DEVELOPMENT OF A PROTOCOL FOR HAND THERAPIST IN THE TELEREHABILITATION MANAGEMENT OF REPETITIVE STRAIN INJURY (LATERAL EPICONDYLITIS)

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ABSTRACT

Lateral epicondylitis, a degenerative condition affecting the extensor tendons from the lateral epicondyle, can extend to the joint (Hecht, 2017). Linked to repetitive tasks, forceful exertions, and awkward positions, it can impact various body parts (Newman, 2018). Symptoms may hinder physical activity, sports, and work, persisting for years (Willy, 2019). Therapists use diverse techniques like manual therapy, scar management, and edema control to enhance mobility and hand function (Sloane, 2020). However, therapeutic touch, vital in hand therapy, often requires close, direct contact, posing a challenge for remote interventions. The aim of this study was to develop a protocol for hand therapists in Qatar for the telerehabilitation management of lateral epicondylitis, a form of repetitive strain injury. This study employed a descriptive developmental research design todescribes the current practices in Telerehabilitation management ,developed protocol level of acceptability of telerehabilitation management of lateral epicondylitis. The findings revealed that the hand therapists strongly agree with current practices in telerehabilitation management for lateral epicondylitis, as indicated by the average weighted mean of 3.68. Hand therapists' developed protocol for Telerehabilitation Management of Lateral Epicondylitis received a rating of "Strongly Agree" based on the average weighted mean of 3.92and the Level of Acceptability of Telerehabilitation Management of Lateral Epicondylitis was “very high with an average weighted mean of 3.85.It was concluded that the hand therapist provides patient and family education regarding acute lateral epicondylitis, utilizes telerehabilitation technology to conduct assessments and reassessment of patients with acute lateral epicondylitis, and remotely implements and adjusts treatment plans to ensure effective management of the condition. The hand therapists' protocol, encompassing comprehensive assessment, frequent reassessment, strategic management, and ongoing progress monitoring utilizing outcome measures, coupled with the application of wrist splints or athletic tape to restrict range of motion and alleviate pain in affected muscles, has demonstrably enhanced the management of acute lateral epicondylitis and hand therapists are confident that the protocol's utilization of telerehabilitation technologies for delivering remote rehabilitation services to patients with acute lateral epicondylitis yields positive outcomes. This approach not only reduces healthcare and patient expenses but also offers effective and convenient care for numerous remote patients, underscoring its potential for widespread application and benefit.

KEYWORDS: Lateral epicondylitis, Telerehabilitation, Hand Therapists

I. INTRODUCTION

Lateral epicondylitis, a degenerative disorder that compromises the extensor tendons originating from the lateral epicondyle, extending infrequently to the joint (Hecht, 2017). These are associated with repetitive tasks, forceful exertions, vibrations, mechanical compression, and sustained or awkward positions that can affect almost any movable part of

the human body (Newman, 2018). Willy (2019) explained that symptoms could restrict participation in physical activity, sports, and work, as well as recur and persist for years. Hence, Sloane (2020) conferred that therapists implement a variety of treatment techniques to improve range of motion, dexterity, and hand use in daily activity, with manual techniques, scar management, and edema control cited among the most critical and frequently used interventions. In hand therapy, practitioners assess and implement tailored intervention programs to address a range of diagnoses with varying severity, complexity, and chronicity (Sloane, 2020). Certified hand therapists collaborate closely with surgeons and physicians to provide conservative rehabilitation and postoperative management (Worboys, 2018). However, amidst the pandemic, healthcare facilities face challenges in meeting essential public health goals due to overwhelming capacity issues (Falvey, Krafft, &Kornetti, 2020). To address this, the use of communication technologies to serve patients has become increasingly prevalent. Additionally, in managing repetitive strain injury, telerehabilitation has become increasingly utilized (Tsymbal, 2022).

Telerehabilitation utilizes information and communication technologies to deliver remote rehabilitation services to individuals with disabilities in their homes (Boccalandro, Dallari, &Manucci, 2019). Anton (2018) highlights its potential to offer physiotherapy support anytime and anywhere, benefiting various groups such as the elderly, disabled, and sick, thereby enhancing their quality of life by facilitating contact with caregivers. A basic telerehabilitation system typically includes at least one camera for videoconferencing, enabling physiotherapists to directly monitor therapy sessions. Turan, Topaloglu, &Taskiran (2021) demonstrated that telerehabilitation is a feasible, effective, and safe approach for patients with COPD, with no major adverse events reported. Seron et al. (2021) found that telerehabilitation improves functionality and quality of life in patients with knee osteoarthritis, non-specific low-back pain, and those undergoing knee and hip arthroplasty. However, Dong et al. (2021) identified limitations in hand telerehabilitation for accurately assessing small finger joint range of motion. They proposed the 'DIGITS' application as a solution for rapid and reliable assessment. Dar (2019) observed the effectiveness of digital platform rehabilitation across various disciplines, including trauma, stroke, multiple sclerosis, head injuries, Parkinson's disease, and heart and lung diseases.

