from Sault Ste Marie and vicinity. All potential subjects who expressed an interest in participating were contacted by phone. The number of subjects recruited for the primary study were 26 (29%) from Thunder Bay and 16 (18%) from Sault Ste Marie. The following results characterize the 42 subjects who agreed to participate.

The majority of the respondents' ages ranged from 20-49 years of age. Just over two thirds of the subjects were degree prepared physical therapists who had received their training through a traditional lecture based programme. More than half (60%) of the physical therapists practice in the specialty of orthopaedics. Just under half (40%) stated they had previous training in hand therapy but 65% of this training was obtained during their university courses or clinical placements. A large portion of the subjects (93%) reported having experience in treating paediatric patients before but of this group only 7% had treated a paediatric patient who had undergone plastic surgery for a hand injury. Currently, 7% of the surveyed physical therapists practise full time in the specialty of paediatrics.

Of the 42 subjects, 60% had previously used Telehealth compared to 47% who were not available for the study but had previously used Telehealth.

A chi square analysis (see Table 1) demonstrated no significant relationship ($\chi^2 = 2.28$, $p = 0.131$) between prior utilization of Telehealth and the availability to participate in the intervention study, suggesting that the results of the current study should be generalizable to individuals who were not available.

It is interesting to note, of the 42 subjects available to participate, 88% had used Telehealth for the purposes of continuing education courses which were lecture based courses. Only 8% had used Telehealth for the purposes of consultation or assessment of a patient.

Table 1: Relationship between previous Telehealth experience and availability to participate in the intervention study.

	Available to Participate	Not Available	Total
Previous Experience	25	93	118
No Experience	17	106	123
Total	42	199	241

Furthermore, of the 42 subjects available to participate, 7% had previous experience with treating a paediatric plastic surgery patient compared to 14% who were unable to participate.

A further chi square analysis (see Table 2) demonstrated no relationship (χ^2 = 1.48, p = 0.223) between prior paediatric plastic surgery therapy experience and availability to participate in the intervention study.

Table 2: Relationship between previous treatment of the paediatric plastic surgery patient and availability to participate in the intervention study.

	Available to Participate	Not Available	Total
Previous Experience	3	28	31
No Experience	39	171	210
Total	42	199	241

(2) MEASUREMENT TOOL DEVELOPMENT

Inter-rater Reliability

The between rater random effects intraclass correlation coefficient for each of the five skills is presented in Table 3. All values ranged from 0.78 - 0.91, which are well within the confidence intervals proscribed around a true value of 0.8 as described in the power calculation on page 37. This suggests that the score from a single rater has quite reasonable generalizability to other similarly trained raters.

Table 3 : Between rater intraclass correlation coefficient for each of the five skills.

SKILL	$ICC_{(2,1)}$	LOWER LIMIT
Volumetrics	0.87	0.76
Total Active Movement	0.91	0.75
Joint Mobilization	0.87	0.77
Grip Strength	0.84	0.70
2 Point Discrimination	0.78	0.59

Construct Validity

The mean performance summary scores by levels of experience for each of the five skills are presented in Table 4. The analysis of variance (see Table 5) demonstrated a significant effect of years of experience in all five skills with length of training accounting for 20% - 67% of variance in scores, suggesting quite reasonable construct validity.

Table 4: **Mean scores for all three levels of experience.**

SKILL	EXPERIENCE	MEAN (SD)	N
Volumetric	Neophyte †	7.85 (3.42)	20
	Moderate ‡	13.33 (3.93)	6
	Expert ✤	15.50 (3.70)	4
Total Active Movement	Neophyte	8.05 (2.82)	20
	Moderate	12.17 (3.31)	6
	Expert	19.00 (1.41)	4
Joint Mobilization	Neophyte	7.80 (4.16)	20
	Moderate	10.00 (2.37)	6
	Expert	13.50 (6.35)	4
Grip Strength	Neophyte	10.50 (3.35)	20
	Moderate	14.50 (2.81)	6
	Expert	17.50 (1.73)	4
2 Point Discrimination	Neophyte	6.40 (2.48)	20
	Moderate	8.00 (2.19)	6
	Expert	15.00 (2.00)	4

† <2 years experience
‡ >2 years experience
✤ Certified hand therapist

Table 5: **Relationship between Performance Scores and years of experience (One way analysis of variance and proportion of variance)**

HAND SKILL	F VALUE	*p* VALUE	Proportion of Variance (R_2)
Volumetrics	$F_{2,27} = 11.09$	$p < 0.01$	0.45
Total Active Movement	$F_{2,27} = 27.08$	$p < 0.01$	0.67
Joint Mobilization	$F_{2,27} = 3.27$	$p < 0.05$	0.20
Grip Strength	$F_{2,27} = 10.42$	$p < 0.01$	0.44
2 Point Discrimination	$F_{2,27} = 21.79$	$p < 0.01$	0.62

(3) EDUCATIONAL INTERVENTIONS

The goal was to have eight subjects per educational intervention from each city, thus doubling the required sample size per group. Unfortunately, the number of physical therapists willing to participate was smaller than expected per city. This was primarily influenced by the time of year that the study was executed (winter). The physical therapists were concerned about committing to the study as they were not willing to drive during unfavorable weather conditions. Unequal group sizes occurred secondary to re-allocation of two subjects upon arriving in the respective cities. Two subjects' had last minute unexpected commitments not allowing them to attend the Saturday sessions but were willing to participate in the SS group. The final composition of the groups were: Telehealth n = 13 (Thunder Bay n = 9, Sault Ste Marie n = 4), direct teaching n = 13 (Thunder Bay n = 9, Sault Ste Marie n = 4) and self study n = 16 (Thunder Bay n = 8, Sault Ste Marie n = 8). However, the minimum requirements of the sample size were met.

Performance Scores

The summary statistics for the performance scores for all five skills are presented in Table 6 on the page 59.

Table 6 : Summary Statistics for Performance Scores

SKILL	EDUCATIONAL FORMAT	PRE-TEST MEAN (SD)	POST-TEST MEAN (SD)	DIFF (SD)
Volumetrics	Direct $n = 13$	8.68 (5.68)	18.52 (1.84)	9.84 (-3.84)
	Telehealth $n = 13$	8.92 (5.44)	18.00 (1.60)	9.08 (-3.84)
	Self-directed $n = 16$	8.92 (4.92)	12.72 (4.96)	3.80 (0.04)
Total Active Movement	Direct $n = 13$	5.52 (2.04)	17.32 (3.00)	11.80 (0.96)
	Telehealth $n = 13$	6.32 (2.72)	18.60 (2.36)	12.28(-0.36)
	Self-directed $n = 16$	5.80 (1.60)	8.92 (4.32)	3.12 (2.72)
Joint Mobilization	Direct $n = 13$	10.48 (5.64)	19.68(1.12)	9.20 (-4.52)
	Telehealth $n = 13$	10.76 (6.44)	19.36 (1.68)	8.60 (-4.76)
	Self-directed $n= 16$	11.92 (6.76)	14.64 (5.28)	2.72 (-1.48)
Grip Strength	Direct $n = 13$	12.24 (4.84)	18.76 (0.92)	6.52 (-3.92)
	Telehealth $n = 13$	12.52 (4.96)	17.40 (4.52)	4.88 (-0.44)
	Self-directed $n = 16$	11.68 (4.88)	12.24 (3.36)	0.56 (-1.52)
2 Point Discrimination	Direct $n = 13$	4.52 (0.88)	16.40 (3.16)	11.88 (2.28)
	Telehealth $n = 13$	4.48 (1.40)	16.16 (3.56)	11.68 (2.16)
	Self-directed $n = 16$	4.44 (1.04)	7.36 (4.12)	2.92 (3.08)

For all five skills, the interactive term from the two way ANOVAs[♠] suggests that there was a significant difference in the amount of learning among the groups (see Table 7).

