# Telerehabilitation versus traditional rehabilitation of adults with upper-extremity orthopedic conditions: a systematic review

Thierry Y. Lienou, OTD, OTR/L

Department of Occupational Therapy

NYU Steinhardt

August 30, 2020

**Abstract**

Orthopedic injuries to the upper extremities are among the most common injuries to the body (Worboys *et al.*, 2018). This systematic review aimed to compare the outcomes of telerehabilitation and traditional rehabilitation while treating adults with upper-extremity orthopedic conditions. The literature search engines used to identify relevant studies included Medline, PubMed, Rehab data, Seeker, CINAHL, Google Scholar, EMBASE, and Science Direct. We critically appraised the selected articles using quantitative review guidelines by Law & MacDermid (2014). Video conferencing, digital systems, virtual exercise rehabilitation assistants, video/photo interface, over-the-phone supervision, virtual reality, and mobile applications were the telerehabilitation platforms used in previous studies. These platforms were compared to traditional outpatient therapy, home exercise programs, face-to-face therapy, clinical models and evaluation, and goniometric measurements. Of the 10 studies that met our inclusion and exclusion criteria, 6 demonstrated that telerehabilitation is either equivalent or superior to traditional rehabilitation. Two of the remaining 4 studies compared levels of agreement for the objective measures of telerehabilitation and traditional rehabilitation (the last 2 studies did not compare the outcomes of both methods because of the study design and absence of control groups). Although the studies had many limitations, we observed that telerehabilitation outcomes were either equivalent or superior to those of traditional rehabilitation in individuals with upper-extremity orthopedic conditions; however, further large-scale randomized controlled trials that focus on specific telerehabilitation interventions are necessary to confirm this. This review provides preliminary information to guide occupational therapists when using telerehabilitation to treat individuals in remote areas or those who cannot travel to their therapy appointments.

## Introduction

Orthopedic upper extremity injuries are among the most common injuries to the body, accounting for approximately 50% of all orthopedic injuries in the United States (Worboys *et al.*, 2018). Given the high incidence of upper-extremity orthopedic injuries, the growing demand for rehabilitation can result in increased costs and longer waiting lists and threaten the sustainability of health care services (Pastora-Bernal *et al.*, 2017). The literature shows that telerehabilitation might improve or at least maintain the continuity of rehabilitation care and services by making them more efficient and cost-effective (Pastora-Bernal *et al.*, 2017). Telerehabilitation involves dispensing rehabilitation services from a distance, with patients and physicians using technology to communicate (Macías-Hernández *et al.*, 2016). As of March 2020, there were no literature review on telerehabilitation exclusively for upper-extremity orthopedic disorders. To address this knowledge gap, we carried out a systematic review to compare the outcomes of telerehabilitation and traditional rehabilitation to assess and treat adults with upper-extremity orthopedic conditions. We aim to answer the following question: how does telerehabilitation compare to traditional rehabilitation in the assessment and treatment of adults with upper-extremity orthopedic conditions?

## Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (Moher *et al.*, 2009).

### *Search*

Online databases, such as Medline, PubMed, Rehab data, Seeker, CINAHL, Google Scholar, EMBASE, and Science Direct were searched thoroughly. Initial searches were carried out in October 2019 February 2020.

### *Selection criteria*

Studies that met the following inclusion criteria were included: (1) study was published between February 2009 and February 2020; (2) participants were 18 years and older; (3) orthopedic interventions addressed injuries of the shoulder, arm, elbow, forearm, wrist, and/or hand; and (4) all interventions involved remote physical rehabilitation.

We excluded studies (1) in which participants had comorbidities, a history of neurological injuries, or debilitating illnesses; and (2) that did not involve physical rehabilitation specialists. There were no limitations with regards to the type of outcomes that were measured. The articles were selected using the PRISMA guidelines (Moher *et al.*, 2009) and levels of evidence were considered.

### *Data extraction*

The following information was extracted from the included articles: article title, study design, year of publication, purpose, sample size, orthopedic condition, type of rehabilitation intervention, other traditional rehabilitation intervention, duration and frequency of the intervention, outcome measured, results of the study, conclusion, limitations, and level of evidence/critical appraisal (Tables 1 and 2 in the Appendix).

### *Critical appraisal and data analysis*

All the selected articles were appraised according to the quantitative review form and guidelines by Law & MacDermid (2014). We classified the levels of evidence for each article based on Holm's Hierarchy of Evidence (Moore, 1995).

## Results

### *Article selection*

Figure 1 (see Appendix) shows the flowchart of our selection process.

### *Demographics*

Table 1 (see Appendix) summarizes the studies included in this review. The 10 selected articles were published between 2009 and 2019.

### *Outcome Assessments*

The outcome assessments used in this review measured the following outcomes: pain, function, ROM, QoL, and edema.