Taking into consideration the preceding discussion reveals that only a few studies existed that described the use of telehealth with the hand therapy population. It entails no sufficient data from a study on the protocol implemented by hand therapists in the telerehabilitation management of lateral epicondylitis. Thus, this study is conceived to determine the current practices of hand therapists in dealing with lateral epicondylitis; identify protocols that may develop for the rehabilitation of lateral epicondylitis via telerehabilitation management. Further, this study will explain the relationship between the variables covered and will serve as the basis to improve the practice in the application of protocols for hand therapists in the telerehabilitation management of lateral epicondylitis.

This study was conducted in Qatar. The respondents of this study were Five (5) Occupational Hand therapist were included in the study group. The respondents received an email of invitation for the participation in research program. Lastly, by the time this study had concluded, the researcher came up with several recommendations in hopes that it would serve as a guide for the implementers in developing protocol for rehabilitation of lateral epicondylitis via telerehabilitation management.

I.I Objective of the Study

The overall objective of this study was tofocused on the protocol for hand therapists in dealing with the telerehabilitation management of lateral epicondylitis. Specifically this study had the following aims (1) investigate the current practices of the hand therapist in dealing with the telerehabilitation management of lateral epicondylitis (2) develop protocol maybe develop for hand therapists in dealing with the telerehabilitation management of lateral epicondylitis and discern the level of acceptability of the hand therapists on the developed protocol in telerehabilitation management of lateral epicondylitis.

II. METHODS

To obtain the necessary data needed for the study, The study utilized cross-sectional survey design research design. A cross-sectional survey design could indeed be employed to establish the protocol for hand therapists regarding the tele-rehabilitation management of lateral epicondylitis (Maier 2023). This approach involves gathering data from hand therapists at a single point in time to ascertain their current practices, perspectives, and preferences regarding tele-rehabilitation techniques for this condition. Through the survey, therapists could be queried on their familiarity and experience with tele-rehabilitation, their existing protocols for treating lateral epicondylitis, as well as their perceptions of the benefits and challenges associated with utilizing tele-rehabilitation in this context, followed a descriptive-developmental design, specifically a cross-sectional survey design (Creswell & Creswell, 2019) According to McCombes (2019), Descriptive developmental designs refer to when data are collected. These included cross-sectional, longitudinal, and sequential designs. Through this research design, this study gives emphasis on determining the Protocol for Hand Therapists by Tele rehabilitation Management of lateral epicondylitis. Descriptive developmental designs provide a structured method for establishing the protocol guiding hand therapists in utilizing tele-rehabilitation for managing lateral epicondylitis. Initially, these designs involve thoroughly documenting existing practices and protocols employed by hand therapists through interviews, surveys, and observations. This phase aims to gain insights into current approaches, challenges faced, and areas for improvement.

The respondents were occupational and hand therapists at Qatar. The respondents were 5 came from the hand therapists. A purposive sampling technique was used in the study therapist that has below 10 years of experience in handling hand injury cases. . The study utilized a self-made questionnaire and was utilized for collecting data pertaining to the practices, protocol and level of acceptability of Hand Therapists by Tele rehabilitation Management of lateral epicondylitis. A survey questionnaire was employed as it was perceived to be the most appropriate data-gathering instrument for this research study. Consent to conduct the study and administer the questionnaire online has been obtained from the target respondents after validating and checking the survey questionnaire for its reliability. The questionnaires were sent to the respondents, who were assured of their privacy and the confidentiality of information about their identities. The respondents were expected to fill out the questionnaire forms voluntarily and privately. The information gathered were tallied and statistically treated.

Weighted mean was used to describe the a) current practices in Telerehabilitation management of lateral epicondylitis b) developed protocol for telerehabilitation management of lateral epicondylitis and c) level of acceptability of telerehabilitation management of lateral epicondylitis.