Table 7: Two way analysis of variance: F values for the interaction of time and method for the performance scores for each of the five skills comparing all three groups.

HAND SKILL	F VALUE	*p* VALUE
Volumetrics	$F_{2, 39} = 5.10$	$p < 0.05$
Total Active Movement	$F_{2, 39} = 26.48$	$p < 0.01$
Joint Mobilization	$F_{2, 39} = 6.06$	$p < 0.01$
Grip Strength	$F_{2, 39} = 4.98$	$p < 0.05$
2 Point Discrimination	$F_{2, 39} = 26.50$	$p < 0.01$

[♠] For all analysis multivariate statistical tests were rerun, not assuming sphericity, and this did not affect the results of the F-test; therefore, all results will be presented using univariate statistics.

The subsequent one way analysis of variance (see Table 8) comparing the three groups on the pre-test showed no effects for any of the five skills, suggesting that all three groups started at the same skill level. A *post hoc* test (Tukey's) supported the results with all 3 groups within one homogeneous subset.

Table 8: **Pre-test One way Analysis of Variance: F values for performance scores for each of the five skills comparing all three groups**

HAND SKILL	F VALUE	*p* VALUE
Volumetrics	$F_{2, 39} = 0.01$	ns
Total Active Movement	$F_{2, 39} = 0.42$	ns
Joint Mobilization	$F_{2, 39} = 0.22$	ns
Grip Strength	$F_{2, 39} = 0.11$	ns
2 Point Discrimination	$F_{2, 39} = 0.31$	ns

However, the one way analysis of variance (see Table 9) comparing the three groups on post-test showed powerful significant effects of group, suggesting differences in abilities among the three groups after the intervention. A series of *post hoc* analysis (Tukey's, see Table 10) demonstrated no significant differences between direct teaching and teaching via Telehealth but a significant difference between self study and both direct teaching and teaching via Telehealth suggesting that the significant effect of the one way analysis of variance on post-test scores was indicative of the fact that the Telehealth and direct teaching groups learned more during training.

Table 9: **Post-test One way Analysis of Variance: F values for performance scores for each of the five skills comparing all three groups**

HAND SKILL	F VALUE	*p* VALUE
Volumetrics	$F_{2,39} = 13.33$	$p < 0.01$
Total Active Movement	$F_{2,39} = 35.06$	$p < 0.01$
Joint Mobilization	$F_{2,39} = 9.94$	$p < 0.01$
Grip Strength	$F_{2,39} = 15.95$	$p < 0.01$
2 Point Discrimination	$F_{2,39} = 28.92$	$p < 0.01$

Table 10: ***Post hoc* analysis: *p* values comparing the post-test groups for each of the five skills**

HAND SKILL	EDUCATIONAL FORMAT	*p* VALUE
Volumetrics	Telehealth vs Direct	ns
	Telehealth vs Self-directed	$p < 0.01$
	Direct vs Self-directed	$p < 0.01$
Total Active Movement	Telehealth vs Direct	ns
	Telehealth vs Self-directed	$p < 0.01$
	Direct vs Self-directed	$p < 0.01$
Joint Mobilization	Telehealth vs Direct	ns
	Telehealth vs Self-directed	$p < 0.01$
	Direct vs Self-directed	$p < 0.01$
Grip Strength	Telehealth vs Direct	ns
	Telehealth vs Self-directed	$p < 0.01$
	Direct vs Self-directed	$p < 0.01$
2 Point Discrimination	Telehealth vs Direct	ns
	Telehealth vs Self-directed	$p < 0.01$
	Direct vs Self-directed	$p < 0.01$

Even though SS was proven to be less effective, a series of paired T-tests were performed on the SS group results to determine if SS was a worthwhile intervention in the absence of other means of education (see Table 11). In three of the five hand assessment skills (VOL, TAM and 2PTDISC) there was a significant difference in the performance of these skills when comparing pre and post results ($p < 0.05$). However, in Table 6, the difference scores for these three skills are relatively small raising the question if the difference is clinically significant. The two remaining skills, joint mobilization and grip strength showed no significant differences.

Table 11: Paired T-tests: pre and post SS

HAND SKILL	*t* VALUE ($n = 16$)	*p* VALUE
Volumetrics	$t_{15} = 2.37$	$p < 0.05$
Total Active Movement	$t_{15} = 2.57$	$p < 0.05$
Joint Mobilization	$t_{15} = 2.08$	ns
Grip Strength	$t_{15} = 0.37$	ns
2 Point Discrimination	$t_{15} = 2.80$	$p < 0.05$

Competency Scores

A similar pattern of results occurred with the competency scores. The pre-test and post-test percent competency scores are presented in Table 12.

Table 12: Summary Statistics for Competency Scores

SKILL	EDUCATIONAL FORMAT	% COMPETENT PRE-TEST	% COMPETENT POST-TEST	Δ IN % COMPETENT
Volumetrics	Direct n = 13	30.7	100.0	69.3
	Telehealth n = 13	30.7	100.0	69.3
	Self-directed n = 16	37.5	53.6	16.1
Total Active Movement	Direct *n* = 13	0	76.9	76.9
	Telehealth *n* = 13	0	92.3	92.3
	Self-directed *n* = 16	0	12.5	12.5
Joint Mobilization	Direct *n* = 13	53.8	100.0	46.2
	Telehealth *n* = 13	38.5	100.0	61.5
	Self-directed *n*= 16	56.3	75	18.7
Grip Strength	Direct *n* = 13	61.5	100.0	38.5
	Telehealth *n* = 13	61.5	84.6	23.1
	Self-directed *n* = 16	68.8	50	-18.8
2 Point Discrimination	Direct *n* = 13	0	76.9	76.9
	Telehealth *n* = 13	0	76.9	76.9
	Self-directed *n* = 16	0	6.3	6.3

Chi square analyses of the pre-test competency assessments (see Table 13) showed no significant differences between groups on any of the five skills suggesting that individuals from each group were equally likely to be competent.

Table 13: Pre-test: Chi-square analysis of competency scores for each of the five skills comparing all three groups

HAND SKILL	χ^2	df	*p* VALUE
Volumetrics	0.20	2	ns
Total Active Movement	unable to calculate		
Joint Mobilization	1.03	2	ns
Grip Strength	0.226	2	ns
2 Point Discrimination	unable to calculate		

By contrast, chi-square analyses of the post-test results (see Table 14) revealed significant effects of group for all five skills.