### *Statistical Analysis*

Tables 2 and 3 (see Appendix) summarize the data extracted from the selected articles and the statistical significance of the outcomes of telerehabilitation platforms in comparison with those of traditional rehabilitation.

## Discussion

Even though Martinez-Rico *et al.*, had the largest sample size of all the selected articles, 71 participants is still a relatively small patient pool. Larger sample sizes may be more representative of the population and limit the influence of outliers or extreme observations. Its positive aspect is that it was a randomized controlled trial, which tends to have a high level of evidence (Level 1). Even though Eriksson *et al.* reported the same results, theirs was a control study with a lower level of evidence (Level 3), a very small sample size (n=22), and a non-randomized design to avoid uneven recruitment (as per the authors' explanation). Even though these studies were randomized controlled trials (Level 1 evidence), their sample sizes were small (n=18 and n=30, respectively). Moreover, Pastora-Bernal *et al.* (2018) reported a potential limitation of selection bias and information, while Ismail & El Shorbagy's (2014) study was single-blinded. Ramkumar *et al.* and Cui *et al.* studies also had small sample sizes (n=10 and n=25, respectively) and were single-blinded. Also, Ramkumar *et al.* was a cohort study with a

lower level of evidence (Level 2) and Cui *et al.* revealed a primary limitation due to the wireless sensor hardware used; the size, weight, and "wearability" of the device influenced the participants' willingness to use the system.

***Clinical implications***

The statistically significant superiority of video- and phone-based telerehabilitation over traditional outpatient therapy and home exercise programs for improving pain, QoL, ROM, and function, as demonstrated by Eriksson *et al.* (2009) and Martinez-Rico *et al.* (2018) could have many implications for occupational therapy. Video conferences and over-the-phone supervision can be easily applied by occupational therapists, who can address pain, ROM, functional, and QoL of older adults at a distance while yielding results that are potentially superior to traditional outpatient therapy or home exercise programs. This could contribute to solving the issues identified by Pastora-Bernal *et al.* (2017), who reported that people with upper-extremity orthopedic injuries living in remote locations may not have to access in-person rehabilitation services. Along with Ismail & El Shorbagy (2014) and Martinez-Rico *et al.* (2018), they also demonstrated the equivalence of video and telephone interactions to traditional face-to-face therapy in terms of achieving similar outcomes. This reinforces the idea that these telerehabilitation platforms can be used without compromising patient recovery. Even though video/phone platforms, virtual reality interfaces, and mobile applications also yielded statistically significant equivalence to traditional goniometric measurements of shoulder ROM (Ramkumar *et al.*, 2018; Cui *et al.*, 2019), occupational therapists could experience difficulties in using these relatively more complicated technological platforms.

***Limitations***

There are some limitations to this systematic review, that is, 4 of 10 selected articles did not provide sufficient data to analyze the effectiveness of telerehabilitation. Macías-Hernández *et al.* (2016) conducted a quasi-experimental study that tested the effectiveness of a

Regardless of the limitations of the studies included in this systematic review, it is important to note that studies with a high level of evidence (randomized controlled trials) indicated that over-the-phone supervision is significantly superior to home exercise programs for improving shoulder ROM (Martinez-Rico et al., 2018). Phone/video platforms and virtual reality interfaces were shown to be equivalent to traditional home exercise programs, face-to-face therapy, and traditional outpatient therapy for improving the pain, QoL, function, and ROM (Ismail & El Shorbagy, 2014; Pastora-Bernal *et al.*, 2018) and for measuring ROM (Cui *et al.*, 2019). It is also important to consider that the literature on telerehabilitation and upper extremity orthopedic injuries is limited, which explains the restricted number of articles included in this review.

## Conclusion

Although there were many limitations in this analysis and in the studies that were reviewed, we were able to elucidate that telerehabilitation yields equivalent or superior outcomes to traditional rehabilitation when assessing or treating patients with upper-extremity orthopedic conditions. This depends on the type of telerehabilitation platform, traditional rehabilitation setting, and the outcome measuredFurther research based on higher levels of evidence and focusing on specific telerehabilitation interventions are needed to validate its equivalence or superiority to traditional rehabilitation for assessing or treating adults with upper-extremity orthopedic conditions.