III. RESULTS AND DISCUSSION

Table 1
Current Practices in Telerehabilitation Management of Lateral Epicondylitis

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. Using telerehabilitation technology to conduct assessments and reassessment of patient with acute lateral epicondylitis.	4.00	Strongly Agree	1.5
2. Implementing and adjusting treatment plans remotely	3.80	Strongly Agree	3
3. Provide patient and family education regarding acute lateral epicondylitis	4.00	Strongly Agree	1.5
4. Collaborate with other healthcare professionals to ensure comprehensive and uniform of treatment.	3.20	Strongly Agree	5
5. Provide guidance on ergonomic adjustments to work or home environments to prevent further injury or aggravation of the condition.	3.40	Strongly Agree	4
Overall Weighted Mean	**3.68**	Strongly Agree	

Table 1 presents the current practices in telerehabilitation management of lateral epicondylitis

As seen in the table, indicator 1 and 3 ” Using telerehabilitation technology to conduct assessments and reassessment of patient with acute lateral epicondylitis, and “Provide patient and family education regarding acute lateral epicondylitis.” was ranked 15 with a weighted mean of 4.00 verbally interpreted as “Strongly Agree”; indicator 2 ” Implementing and adjusting treatment plans remotely” was ranked 2 with a weighted mean of 3.59, verbally interpreted as “Strongly Agree; indicator 2 ” Implementing and adjusting treatment plans remotely” was ranked 3 with a weighted mean of 3.80, verbally interpreted as “Strongly Agree,” indicator 5 ” . Provide guidance on ergonomic adjustments to work or home environments to prevent further injury or aggravation of the condition.” was ranked 4 with a weighted mean of 3.40, verbally interpreted as “Strongly Agree,”Indicator 4” Collaborate with other healthcare professionals to ensure comprehensive and uniform of treatment.”ranked 5 with a weighted mean of 3.20 verbally interpreted as “Strongly Agree”.

To sum up the average weighted mean of 3.68 indicates that hand therapists strongly agree with current practices in telerehabilitation management for lateral epicondylitis.” This implies that they provide patient and family education regarding acute lateral epicondylitis, use telerehabilitation technology to conduct assessments and reassessment of patient with acute lateral epicondylitis and implementing and adjusting treatment plans remotely.

2. Developed Protocol for Telerehabilitation Management of Lateral Epicondylitis

Table 2
Developed Protocol for Telerehabilitation Management of Lateral Epicondylitis

Indicators	Weighted Mean	Verbal Interpretation	Rank

1. The treatment protocol conduct an assessment,reassessment, management and monitor the progress the ofrehabilitation through outcome measures with acute lateral epicondylitis.	4.00	Strongly Agree	2.5
2. The Protocol is an evidence-based treatment for acute lateral epicondylitis	4.00	Strongly Agree	1
3. Use of wrist splint or athletic tape to limit range of motion of affected muscle to reduce pain.	4.00	Strongly Agree	2.5
4. Use of therapeutic interventions such as exercises, manual therapy, and modalities stipulated in protocol to address pain, and improve ADL (activity of daily living) with acute lateral epicondylitis.	4.00	Strongly Agree	4
5. The Protocol can elicit a significant difference in pain level, functional outcome, and quality of life with acute lateral epicondylitis.	3.60	Strongly Agree	5
Overall Weighted Mean	**3.92**	**Strongly Agree**	

As seen in the table, indicator 1 ” The Protocol is an evidence-based treatment for acute lateral epicondylitis,” was ranked 1 with a weighted mean of 4.00 verbally interpreted as “Strongly Agree”; indicator1 and 3 ” The treatment protocol conduct an assessment,reassessment, management and monitor the progress the of rehabilitation through outcome measures with acute lateral epicondylitis. and Use of wrist splint or athletic tape to limit range of motion of affected muscle to reduce pain. ” was ranked 2.5 with a weighted mean of 4.00, verbally interpreted as “Strongly Agree’’; indicator 4 ” Use of therapeutic interventions such as exercises, manual therapy, and modalities stipulated in protocol to address pain, and improve ADL (activity of daily living) with acute lateral epicondylitis.” was ranked 4 with a weighted mean of 4.00, verbally interpreted as “Strongly Agree,” indicator 5 ” The Protocol can elicit a significant difference in pain level, functional outcome, and quality of life with acute lateral epicondylitis.” was ranked 5 with a weighted mean of 3.60, verbally interpreted as “Strongly Agree.

In summary, hand therapists' developed protocol for Telerehabilitation Management of Lateral Epicondylitis received a rating of "Strongly Agree" based on the average weighted mean of 3.92.This implies that hand therapists' protocol, which includes assessment, reassessment, management, and progress monitoring through outcome measures, along with the use of wrist splint or athletic tape to limit range of motion and reduce pain in affected muscles, has effectively improved the treatment of acute lateral epicondylitis.