Table 14 Post-test: Chi-square analysis of competency scores for each of the five skills comparing all three groups

HAND SKILL	χ^2	df	*p* VALUE
Volumetrics	15.92	2	$p < 0.01$
Total Active Movement	24.21	2	$p < 0.01$
Joint Mobilization	8.42	2	$p < 0.05$
Grip Strength	12.76	2	$p < 0.01$
2 Point Discrimination	22.65	2	$p < 0.01$

A series of subsequent chi-square analyses (see Table 15) comparing the methods by pairs again showed no significant differences between direct teaching and Telehealth but significant differences between self study and teaching via Telehealth and also significant differences between self study and direct teaching for all five skills.

Table 15: ***Post hoc*** **chi-squares comparing the groups for all five skills**

HAND SKILL	EDUCATIONAL FORMAT	χ^2	*p* VALUE
Volumetrics	Telehealth vs Direct	can't calculate	ns
	Telehealth vs Self-directed	10.12	$p < 0.01$
	Direct vs Self-directed	10.12	$p < 0.01$
Total Active Movement	Telehealth vs Direct	1.23	ns
	Telehealth vs Self-directed	21.06	$p < 0.01$
	Direct vs Self-directed	13.23	$p < 0.01$
Joint Mobilization	Telehealth vs Direct	can't calculate	ns
	Telehealth vs Self-directed	5.27	$p < 0.05$
	Direct vs Self-directed	5.27	$p < 0.05$
Grip Strength	Telehealth vs Direct	2.94	ns
	Telehealth vs Self-directed	4.02	$p = 0.05$
	Direct vs Self-directed	11.98	$p < 0.01$
2 Point Discrimination	Telehealth vs Direct	0.00	ns
	Telehealth vs Self-directed	16.97	$p < 0.01$
	Direct vs Self-directed	16.97	$p < 0.01$

A series of subsequent analyses (McNemar's) (see Table 16) were performed on the SS group competency results to determine if this intervention was worthwhile to change the competency levels of subjects. In all five skills there was no significant difference in competency levels.

Table 16: Nonparametric test (McNemar) for SS group

HAND SKILL	McNemar *p*
Volumetrics	$p = 0.51$
Total Active Movement	$p = 0.50$
Joint Mobilization	$p = 0.25$
Grip Strength	$p = 0.45$
2 Point Discrimination	$p = 1.00$

DISCUSSION

The primary purpose of this study was to determine if Telehealth could be utilized to effectively teach specialized assessment skills to rural physical therapists. This study has demonstrated that Telehealth may be used in this capacity. For the community physical therapist this technology provides additional assistance with difficult new specialized cases or techniques and reduces a perception of professional isolation. For the patient, it now means increased accessibility to rehabilitation specialists with specialized skills and decreased travel time.

Prior to determining the effectiveness of Telehealth as an effective teaching tool, the physical therapy population in Northern Ontario required evaluation to determine appropriate candidates for this Telehealth study. Following this, the development of a measurement tool was necessary.

(1) PHYSICAL THERAPIST SURVEY

The primary objective of this survey was to identify potential candidates for inclusion in the primary study to determine the effectiveness of utilizing Telehealth to teach specialized assessment techniques.

The demographic characteristics of the Northern Ontario physical therapists who answered the Telehealth survey were similar to those responding to Tassone and Speechley's[35] 1994 survey. The majority of physical therapists in Northern Ontario

continue to be degree prepared specialists ranging in age from 20-49 years. One difference is that there has been a 20% increase in the number of physical therapists who practise in the area of orthopaedics but the number of paediatric physical therapists has remained unchanged at 7%. Combining this low percentage of paediatric physical therapists with fewer than half having hand therapy experience supports the potential difficulties in early referral of paediatric patients with a hand injury to the community for ongoing specialized rehabilitation.

In Tassone and Speechley's[35] survey the Northern Ontario physical therapist expressed an interest in pursuing learning via teleconferencing. Of the forty-two subjects selected for the Telehealth study 88% had experienced Telehealth learning by previously attending a CE course which was lecture based via Telehealth. Only 8% of the forty-two subjects had used Telehealth for direct patient related purposes. This familiarity of using Telehealth for the purposes of CE may have provided the impetus for more practical teaching sessions and further utilization for patient care as proposed in this study.

The utilization of Telehealth has the potential to significantly decrease the cost of CE courses for the Northern Ontario physical therapist by reducing the amount of travel time and cost. Telehealth also has the potential to broaden the scope of courses that are currently available to the Northern Ontario physical therapists thus decreasing the burden of continued evidence-based practice demands.

(2) MEASUREMENT TOOL

The development of a measurement tool was required for the primary study so that the physical therapists' ability to perform certain clinical skills required for a hand assessment could be evaluated. Prior to utilizing the measurement tool, the reliability and validity of this tool was established.

In this study, the single rater intraclass, correlation coefficient ($ICC_{2,1}$) values for the five skills were all greater than 0.78 indicating good inter-rater reliability.[85] Using this random effects ICC model, the results suggest that this measurement tool has good generalizability to other similarly trained raters.

Validity may be defined as the accuracy of an instrument.[88] In simple terms it raises the question, does the scale measure what it was intended to measure?

Content validity of this measurement tool was established during the development phase. For an instrument to possess content validity, it must fully represent the domain under investigation.[67] The measurement tool was initially developed by reviewing previous literature. At the completion of this process the proposed measurement tool was reviewed by three clinicians deemed to be experts in the field of GRS to determine if all essential components had been identified. Law[67] identified that content validity may be established by using the judgmental processes of experts. However, prior to further application of this proposed measurement tool, statistical analysis (*e.g.* factor analysis)

should be completed to further support that the domains that were selected for the GRS possessed good discriminative capabilities.

Construct validity is an essential component of any evaluative tool.[67] The tool must be able to differentiate between groups who possess known characteristics. Evidence of construct validity in this study was provided with the years of clinical experience reflecting the variance in the scores. In this study the amount of experience accounted for 20-67% of variance in the scores of the five skills. This finding is consistent with other studies which found that residents scored better than clinical clerks on OSCE global rating scales.[72] This result suggests that the developed measurement tool is capable of detecting increases in levels of expertise.

There are two main limitations of this developed measurement tool. Firstly, this measurement tool was only tested on a narrow scope using five very specific hand assessment techniques. Although these five skills possess different components that are inherently important to physical therapy (visual and tactile elements), further work should be completed to determine if this measurement tool is reliable and valid when used in conjunction with other physical therapy skills thereby broadening the potential applications of the measurement tool. Secondly, Law[67] suggests that an evaluative tool should also be responsive and show evidence of test-retest reliability. Further work should be completed to establish these factors resulting in a standardized tool which subsequently may be employed to evaluate effective performance in other areas of assessment.

(3) PRIMARY STUDY - EFFECTIVENESS OF TEACHING VIA TELEHEALTH

With ongoing changing financial constraints on the health care professional it is now, more than ever, necessary to develop new communication strategies that provide support for specialized referrals. Budgetary limitations make face-to-face meetings, consultations and assessments increasingly difficult, if not impossible. The utilization of Telehealth, as investigated in this research, may help alleviate this problem.