## References


Cui, J., Yeh, S. C., & Lee, S. H. (2019). Wearable sensors integrated with virtual reality: A self-guided healthcare system measuring shoulder joint mobility for frozen shoulder. *Journal of Healthcare Engineering, 2019*, 7681237. doi:10.1155/2019/7681237

Dias Correia, F., Nogueira, A., Magalhães, I., Guimarães, J., Moreira, M., Barradas, I., Molinos, M., Teixeira, L., Pires, J., Seabra, R., Lains, J., & Bento, V. (2019). Digital versus Conventional Rehabilitation after total hip arthroplasty: A single-center, parallel-group pilot study. *JMIR Rehabilitation and Assistive Technologies, 6(1)*, e14523. doi:10.2196/14523

Eriksson, L., Lindström, B., Gard, G., & Lysholm, J. (2009). Physiotherapy at a distance: A controlled study of rehabilitation at home after a shoulder joint operation. *Journal of Telemedicine and Telecare, 15(5)*, 215-220. doi:10.1258/jtt.2009.081003

Ismail, M. M., & El Shorbagy, K. M. (2014). Motions and functional performance after supervised physical therapy program versus home-based program after arthroscopic anterior shoulder stabilization: A randomized clinical trial. *Annals of Physical and Rehabilitation Medicine, 57(6-7)*, 353-372. doi:10.1016/j.rehab.2014.06.002

Jiang, S., Xiang, J., Gao, X., Guo, K., & Liu, B. (2018). The comparison of telerehabilitation and face-to-face rehabilitation after total knee arthroplasty: A systematic review and meta-analysis. *Journal of Telemedicine and Telecare*, *24*(*4*), 257-262. doi:10.1177/1357633X16686748

Lade, H., McKenzie, S., Steele, L., & Russell, T. G. (2012). Validity and reliability of the assessment and diagnosis of musculoskeletal elbow disorders using telerehabilitation. *Journal of Telemedicine and Telecare, 18*(*7*), 413-418. doi:10.1258/jtt.2012.120501

Law, M., & MacDermid, J. (2014). Evidence-based rehabilitation: A guide to practice. (3rd ed.). NJ: Slack Inc

Macías-Hernández, S. I., Vásquez-Sotelo, D. S., Ferruzca-Navarro, M. V., Badillo Sánchez, S. H., Gutiérrez-Martínez, J., Núñez-Gaona, M. A., Meneses, H. A., Velez-Gutiérrez, O. B., Tapia-Ferrusco, I., Soria-Bastida, Mde L., Coronado-Zarco, R., & Morones-Alba, J. D. (2016). Proposal and evaluation of a telerehabilitation platform designed for patients with partial rotator cuff tears: A preliminary study. *Annals of Rehabilitation Medicine, 40(4),* 710-717. doi:10.5535/arm.2016.40.4.710

Marik, T. L., & Roll, S. C. (2017). Effectiveness of occupational therapy interventions for musculoskeletal shoulder conditions: A systematic review. *American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association, 71(1)*, 7101180020p1-7101180020p11. doi:10.5014/ajot.2017.023127

Martinez-Rico, S., Lizaur-Utrilla, A., Sebastia-Forcada, E., Vizcaya-Moreno, M. F., & de Juan-Herrero, J. (2018). The impact of a phone assistance nursing program on adherence to home exercises and final outcomes in patients who underwent shoulder instability surgery: A randomized controlled study. *Orthopedic Nursing*. *National Association of Orthopedic Nurses 37(6)*: 372-378. doi:10.1097/NOR.0000000000000501

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA, PRISMA-P Group 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews, 4*, 1 doi:10.1186/2046-4053-4-1

Moore, A. (1995). Evidence-based everything. *Bandolier, 1*(*12*), 1. Retrieved from https://ci.nii.ac.jp/naid/10018476109/en/.

Pastora-Bernal, J. M., Martín-Valero, R., Barón-López, F. J., Estebanez-Pérez, M. J. (2017). Evidence of benefit of telerehabilitation after orthopedic surgery: A systematic review. *Journal of Medical Internet Research, 19(4),* e142. doi:10.2196/jmir.6836

Pastora-Bernal, J. M., Martín-Valero, R., Barón-López, F. J., Moyano, N. G., Estebanez-Pérez, M. J. (2018). Telerehabilitation after arthroscopic subacromial decompression is effective and not inferior to standard practice: preliminary results. *Journal of Telemedicine and Telecare 24(6)*, 428-433. doi:10.1177/1357633X17706583

Ramkumar, P. N., Haeberle, H. S., Navarro, S. M., Sultan, A. A., Mont, M. A., Ricchetti, E. T., Schickendantz, M. S., & Iannotti, J. P., .. . Iannotti (2018) Mobile technology and telemedicine for shoulder range of motion: Validation of a motion-based machine-learning software development kit *Journal of Shoulder and Elbow Surgery 27*(*7*), 1198-1204. doi:10.1016/j.jse.2018.01.013

Tousignant, M., Giguère, A. M., Morin, M., Pelletier, J., Sheehy, A., & Cabana, F. (2014). In-home telerehabilitation for proximal humerus fractures: A pilot study. *International Journal of Telerehabilitation, 6(2),* 31-37. doi:10.5195/ijt.2014.6158.

Worboys, T., Brassington, M., Ward, E. C., Cornwell, P. L. (2018). Delivering occupational therapy hand assessment and treatment sessions via telehealth *Journal of Telemedicine and Telecare 24*(*3*), 185-192. doi:10.1177/1357633X17691861