Protocol for Hand Therapist in the Telerehabilitation Management of Repetitive Strain Injury (Lateral Epicondylitis) in Qatar:

To provide uniform Occupational therapy services for the patients with lateral epicondylitis through telerehabilitation. To enable the patient in attaining the maximum/optimum functional level of independence in a cost-effective rehabilitation program. To provide safety

to therapist and patient through virtual consultation/telerehabilitation. To serve as a practical guide for all HMC qualified Hand Therapist and Occupational therapists involved in the management of patients eligible for entering a lateral epicondylitis management. To educate the patient/caregiver about benefits and use of virtual consultation. To provide service at a location that is physically distant from the client, thereby allowing service to occur where the client lives, works, learns and plays, if that is needed or desired. The protocol is compose of seven section: purpose, definitions, application, patient group, exceptions, target areas, protocol. Under the protocol section the following subcategories are areas to be assessed, method of evaluation, conservative management.

Conserve management are compose of control of pain, preservation of motion, flexibility, strength and the development of endurance over time. The evidence-based management is stated in the protocol for splinting wearing of Elbow band, Stretching, Grip strengthening, Taping Techniques, therapeutic rom exercises, ice massage, deep transverse (friction)
In the Intermediate phase: Continue stretching, appropriate modalities, and bracing Initiate progressive pain-free resistive strengthening (three sets of 15, twice a day). Elbow Flexion/extension (2-3 lbs, progressing to 5-10 lbs.), Forearm pronation/supination (0-2 lbs., progressing to 3-5 lbs.), Shoulder Strengthening to prevent disuse atrophy. Resume previously aggravating activities.

In Restorative Phase: Restoration of flexibility, strength, and endurance to the extensor muscle, at this phase there's no pain at rest and minimal pain during wrist extension activities.

Work Modification:
Job analysis and Ergonomics. Determine the work-related factors potential to the cause of lateral tendinitis, likewise repetitive gripping, awkward or static posture. Tool Handles should adequate size to the workers.

Sports Considerations: Participate in interval training program. Good technique is essential so seek help from a professional player.

3. Level of Acceptability of Telerehabilitation Management of Lateral Epicondylitis

Table 3
Level of Acceptability of Telerehabilitation Management of Lateral Epicondylitis

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. The protocol has a positive impact in using telerehabilitation technologies to provide remote rehabilitation services to patients with acute lateral epicondylitis.	4.00	Very High	1
2. The protocol using telerehabilitation services in treating acute lateral epicondylitis reduce healthcare and patient expenses.	4.00	Very High	2
3. The protocol has the potential to provide effective and convenient care for many remote patients through telerehabilitation.	3.80	Very High	3

4. Therapists can recommend modifications of ADL (activities of daily living), work simplification and ergonomics, to reduce the strain on the elbow.	3.40	Very High	4
Overall Weighted Mean	**3.85**	**Very High**	

As seen in the table, indicator 1 ”The protocol has a positive impact in using telerehabilitation technologies to provide remote rehabilitation services to patients with acute lateral epicondylitis.,” was ranked 1 with a weighted mean of 4.00 verbally interpreted as “very high”; indicator 2” The protocol using telerehabilitation services in treating acute lateral epicondylitis reduce healthcare and patient expenses.. ” was ranked 2 with a weighted mean of 4.00, verbally interpreted as “very high’’; indicator 3” The protocol has the potential to provide effective and convenient care for many remote patients through telerehabilitation.” was ranked 3 with a weighted mean of 3.80, verbally interpreted as “very high,” indicator 4” Therapists can recommend modifications of ADL (activities of daily living), work simplification and ergonomics, to reduce the strain on the elbow was ranked 4 with a weighted mean of 3.40, verbally interpreted as “very high,

To sum up, the average weighted mean of 3.85 revealed that the Level of Acceptability of Telerehabilitation Management of Lateral Epicondylitis was “very high”. This implies that hand therapists believed that the protocol has a positive impact in using telerehabilitation technologies to provide remote rehabilitation services to patients with acute lateral epicondylitis, the protocol using telerehabilitation services in treating acute lateral epicondylitis reduce healthcare and patient expenses and the protocol has the potential to provide effective and convenient care for many remote patients through telerehabilitation.

IV. CONCLUSION AND RECOMMENDATION

The management of acute lateral epicondylitis is crucial, and hand therapists play a significant role in it. They provide education to patients and families about the condition and use telerehabilitation technology to conduct assessments and reassessments. This allows for remote monitoring and adjustment of treatment plans to ensure effective management. The hand therapists' protocol includes a comprehensive assessment, frequent reassessment, strategic management, and ongoing progress monitoring using outcome measures. The application of wrist splints or athletic tape to restrict range of motion and alleviate pain in affected muscles has also significantly enhanced the management of acute lateral epicondylitis. Hand therapists express confidence in the protocol's utilization of telerehabilitation technologies, which not only reduces healthcare and patient expenses but also offers effective and convenient care for numerous remote patients. This approach has great potential for widespread application and benefit. The following recommendations were made by the researcher based on the following findings.