In this study, five hand assessment techniques were taught via three modes - teaching via Telehealth, direct, face-to-face teaching and self study. No studies have been reported to date comparing these three methods for teaching specialized rehabilitation techniques. Tassone and Speechley[35] confirmed the observations of Seymour *et al.*[89] that physical therapists prefer lectures, workshops or laboratory settings for learning new skills. However, with minimal financial support to attend CE activities, 80% of the physical therapists who participated in Tassone and Speechley's[35] survey reported that written material was the most frequently used method of learning. As an alternative, learning via teleconferencing was more acceptable to the Northern Ontario physical therapists.[35]

The five hand assessment and treatment techniques that were selected for this study all possessed components that would challenge the transmission capabilities of Telehealth. Three of the skills, volumetrics, total active movement and grip strength required the subjects to primarily use visual learning skills. The subjects were required to learn the steps to complete the skill and the correct placement of the tool or body

alignment of the standardized patient. All elements of these three skills are easily learned by watching a demonstration or studying written material. Therefore, it was of no great surprise that these three skills were successfully taught via Telehealth. What was somewhat surprising were the low pre-test performance and competency scores for the grip strength technique. This skill is simple and frequently used in many areas of physical therapy; however, the low scores are easily explained by the strict guidelines set by the ASHT that were used during the evaluation of the subjects.

The two remaining skills, joint mobilization and two point discrimination are not strictly visual but are skills that require tactile input. Initially, it was a concern on how transmission of tactile feelings could be transmitted via Telehealth. With clear, concise instructions and appropriate camera placement it was demonstrated that these two skills could be learned.

In this study, it was demonstrated that Telehealth teaching when compared to the conventional teaching model of direct face-to-face teaching had no statistically significant differences between the performance scores for any of the five taught skills. However, when compared to self study, there were statistically significant differences in the performance scores suggesting that the Telehealth group learned more. Both of these results suggest that Telehealth may by used as effectively as the conventional method and more effectively than self study to teach these five assessment skills.

When direct, face-to-face teaching was compared to self study there were statistically significant differences in the performance scores suggesting that once again

the self study group did not learn as much when compared to the conventional method of teaching.

Further investigations were completed to determine if self study could improve performance scores, if other educational formats were not available to the learners. Three of the five skills showed statistically significant differences. The two skills that did not demonstrate statistically significant differences were joint mobilization and grip strength. When examining the pre-test performance scores, these were the two skills that the self study group performed better suggesting that these two skills were more familiar to the subjects prior to the test. As a result of this perhaps the subjects did not feel it was necessary to complete any further study of these two skills. This concept is supported by the post-test mean score of the two skills as it revealed significant deficiencies in performance. It was encouraging to see that three of the five skills showed a significant difference in the performance scores. However, when the difference scores for the performance scores were examined, minimal change in the scores had occurred. This raised the question of whether the statistically significant differences that were determined were in fact clinically significant. This issue was addressed by reviewing the competency scores of the self study group. There was no significant difference in competency levels of any of the five skills after the educational intervention by this learning group, supporting the concept that the statistically significant differences found for the three skills did not result in clinically significant competency levels.

In examining the competency scores for the Telehealth and the direct, face-to-face groups there were once again no statistically significant differences between the groups.

Differences in the competency levels were determined however, after the educational intervention indicating that the groups had become more competent in all five skills. When Telehealth was compared to the self study group there were statistically significant differences between the groups' competency scores for all five skills. In addition, there were statistically significant differences between the direct face-to-face teaching and self study groups' competency scores for all five skills.

The performance and competency results suggest that learning may occur through self study but the learner may not become clinically competent.

Prior to the completion of this study, the literature indicated that today Telehealth is primarily being used for consultations and CE.[38, 39] The effectiveness studies that have been reported to date have evaluated the use of specific equipment or addressed the reliability of Telehealth for assessment of a patient but no studies have investigated the possibility of teaching technical assessment skills. Belmont *et al.*[50] demonstrated that tele-stethoscopy was successful in screening paediatric cardiology patients. During this study Belmont *et al.* did have difficulties with the placement and the pressure that was applied to the stethoscope but felt that during routine tele-cardiology assessments this problem was correctable by guiding the distant assistant with verbal cues. This issue indicated pitfalls to be avoided with tactile evaluation techniques via Telehealth, which are directly relevant to physical therapists and the current study. Further work in the area of cardiology has been completed by the Ottawa Telehealth Project.[1] In addition to assessing tele-stethoscopy, this group also investigated the ability to review

echocardiograms via Telehealth and deemed it reliable. A group of orthopeadic surgeons in Finland demonstrated that orthopaedic consultations could be completed via Telehealth. In fact 69% of the subjects in this orthopaedic study were provided with a definitive treatment decision eliminating the need for a face-to-face consultation with the specialist.[16] Other disciplines have successfully utilized both the store and forward[7-15] and real time capabilities of Telehealth.[16-22] A multitude of centres have used Telehealth for CE purposes but the format for these sessions was primarily didactic or interactive discussions or demonstrations with no reported "hands on" teaching components.[20, 53-56] Thus with the lack of evidence in the literature regarding the effectiveness of teaching assessment skills, this study is timely in demonstrating that hand assessment skills could be taught through this telecommunication modality.

Establishing Telehealth as an effective teaching tool provides a method of continuing education to rural physical therapists, thereby allowing increasingly early referral of complex cases to the community for ongoing rehabilitation. If Telehealth is utilized to transmit and teach the required information, continuity of specialized care will be maintained with support provided to the community physical therapist.

METHODOLOGICAL ISSUES AND LIMITATIONS

Although every effort was taken to ensure a sound scientific research project, some methodological limitations did occur.

This research was based on only five hand assessment techniques; however, each skill contained elements that are common to many other physical therapy assessment skills, perhaps allowing generalizability of the results to other specialized therapy skills.

The two telecommunication sites in Sault Ste Marie did not house the same line configurations for the transmission of information. The fewer lines available for transmission has the potential to affect the clarity of the images being transmitted. The ability of the instructor to assess each subject while performing the assessment skill was an integral component of the research project. During the initial evaluations of the sites, the transmission capabilities were deemed adequate for the purposes of this study. This is supported by the results that no statistical significant differences occurred between the direct, face-to-face learning group and the Telehealth group in Sault Ste Marie.

Stratified random sampling was not completed for the assignment of the subjects to the initial educational groups because there were a large number of variables that needed to be controlled and the group sizes were too small. To attempt to overcome any potential bias the groups were balanced according to age of the subjects, graduation year, type of educational format utilized at the university where each subject trained, prior hand therapy experience, prior Telehealth experience and type of current clinical practice.

It took 3.5 hours in Thunder Bay to train nine physical therapists via Telehealth compared to 2.5 hours to train four physical therapists in Sault Ste Marie. This time discrepancy can be explained by the difference in group numbers. The same protocol and time spent with individual physical therapists was the same at each site. A time differential also occurred with the direct teaching groups as a result of unequal group sizes.

The post-testing occurred either 48 or 72 hours after the educational intervention depending on the work schedules of the subjects. This is a short period of time for the retention of knowledge. It would be of importance to return to both cities six months after the initial teaching and re-evaluate the subjects to determine if one educational format contributed to better retention of appropriate information.

Telehealth is a rapidly growing field but currently it does require specialized equipment and ISDN lines for clear audio-visual transmissions. However, technology is moving towards the adaptation of personal computers creating further opportunities for new teaching applications of this technology making it potentially accessible even in small towns.

FUTURE IMPLICATIONS FOR USE

The results of this study demonstrated that five hand assessment techniques, each possessing a variety of technical elements, could be successfully taught through a telecommunication medium. The ability to perform technical skills denotes a level of clinical competence.[66]

The importance of the results are two fold. Firstly, the utilization of Telehealth may increase for the purposes of referring complex patients to the community. Using this process, the referring specialist could review the patient with the community professional demonstrating and teaching any required specialized skills. Secondly, the scope and format of CE courses may multiply to include practical sessions as well as lecture based series. These results strongly suggest an avenue which may be followed to bring the urban and rural health care professional together increasing the availability of resources and decreasing the feeling of isolation for both the health care consumer and provider.

From this study we now know that we can teach specialized rehabilitation hand assessment skills, whether we taught diagnostic sensitivity is unknown. It is unclear if the subjects could use the information gained to make a diagnosis. This study is limited in that it did not determine diagnostic accuracy from the assessment findings taught. Further work should be completed to determine if the learners are able to transfer their new knowledge and make accurate diagnosis. This could be completed by incorporating patients with real pathology into the assessment testing scenario challenging the subject to identify the correct problem.

Although strong, positive results were determined in this research, vigorous and continuous evaluation of Telehealth in all areas of utilization is mandatory to ensure that patients and health care professionals are receiving information through a reliable and safe modality. The development of the technology must not drive the use of Telehealth; the need for and the effectiveness of this tool should be the determining factor.[90] If evaluation is not mandatory then patients may run the risk of being evaluated by inadequate equipment.[78]

Telehealth does have the potential to provide equitable health care to both consumers and providers in this country within the realm of available resources.

Conclusion

We have demonstrated that Telehealth may be used to teach specialized hand assessment techniques. It is hoped that this would mean that upon discharge of the complex plastic surgery patient from the urban acute care facility, it would be possible to teach the required techniques to community physical therapists. As a result, the community physical therapist would be better equipped to continue complex rehabilitation of the paediatric hand injured patient. This technology has the capability to transfer clinical information and management strategies to the community physical therapist through audiovisual interactive demonstrations. Using this technology, ongoing consultation and follow up with the community physical therapist may occur. A partnership may be established between community and specialist physical therapist.

There is significant potential in the application of this technology to the specialty of physical therapy and to other health care disciplines. Perhaps teaching of all assessment skills will not be possible but Telehealth will continue to provide a rich communication link between the acute care facilities and the community for the sharing of information and to assist with the continuation of complex care through interactive discussions.

Although the potential use for Telehealth is increasing, strict scientific evaluation must occur to prove efficacy and to define its potential benefits and its limitations.

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Appendices

Appendix 1: Telehealth Survey

TELEHEALTH SURVEY:

DETERMINING THE AWARENESS AND THE UTILIZATION OF THIS TECHNOLOGY

- INSTRUCTIONS -

1.	This booklet asks you about your awareness and/or utilization of Telehealth.
2.	Please check the most appropriate answer or fill in the blank where indicated.
3.	Your answers will remain confidential. However, if you indicate that you are willing to be a potential subject for the future study determining the efficacy of Telehealth then you will be asked to provide your name and contact number. This will be completed on a separate card from the questionnaire.
4.	This questionnaire should take you approximately 15 minutes to complete.
5.	Once you have completed the questionnaire, please return it in the pre-addressed and stamped envelope that was enclosed in your initial package.
6.	Return the prepaid blue postcard separately. This postcard will inform us that you have completed the questionnaire but will maintain confidentiality.
7.	Please also return the yellow postcard stating your name and number if you are willing to be a potential subject.
8.	Thank you very much for participating in the questionnaire portion of the study.

I.D. #_____

SECTION A:

HEALTH CARE INFORMATION MAY BE EXCHANGED BETWEEN PROFESSIONALS USING TELECOMMUNICATION TECHNOLOGY. THIS MAY BE KNOWN AS TELEHEALTH. TELEHEALTH IS VIDEOCONFERENCING WHICH PROVIDES VISUAL AND AUDITORY FEEDBACK TO ALL PARTICIPANTS. YOU WILL NOW BE ASKED QUESTIONS REGARDING TELEHEALTH. PLEASE CIRCLE THE CORRECT ANSWER.

1. **Are you aware that Telehealth may be used by health care professionals to provide education and clinical consultation?**

   1 Yes
   2 No

2. **Have you ever used Telehealth before?**

   1 Yes
   2 No **(if no, go to question #9)**

3. **When did you last use Telehealth?**

   1 1 - 6 months ago
   2 7 - 12 months ago
   3 1 - 2 years ago
   4 > 2 years

4. **For what purpose did you use Telehealth?**

   1 Continuing Education Course
   2 Receiving a Referral of a Patient
   3 Consultation/Assessment of a Patient
   4 Other (please specify) _____

5. Were you satisfied with the results from using Telehealth?

1 Yes
2 No

6. Do you find Telehealth useful?

1 Yes
2 No

7. Is telehealth accessible to you?

1 Yes
2 No

8. How far do you have to travel to use Telehealth?

1 0-50 kms
2 51-100 kms
3 101-200 kms
4 201-300 kms
5 > 300 kms

9. When you receive a referral for an unfamiliar diagnosis what method do you primarily utilize to obtain the required information for assessing and treating this patient?

1 Reviewing the literature
2 Personal conversation with a colleague
3 Telephone conversation with the referring health care professional
4 Telecommunication technology session with referring institution
5 Other

10. How important is each of the methods to you?

	not important				very important
Reviewing the literature	1	2	3	4	5
Personal conversation with colleague	1	2	3	4	5
Telephone contact with referring health care professional	1	2	3	4	5
Telecommunication technology session with referring institution	1	2	3	4	5
Other	1	2	3	4	5

SECTION B:

YOU WILL NOW BE ASKED QUESTIONS REGARDING YOUR EXPERIENCES WITH TREATING CHILDREN BETWEEN 0-18 YEARS OF AGE. PLEASE CIRCLE THE CORRECT ANSWER AND/OR FILL IN THE BLANKS

11. Have you treated paediatric (children 0-18 yrs of age) patients?

1 Yes
2 No **(go to question #18)**

12. Have you treated paediatric plastic surgery patients?

1 Yes
2 No **(go to question #18)**

13. How many paediatric plastic surgery patients have you treated in the last

day _____
week _____
month _____
year _____

14. On average, what type of problems did the patients have surgery for?

1 Congenital
2 Traumatic

15. Generally, where were the injuries or congenital malformations located? (circle as many as apply)

1 Face/Neck
2 Upper Extremity
3 Hand
4 Trunk
5 Lower Extremity

16. What assessment techniques do you use when assessing a paediatric plastic surgery patient? (circle as many as apply)

1 Volumetrics
2 Girth Measurements
3 Goniometry
4 Joint Mobility
5 Nerve function
6 Manual Muscle Test
7 Hand Dynamometer
8 Pinch Gage
9 Other (please specify) _____

17. What treatment techniques do you use when treating a paediatric plastic surgery patient? (circle as many as apply)

1 Wax
2 Cryotherapy
3 Ultra sound
4 Manual therapy
5 Graded exercises
6 Strengthening
7 Other (please specify) _____

SECTION C:

YOU WILL NOW BE ASKED QUESTIONS REGARDING THE TELEHEALTH STUDY. PLEASE CIRCLE THE CORRECT ANSWER AND/OR FILL IN THE BLANK.