Hand therapists should continue using patient education, telerehabilitation for assessments, and remote treatment adjustments to ensure effective management of acute lateral epicondylitis, maximizing accessibility and improving patient outcomes.

Hospital management should endorse and support the implementation of the hand therapists' protocol for acute lateral epicondylitis treatment due to its demonstrated effectiveness in enhancing patient care. Additionally, allocating resources towards training staff in this

protocol and ensuring availability of necessary equipment would further optimize its utilization and impact within the hospital setting. Hand therapists should further embrace and refine the use of telerehabilitation technologies in delivering remote rehabilitation services for patients with acute lateral epicondylitis. This approach has demonstrated positive outcomes, including reduced healthcare and patient expenses, while providing effective and convenient care for remote patients. Continuing to integrate and innovate in this area can lead to expanded access to care and improved patient outcomes.

Future researchers should focus on exploring the long-term efficacy and patient satisfaction of telerehabilitation interventions for acute lateral epicondylitis. Investigating potential barriers and facilitators to the adoption of these technologies in clinical practice is also essential. Additionally, examining the comparative effectiveness of different telerehabilitation approaches and optimizing protocols to address specific patient needs could further advance the field and improve outcomes for individuals with this condition.

REFERENCES

Abdullah A, An, J., Ryu, H. K., Lyu, S. J., Yi, H. J., & Lee, B. H. (2021). Effects of preoperative telerehabilitation on muscle strength, range of motion, and functional outcomes in candidates for total knee arthroplasty: a single-blind randomized controlled trial. *International Journal of Environmental Research and Public Health*, *18*(11), 6071.2019).

Ang, B. F., Mohan, P. C., Png, M. A., Allen Jr, J. C., Howe, T. S., Koh, J. S., ... &Morrey, B. F. (2021). Ultrasonic percutaneous tenotomy for recalcitrant lateral elbow tendinopathy: clinical and sonographic results at 90 months. *The American Journal of Sports Medicine*, *49*(7), 1854-1860.Anton (2018)

Ambrosino, P., Fuschillo, S., Papa, A., Di Minno, M. N. D., &Maniscalco, M. (2020). Exergaming as a supportive tool for home-based rehabilitation in the COVID-19 pandemic era. *Games for health journal*, *9*(5), 311-313.

American Society of Hand Therapists, Bachman, S. (2018). Evidence-based approach to treating lateral epicondylitis using the Occupational Adaptation model. *The American Journal of Occupational Therapy*, *70*(2), 7002360010p1-7002360010p5.

Aranda BSerrano, P. A., Criado, T.., Fernández-Pinedo, N., Riendas, A., Sevilla, M. M., &Calvo-Arenillas, I. (2022). Robotics and Virtual Reality Exer-Games for the Neurorehabilitation of Children and Adults with Traumatic Brain Injury: The IS-BRAIN Model. In *Engineering Biomaterials for Neural Applications* (pp. 243-276). Springer,

Ashbury, FDChan, R. J., Crichton, M., Crawford-Williams, F., Agbejule, O. A., Yu, K., Hart, N. H., ...& Chan, A. (2021). The efficacy, challenges, and facilitators of telemedicine in post-treatment cancer survivorship care: an overview of systematic reviews. *Annals of Oncology*, *32*(12), 1552-1570. 2021)

Becker F, Øra, H. P., Kirmess, M., Brady, M. C., Winsnes, I. E., Hansen, S. M., (2018). Telerehabilitation for aphasia–protocol of a pragmatic, exploratory, pilot randomized controlled trial. *Trials*, *19*(1), 1-10..

Bernetti A., Agostini, F., Pezzi, L., Paoloni, M., Insabella, R., Attanasi, C., &Paolucci, T. (2021). Motor Imagery: A Resource in the Fatigue Rehabilitation for Return-to-Work in Multiple Sclerosis Patients—A Mini Systematic Review. *Frontiers in Neurology*, *12*, 1132.

Bettger, J. P., Thoumi, A., Marquevich, V., De Groote, W., Battistella, L. R., Imamura, M., ...& Stein, J. (2020). COVID-19: maintaining essential rehabilitation services across the care continuum. *BMJ global health*, *5*(5), e002670.

Bhandari,Orkin, A. M., Gill, P. J., Ghersi, D., Campbell, L., Sugarman, J., Emsley, R., ...& CONSERVE Group. (2021). Guidelines for reporting trial protocols and completed trials modified due to the COVID-19 pandemic and other extenuating circumstances: the CONSERVE 2021 statement. *Jama*, *326*(3), 257-265. 2021)

Boccalandro, E. A., Dallari, G., &Mannucci, P. M. (2019). Telemedicine and telerehabilitation: current and forthcoming applications in haemophilia. *Blood Transfusion*, *17*(5), 385.