18. How important do you think it is to develop new technology to link the acute care physical therapist and the community physical therapist?

not important				very important
1	2	3	4	5

19. Would you be available to participate in a Telehealth study which will be located in Thunder Bay during February/March 1999? The duration of the study will be approximately two hours. A $40.00 honorarium will be provided to assist with expenses.

1 Yes
2 No

20. Would you be available to participate in a Telehealth study which will be located in Sault Ste. Marie during February/March 1999? The duration of the study will be approximately two hours. A $40.00 honorarium will be provided to assist with expenses.

1 Yes
2 No **(go to question #22)**

21. What day of the week would be most convenient for you to participate in the Telehealth study?

1 Sunday
2 Monday
3 Tuesday
4 Wednesday
5 Thursday
6 Friday
7 Saturday

SECTION D:

YOU WILL NOW BE ASKED SOME QUESTIONS ABOUT YOURSELF. THESE QUESTIONS WILL ENSURE THAT THIS SURVEY IS REPRESENTATIVE. PLEASE CIRCLE THE CORRECT ANSWER AND/OR FILL IN THE BLANK.

22. What is your age?

1 20 - 29
2 30 - 39
3 40 - 49
4 50 - 59
5 60 or >

23. In what year did you obtain your Canadian physiotherapy registration?

_____

24. What is your highest level of education?

1 Diploma
2 Degree
3 Master's
4 Doctorate
5 Other (please specify) _____

25 What format of teaching did your university/college use when you were completing your physical therapy training?

1 Traditional lecture based
2 Problem based learning
3 Transitional problem based learning (a combination of the above)

26. Have you received any hand therapy training?

1 Yes
2 No **(go to question #28)**

27. When did you receive your hand therapy training?

1 During university/college
2 During an undergraduate clinical placement
3 During a post-graduate course

28. What is you present employment status?

1 Employed full-time
2 Employed part-time
3 Leave of Absence (includes maternity leave)
4 Retired **(please go to instructions at the end of page 9)**
5 Seeking Employment **(please go to instructions at the end of page 9)**
6 On Disability **(please go to instructions at the end of page 9)**

29. What type of setting do you usually work in?

1 General Hospital
2 Paediatric Hospital
3 Rehabilitation Hospital
4 Community Care Program
5 Other (please specify) _____

30. What is your primary responsibility? (circle one only)

1 Direct Patient Care
2 Consultation
3 Administration **(please go to instructions at the end of page 9)**
4 Administration/Patient Care
5 Research **(please go to instructions at the end of page 9)**
6 Teaching **(please go to instructions at the end of page 9)**

31. What is your primary area of clinical practice? (circle only one)

1 Amputees
2 Burns & Plastics
3 Cardiorespiratory
4 General
5 Gerontology
6 Neurology
7 Neurosurgery
8 Orthopaedics
9 Paediatrics
10 Other (please specify) _____

Thank you for completing this questionnaire. The information that you have provided will allow us to determine certain qualities of Telehealth. Also, we will be able to determine appropriate candidates that may be selected for the future Telehealth study.

PLEASE NOTE:

1. **Please return the completed questionnaire in the enclosed self-addressed, stamped envelope by August 28, 1998.**
2. **Do not include the blue prepaid postcard with the questionnaire, return it separately. This will inform us that you have returned the questionnaire but it will maintain confidentiality.**
3. **If you are willing to be a potential subject please return the yellow post card with your name and number included.**
4. **If you would like further information on the upcoming Telehealth study or the results of this survey please contact me at the number below.**

Wendy Barden HBHK BScPT MSc (candidate)
Physical Therapist, Plastic Surgery Programme,
Department of Rehabilitation Services
Hospital for Sick Children, Toronto, ON M5G 1X8
Phone: 416-813-8144,
e-mail: wendy.barden@sickkids.on.ca

Appendix 2: Cover letter for Telehealth Survey

Dear _____

I am a physical therapist at The Hospital for Sick Children in Toronto specializing in the rehabilitation of plastic surgery patients. Currently, I am also completing my Masters of Science degree. As part of my graduate work, I am conducting research on Telehealth to determine the efficacy of Telehealth as a teaching tool. Telehealth is the utilization of telecommunication technology which provides both auditory and visual feedback between two or more sites. This videoconferencing allows the exchange of medical information to occur between sites.

The initial stage of this research is a questionnaire to determine characteristics of the population to be studied. The final stage of this research will be to utilize Telehealth to teach specialized rehabilitation techniques and then compare these results to self study and face-to-face learning. If you fulfill the criteria, you **may** be invited to participate in one of the three teaching methods in the final stage of this research. All teaching sessions will be taught by a certified hand therapist and skills required in the rehabilitation of a paediatric hand patient will be taught free of charge to the participants!

At this time, I am requesting your participation in the questionnaire. Your personal participation is important! All physical therapists in northern Ontario will be receiving this questionnaire as you are somewhat geographically isolated and continuing education courses are not overly accessible to you. In addition to these two factors, Thunder Bay and Sault Ste. Marie have established Telehealth sites that are essential for the completion of this research. The primary goals of the questionnaire are to determine the level of awareness and utilization of Telehealth, the level of paediatric experience and the availability of the physical therapist to participate in the future Telehealth study. The final results of this study will be submitted for publication. However, you may also contact me directly if you are interested in the results. The questionnaire will take approximately 15 minutes to complete.

The format of the questionnaire is such that confidentiality will be maintained, unless of course, you are available to participate in the next stage of the research. In which case you will be required to provide your name and a contact number.

Section A of the questionnaire addresses Telehealth questions, Section B addresses your level of paediatric experience, Section C determines your willingness and your availability to participate in the Telehealth interactive session and finally Section D will address demographic issues ensuring that this survey is representative of the study population. If you are not available for the next stage, your reply will remain confidential. We ask you to:
-enclose your completed questionnaire in the self-addressed, stamped envelope that we provided in the original package with the questionnaire
-send the blue reminder card separately so that we know that you have completed the questionnaire
-send the yellow reply card if you are able to participate in the study

If you have any further questions please contact Wendy Barden, 416-813-8144 or wendy.barden@sickkids.on.ca. Thank you in advance for participating in this research.

Yours very truly,

Wendy Barden HBHK, BScPT, MSc (candidate)
Physiotherapist
Hospital for Sick Children

Appendix 3: GRS form for pilot test

TELEHEALTH STUDY

TECHNICAL SKILLS GLOBAL ASSESSMENT FORM

Please circle the number corresponding to the subject's performance in each category, irrespective of level of training.

	1	2	3	4	5
Knowledge of Technique	Poor/deficient knowledge of skill. Needed specific cueing for certain components of skill.		Knows important aspects of skill with minor omissions		Demonstrated familiarity with all aspects of skill.
Ability to perform skill.	Unable to perform		Adequate/ acceptable ability to perform skill.		Excellent/expert technique in all components of skill.
Instrument/ Handling skills.	Repeatedly makes tentative or awkward moves with instruments/ improper handling.		Competent handling or use of instruments. Occasionally appeared stiff or awkward.		Fluid moves with instruments or appropriate hand placement.
Organization /planning	Unable to initiate skill or omissions of critical steps.		Systematic approach. Inefficient use of time.		Systematic approach with no omissions. Technique performed in time efficient manner.

TOTAL: **/20** **EXAMINER:** _____

Appendix 4: Consent form for development of measurement tool

CONSENT FORM FOR THE HEALTH CARE PROFESSIONAL PARTICIPATING IN THE RELIABILITY TESTING OF A PHYSICAL THERAPY MEASUREMENT TOOL

Title of Research Project:

Efficacy of Telehealth for Teaching Specialized Rehabilitation Techniques - A Pilot of Five Techniques.

Investigator(s):

Primary Investigator:

Wendy Barden, HBHK, BScPT, MSc (candidate)
Rehabilitation Services
Hospital for Sick Children
416-813-6755

Co-Investigators:

Nancy McKee, MD
Plastic Surgery
Mount Sinai Hospital
416-586-5197

Howard Clarke, MD, PhD
Division of Plastic Surgery
Hospital for Sick Children
416-813-6444

Nancy Young, BScPT, MSc, PhD
Port Programme, Paediatric Medicine
Hospital for Sick Children
416-813-5446

Glen Regehr, PhD
Associate Director, Centre for Research in Education at The Toronto Hospital
University of Toronto, Faculty of Medicine
416-340-3615

Purpose of the Research:

A large number of The Hospital for Sick Children's patients come from outside of the metropolitan Toronto area and referral to the community is desirable and necessary. In addition, the shortened length of stay in an acute care facility has lead to earlier referrals to the community physical therapists. It is essential that an accessible bridge be built between the specialist and the generalist so that relevant information can be disseminated in a timely and effective manner.

Telehealth, which is the utilization of telecommunication technology to transmit information, may have the potential for improving this situation. The geographical gap between the acute care and community physical therapists may diminish and new pathways for exchanging information may be established. A first step in this process is to determine if physiotherapy assessment skills may be effectively taught through Telehealth communication technology.

A measure has been developed allowing the researcher to assess the competency of physical therapists performing physiotherapy assessment techniques which may be utilized when assessing an upper-extremity condition.

The purpose of this component of the study is to assess the reliable of this measurement tool. If proven reliable, the measurement tool may then be utilized to determine if physiotherapy assessment skills may be effectively taught through Telehealth.

Description of the Research:

This component of the study will be completed at The Hospital for Sick Children. Thirty rehabilitation therapists, with a variety of hand assessment experience, from the University of Toronto's teaching hospitals have been selected to participate as subjects. You, as a subject, will be required to complete five hand assessment techniques. A facilitator will be present at each station to answer any questions hat you may have. No discussion will occur between you and the judges. You will be assessed by two expert hand therapists simultaneously. You will complete the five assessment techniques consecutively. The testing should not require more than 30 minutes to complete.

Potential Harms, Injuries, Discomforts or Inconveniences:

There are no known harms associated with this study.

Potential Benefits:

You will help determine the reliability of a measurement tool which may then be utilized to assess the efficacy of Telehealth as a teaching tool for physical therapy skills. Telehealth may help to expand referral sites and improve the availability of physical therapists with the skills required in rehabilitating plastic surgery patients with an upper-

extremity condition. This may also promote the utilization of Telehealth for teaching post graduate physical therapy courses and therefore, increase the opportunity for learning without having to travel great distances.

Confidentiality:
Confidentiality will be respected and no information that discloses your identity will be released or published without consent unless required by law. For your information, the research consent will be retained by the primary investigator.

Reimbursement:
If required, your department will receive reimbursement for the 30 minutes that is required to complete the study.

Participation:
Participation in this study is voluntary. If you choose not to participate there will be no repercussions.

Sponsorship:
This project is sponsored by the Research Institute at the Hospital for Sick Children and the G.H. Wood Foundation grant.

Consent :
"I acknowledge that the research procedures described above have been explained to me and that any questions that I have asked have been answered to my satisfaction. I have been informed of the alternatives to participation in this study, including the right not to participate and the right to withdraw without compromising the quality of medical care at The Hospital for Sick Children for me and for other members of my family. As well, the potential harms and discomforts have been explained to me and I also understand the benefits (if any) of participating in the research study. I know that I may ask now, or in the future, any questions I have about the study or the research procedures. I have been assured that records relating to me and my care will be kept confidential and that no information will be released or printed that would disclose personal identity without my permission unless required by law."

I hereby consent to participate.

_____
Name

_____
Signature

_____
Name of person who obtained consent

_____
Signature

The Person who may be contacted about the research is: Wendy Barden
who may be reached at tel #:
416-813-6755
e-mail:wendy.barden@.sickkids.on.ca

_____
Signature

_____
Date

Appendix 5: Video consent form for development of measurement tool

CONSENT FORM FOR THE HEALTH CARE PROFESSIONAL PARTICIPATING IN THE RELIABILITY TESTING OF A PHYSICAL THERAPY MEASUREMENT TOOL - VIDEO CONSENT

Title of Research Project:

Efficacy of Telehealth for Teaching Specialized Rehabilitation Techniques - A Pilot of Five Techniques.

Investigator(s):

Primary Investigator:

Wendy Barden, HBHK, BScPT, MSc (candidate)
Rehabilitation Services
Hospital for Sick Children
416-813-6755

Co-Investigators:

Nancy McKee, MD
Plastic Surgery
Mount Sinai Hospital
416-586-5197

Howard Clarke, MD, PhD
Division of Plastic Surgery
Hospital for Sick Children
416-813-6444

Nancy Young, BScPT, MSc, PhD
Port Programme, Paediatric Medicine
Hospital for Sick Children
416-813-5446

Glen Regehr, PhD
Associate Director
University of Toronto
Faculty of Medicine
Centre for Research in Education
The Toronto Hospital
416-340-3615

I hereby consent to be taped during participation in this research project. These tapes will be used to carefully determine if video tape analysis is the same as real time evaluation. If this is proven then this will allow the researcher to determine if a rater would assign the same evaluation number to your performance on two separate viewings of the tape (intra-rater reliability). I understand that I am free not to participate in this part of the study and that if I agree to participate I am free to withdraw from this part of the study without any repercussions.

Name of Participant

The Person who may be contacted about the research is:
Wendy Barden

_____
Signature

Who may be reached at telephone #:
(416) 813-6755

_____
Name of person who obtained consent

_____
Signature Date

In addition, I give permission for this tape/photograph to be used for:

1. Other research projects ❑
2. Teaching and demonstration at HSC. ❑
3. Teaching and demonstration at professional meetings outside HSC. ❑
4. Not to be used for anything else. ❑

In giving permission for the use of the tape(s) beyond the current research, I have been offered the opportunity to view the tape(s) and I understand that I am free to withdraw my permission for other uses of the tape(s) at any time.