Boden A.LMaron, D. J., Hochman, J. S., O'Brien, S. M., Reynolds, H. R., Stone, G. W., ... &ISCHEMIA Trial Research Group. (2018). International study of comparative health effectiveness with medical and invasive approaches (ISCHEMIA) trial: rationale and design. *American heart journal*, *201*, 124-135.2018)

Brosseau LMoseley, A. M., Rahman, P., Wells, G. A., Zadro, J. R., Sherrington, C., Toupin-April, K., (2019). Agreement between the Cochrane risk of bias tool and Physiotherapy Evidence Database (PEDro) scale: a meta-epidemiological study of randomized controlled trials of physical therapy interventions. *PloS one*, *14*(9), e0222770.

Carey JR Logerstedt, D. S., Scalzitti, D. A., Bennell, K. L., Hinman, R. S., Silvers-Granelli, H., Ebert, J., ... &Torburn, L. (2018). Knee pain and mobility impairments: meniscal and articular cartilage lesions revision 2018: clinical practice guidelines linked to the International Classification of Functioning, Disability and Health from the OrthopaedicSection of the American Physical Therapy Association. *Journal of Orthopaedic& Sports Physical Therapy*, *48*(2), A1-A50.2018).

Cason J, D. H. S., Kim Hartmann PhD, O. T. R., & Tammy Richmond, M. S. (2018). Telehealth in Occupational Therapy. *The American Journal of Occupational Therapy*, *72*, 1-18.Colombi R.

Cha B.. de la Iglesia, D. H., Mendes, A. S., González, G. V., Jiménez-Bravo, D. M., & de Paz Santana, J. F. (2020). Connected elbow exoskeleton system for rehabilitation training based on virtual reality and context-aware. *Sensors*, *20*(3), 858

Crotty M. Laver, K., Cumming, R., Dyer, S., Agar, M., Anstey, K. J., Beattie, E., ...&Yates, M.(2017). Evidence-based occupational therapy for people with dementia and their families: What clinical practice guidelines tell us and implications for practice. *Australian occupational therapy journal*, *64*(1), 3-10.2017)

Cottrell, M. A., & Russell, T. G. (2020). Telehealth for musculoskeletal physiotherapy. *Musculoskeletal Science and Practice*, *48*, 102193.

Curtis, Comiskey, and DempseyComiskey, C. (2017) Modelling: New prediction estimates, learning from other infectious and social epidemics.

Damschroder McKay, C. D. (Ed.). (2022). *The Mental Impact of Sports Injury*. Routledge.

Dar, G. (2019). Physical Therapy via Telerehabilitation for Chronic Low Back Pain: An Editorial. *Orthopaedics*, *3*(2), 01-05.

Day JM Castrodad, I. M. D., Recai, T. M., Abraham, M. M., Etcheson, J. I., Mohamed, N. S., Edalatpour, A., &Delanois, R. E. (2019). Rehabilitation protocols following total knee arthroplasty: a review of study designs and outcome measures. *Annals of translational medicine*, *7*(Suppl 7).

De Sire, A Lee, K. (2021, November). Agreement between 3D Motion Analysis and Tele-Assessment Using a Video Conferencing Application for Telerehabilitation. In *Healthcare* (Vol. 9, No. 11, p. 1591). MDPI.2021

Dong Y.,Sun, X., Ding, J., Ma, X., Wang, R., Jin, K., ... & Zhang, Y. (2022). A Survey of Technologies Facilitating Home and Community-Based Stroke Rehabilitation. *International Journal of Human–Computer Interaction*, 1-27.

Donelan, K., Barreto, E. A., Sossong, S., Michael, C., Estrada, J. J., Cohen, A. B., ...&Schwamm, L. H. (2019). Patient and clinician experiences with telehealth for patient follow-up care. *Am J Manag Care*, *25*(1), 40-44.

Dornelles MP Fritsch, C. G., Teodoro, J. L., da Silva, L. X., Vaz, M. A., Pinto, R. S., ... &Baroni, B. M. (2019). Effects of photobiomodulation therapy associated with resistance training in elderly men: a randomized double-blinded placebo-controlled trial. *European Journal of Applied Physiology*, *119*(1), 279-289.

Duncan, J., Duncan, R., Bansal, S., Davenport, D., & Hacker, A. (2019). Lateral epicondylitis: the condition and current management strategies. *British Journal of Hospital Medicine*, *80*(11), 647-651.

Frogner, B.K Harwood, K., Andrilla, C. H. A., Schwartz, M., & Pines, J. M. (2018). Physical therapy as the first point of care to treat low back pain: an instrumental variables approach to estimate impact on opioid prescription, health care utilization, and costs. *Health services research*, *53*(6), 4629-4646.