_____
Name of Subject

The Person who may be contacted about the research is:
Wendy Barden

_____
Signature

Who may be reached at telephone #:
(416) 813-6755

_____
Name of person who obtained consent

_____ _____
Signature Date

Appendix 6: Subject questionnaire for development of measurement tool

PILOT TEST FOR GLOBAL RATING - SUBJECT QUESTIONNAIRE

NAME: _____
PHONE: _____
HOSPITAL: _____
SERVICE: _____
PAGER #: _____
NAME OF PHYSICAL THERAPY SCHOOL: _____
YEAR OF GRADUATION: _____

Did you have any hand therapy rotations during university? YES NO

How many weeks of hand therapy rotations during university? _____

Have you had any post-graduate hand therapy training? YES NO

How many hand therapy courses/conferences have you had? _____

Are you a certified Hand Therapist? YES NO

If yes. When were you certified? _____

How often have you treated any of the following hand conditions before?

	Never	Rarely	Occasionally	Often
1. Flexor tendon laceration	1	2	3	4
2. Extensor tendon laceration	1	2	3	4
3. Fractured metacarpal/digit	1	2	3	4
4. Degloving injury	1	2	3	4
5. Peripheral nerve injury	1	2	3	4
6. Reflex Sympathetic Dystrophy	1	2	3	4

How often have you used the following hand therapy assessment skills/techniques?

	Never	Rarely	Occasionally	Often
1. Vancouver Scar Assessment Scale	1	2	3	4
2. Girth Measurement	1	2	3	4
3. Volumetrics	1	2	3	4
4. Sensibility testing of median nerve	1	2	3	4
5. Sensibility testing of ulnar nerve	1	2	3	4
6. Sensibility testing of radial nerve	1	2	3	4
7. Goniometry	1	2	3	4
8. Grip Strength	1	2	3	4
9. Pinch Strength	1	2	3	4
10. Activities of Daily Living	1	2	3	4

PLEASE RETURN TO WENDY BARDEN ONCE COMPLETED.

Appendix 7: GRS form for primary study

TELEHEALTH STUDY
TECHNICAL SKILLS GLOBAL ASSESSMENT FORM
PRE-TEST AND POST-TEST

Please circle the number corresponding to the subject's performance in each category, irrespective of level of training.

	1	2	3	4	5
Knowledge of Technique	Poor/deficient knowledge of skill. Needed specific cueing for certain components of skill.		Knows important aspects of skill with minor omissions		Demonstrated familiarity with all aspects of skill.
Ability to perform skill.	Unable to perform		Adequate/ acceptable ability to perform skill.		Excellent/expert technique in all components of skill.
Instrument/ Handling skills.	Repeatedly makes tentative or awkward moves with instruments/ improper handling.		Competent handling or use of instruments. Occasionally appeared stiff or awkward.		Fluid moves with instruments or appropriate hand placement.
Organization/ planning	Unable to initiate skill or omissions of critical steps.		Systematic approach. Inefficient use of time.		Systematic approach with no omissions. Technique performed in time efficient manner.

TOTAL: /20 **EXAMINER:** _____

Was this subject able to perform this skill competently:

- ❑ Yes
- ❑ No
- ❑ Not able to judge

Appendix 8: Survey results

Survey Question	R**1	R2	R3	R4	R5	R6	R7	R8	R 9	R10	skip	miss
1 Aware of Telehealth	201 (yes)	39 (no)										1
2 Use of Telehealth	118 (yes)	123 (no)										0
3 When last used	37 (1-6m)	21 (<1 y)	39 (1-2 y)	21 (>2 y)							123	0
4 What purpose for use	96 (educ)	0 (ref pt)	14 (Ax pt)	7 (other)							123	1
5 Satisfied with results	88 (yes)	30 (no)									123	1
6 Telehealth useful	106 (yes)	9 (no)									123	3
7 Accessibility	102 (yes)	13 (no)									123	3
8 Travel to Telehealth	108 (<50k)	3 (<100)	2 (<200)	1 (<300)	1 (>300)						123	3
9a Method for rec'ing info: Reviewing literature	145										93	3
9b Conversation colleague	108										130	3
9c Telephone with referr.	95										143	3
9d Telecom. Technology	3										234	4
9e Other	6										231	4
10a Importance of: literat.	1	4	23	88	122						0	3
10b Speaking to colleague	1	4	17	110	107						0	2
10c Talking to ref. site	1	8	45	92	91						0	4
10d Telehealth	1	39	48	67	32	17					0	37
10e Other	2	14	3	6	11	4					0	201

11 Rx'd paediatric pts.	223 (yes)	17 (no)									0	1
12 Rx'd paed. Plast. Sx. Pts	31 (yes)	193 (no)									17	0
13 How many patients treated per:	1 day	5 (1-3pt) week	7 (1-4pt) month	20 (1-15pt) year							200	8
14 Type of problem	6 (cong)	26 (trau)									209	0
15 Where was problem *	7 (head)	14 (U/E)	18 (hand)	6 (trunk)	17 (l/e)						193	5
16 Assessment techniques *	2 (volu)	25 (girth)	30 (gonio)	31 (mobs)	15 (nerve)	27 (mmt)	19 (dyna)	14 (pinch)	2 (other)		193	9
17 Treatment techniques *	5 (wax)	7 (ice)	11 (us)	26 (manu)	31 (exer)	31 (stren.)	6 (other)				193	7
18 Importance new tech.	1	3	18	70	149						0	0
19 Participate T. Bay	46 (yes)	191 (no)									0	4
20 Participate SSM	43 (yes)	192 (no)									0	6
21 Day of week	1 (Sun)	5 (Mon)	4 (Tues)	7 (Wed)	1 (Thurs)	18 (Fri)	35 (Sat)				161	9
22 What is your age	65	93	59	18	4						0	2
23 Year obtained license	3 (50-59)	15 (60-69)	44 (70-79)	72 (80-89)	107 (90-98)						0	0
24 Level of education	37 (dip)	190 (deg)	12 (Mast)	0 (PhD	2 (other)						0	0
25 Type of teaching at uni	140 (lect.)	23 (PBL)	78 (comb)								0	0
26 Hand therapy training	103 (yes)	138 (no)									0	0
27 When rec'd training	27 (uni)	29 (clin)	45 (cours)								138	2
28 Employment status	168 (f/t)	49 (p/t)	12 (loa)	4 (ret)	5 (seek)	0 (disab)					0	3
29 Type of setting	98 (hosp)	2 (ped.h)	17 (rehab)	37 (ccac)	75 (other)						9	3
30 Primary responsibility	193 (ptcar)	4 (cons)	8 (admi)	24 (ad/pt)	0 (resea)	0 (educ)					9	3
31 Clinical practice	1 (amp)	0 (b&p)	3 (c-r)	53 (gen)	11 (geron)	10 (neur)	1 (ne/sx)	116 (ortho)	17 (paed)	10 (other)	12	7

Each row sums to 241 which equals the overall response rate except for questions with an *. Their totals are greater than 241 because more than one response was permitted.

**R=response

Shaded areas indicate where an answer was not required.