Fu, M. J., Curby, A., Suder, R., Katholi, B., & Knutson, J. S. (2020). Home-based functional electrical stimulation-assisted hand therapy video games for children with hemiplegia: development and proof-of-concept. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *28*(6), 1461-1470.

Gelaw, A. Y., Janakiraman, B., Gebremeskel, B. F., &Ravichandran, H. (2020). Effectiveness of Home-based rehabilitation in improving physical function of persons with Stroke and other physical disability: A systematic review of randomized controlled trials. *Journal of Stroke and Cerebrovascular Diseases*, *29*(6), 104800.

Girgis, B., & Duarte, J. A. (2020). Efficacy of physical therapy interventions for chronic lateral elbow tendinopathy: a systematic review. *Physical Therapy Reviews*, *25*(1), 42-59.

Hay A., Connors, B. P. (2018). *Exploring a New Paradigm in Outpatient Musculoskeletal Rehabilitation: Chronic Disease Prevention and Facilitating Patient Self-Management* (Doctoral dissertation, The University of Utah).

Hecht E.M.,Mayer-Hirshfeld, I., Brannan, D., Murphy, L. A., &Caban-Martinez, A. J. (2018). Association between positive and negative affect and musculoskeletal pain among US home health aides. *Archives of environmental & occupational health*, *73*(6), 355-359

Hendrickson L. Castillo, R. C., Huang, Y., Scharfstein, D., Frey, K., Bosse, M. J., Pollak, A. N., ... & Major Extremity Trauma Research Consortium. (2019). Association between 6-week postdischarge risk classification and 12-month outcomes after orthopedic trauma. *JAMA surgery*, *154*(2), e184824-e184824.

Ho K. Krysa, J. A.,O'Connell, P., &PoharManhas, K. (2022). Clinical practice recommendations for prehabilitation and post-operative rehabilitation for arthroplasty: A scoping review. *Musculoskeletal Care*.

Hoogvliet P. Huisstede, B. M., Randsdorp, M. S., van den Brink, J., Franke, T. P., Koes, B. W., (2018). Effectiveness of oral pain medication and corticosteroid injections for carpal tunnel syndrome: a systematic review. *Archives of physical medicine and rehabilitation*, *99*(8), 1609-1622.

Hung D.Neiduski, R. L., & Powell, R. K. (2019). Flexor tendon rehabilitation in the 21st century: a systematic review. *Journal of Hand Therapy*, *32*(2), 165-174. 2019)

Hsu, C. Y., Wu, C. M., Huang, C. C., Shie, H. H., & Tsai, Y. S. (2022). Feasibility and Potential Effects of Robot-Assisted Passive Range of Motion Training in Combination with Conventional Rehabilitation on Hand Function in Patients with Chronic Stroke. *Journal of Rehabilitation Medicine*, jrm00323-jrm00323.

Johns N.,Margetis, J. L., Wilcox, J., Thompson, C., &Mannion, N. (2021). Occupational Therapy: Essential to Critical Care Rehabilitation. *The American Journal of Occupational Therapy*, *75*(2).

Jung S. Nolte, P. C., Tross, A. K., Groetzner-Schmidt, C., Jung, M. K., Porschke, F., Grützner, P. A., ...&Schnetzke, M. (2021). Risk factors for revision surgery following radial head arthroplasty without cement for unreconstructible radial head fractures: minimum 3-year follow-up. *JBJS*, *103*(8), 688-695.

KairyShigekawa, E., Fix, M., Corbett, G., Roby, D. H., & Coffman, J. (2018). The current state of telehealth evidence: a rapid review. *Health Affairs*, *37*(12), 1975-1982.2018)

Kannus P.Uusi-Rasi, K., Karinkanta, S., Tokola, K., &Sievänen, H. (2019). Bone mass and strength and fall-related fractures in older age. *Journal of osteoporosis*, *2019*.

Kenneth NK, Hung KN, G., & Fong, K. N. (2019). Effects of telerehabilitation in occupational therapy practice: A systematic review. *Hong Kong Journal of Occupational Therapy*, *32*(1), 3-21.

Kachanathu S.J. Nuhmani, S., Khan, M. H., Bari, M. A., Abualait, T. S., &Muaidi, Q. I. (2021). Reliability and validity of smartphone applications to measure the spinal range of motion: A systematic review. *Expert Review of Medical Devices*, *18*(9), 893-901.

Kamenov, K., Mills, J. A., Chatterji, S., &Cieza, A. (2019). Needs and unmet needs for rehabilitation services: a scoping review. *Disability and rehabilitation*, *41*(10), 1227-1237.

Keijsers L. Kuroda, Y., Young, M., Shoman, H., Punnoose, A., Norrish, A. R., &Khanduja, V. (2020). Advanced rehabilitation technology in orthopaedics—a narrative review. *International Orthopaedics*, *45*(8), 1933-1940.2020).

Krasovsky M., Beshara, P., Chen, J. F., Read, A. C., Lagadec, P., Wang, T., & Walsh, W. R. (2021). The Reliability and validity of wearable inertial sensors coupled with the microsoftkinect to measure shoulder range-of-motion. *Sensors*, *20*(24), 7238.

Kwon, I. H., & Shin, W. S. (2019). Characteristics of muscle strength and posture among automobile parts manufacturing workers and the necessity of the musculoskeletal injury prevention program. *Journal of the Korean Society of Physical Medicine*, *14*(4), 173-181.

LaMorte B, Fassier, J. B., Sarnin, P., Rouat, S., Peron, J., Kok, G., Letrilliart, L (2019). Interventions developed with the intervention mapping protocol in work disability prevention: a systematic review of the literature. *Journal of occupational rehabilitation*, *29*(1), 11-24.2019).

Laron Higashi, Y., Gautam, S., Delafontaine, P., &Sukhanov, S. (2019). IGF-1 and cardiovascular disease. *Growth Hormone & IGF Research*, *45*, 6-16.

Lapner, P., Pollock, J. W., Zhang, T., Ruggiero, S., Momoli, F., Sheikh, A., &Athwal, G. S. (2020). A randomized controlled trial comparing subscapularis tenotomywith peel in anatomic shoulder arthroplasty. *Journal of Shoulder and Elbow Surgery*, *29*(2), 225-234

Lawford, B. J., Delany, C., Bennell, K. L., &Hinman, R. S. (2019). "I was really pleasantly surprised": firsthand experience and shifts in physical therapist perceptions of telephone-delivered exercise therapy for knee osteoarthritis–a qualitative study. *Arthritis care & research*, *71*(4), 545-557.

Lenoir, D., Coppieters, I., Willaert, W., Kregel, J., Danneels, L., Cagnie, B., ...&Malfliet, A. (2019). Do sociodemographic features, pain sensitivity or pain catastrophizing relate to clinic-based adherence to physiotherapy in people suffering from chronic spinal pain? Secondary analysis of a randomized clinical trial. *Musculoskeletal Science and Practice*, *44*, 102066.

Leochico, C. F. D., Mojica, J. A. P., Rey-Matias, R. R., Supnet, I. E., & Ignacio, S. D. (2021). Role of telerehabilitation in the Rehabilitation Medicine training program of a COVID-19 referral center in a developing country. *American Journal of Physical Medicine &Rehabilitation*, *100*(6), 526-532.

Leochico, C. F. D., Espiritu, A. I., Ignacio, S. D., & Mojica, J. A. P. (2020). Challenges to the emergence of telerehabilitation in a developing country: a systematic review. *Frontiers in neurology*, 1007.

MacDermid J.,Farzad, M., Ferreira, L., Szekeres, M., Cuypers, S., &Shafiee, E. (2019). A description of the barriers, facilitators, and experiences of hand therapists in providing remote (tele) rehabilitation: An interpretive description approach. *Journal of Hand Therapy*, *36*(4), 805-816.

Makovholo, P., Batyashe, N., Sekgweleo, T., &Iyamu, T. (2017). Diffusion of innovation theory for information technology decision making in organisationalstrategy. *Journal of Contemporary Management*, *14*(1), 461-481.

Mandall A.Wu, M., Chen, J., Ma, Y., Yan, B., Pan, M., Peng, Q., ...& Zeng, H. (2020). Ultra elastic, stretchable, self-healing conductive hydrogels with tunable optical properties for highly sensitive soft electronic sensors. *Journal of Materials Chemistry A*, *8*(46), 24718-24733.2020)

Mezian, K., Jačisko, J., Novotný, T., Hrehová, L., Angerová, Y., Sobotová, K., &Naňka, O. (2021). Ultrasound-Guided Procedures in Common Tendinopathies at the Elbow: From Image to Needle. *Applied Sciences*, *11*(8), 3431.

Mohajer N. Nazari, F., Nahavandi, D., Khosravi, A., &Nahavandi, S. (2021). Critical Review of Exoskeleton Technology: State of the art and development of physical and cognitive human-robot interface. *arXiv preprint arXiv:2111.12860*.

Moretti Dionisi, S., Giannetta, N., Di Simone, E., Ricciardi, F., Liquori, G., De Leo, A., ...&Orsi, G. B. (2021). The use of mhealth in orthopedic surgery: a scoping review. *International Journal of Environmental Research and Public Health*, *18*(23), 12549.

Moscagiuri, M., Frizziero, A., Bigliardi, D., Vittadini, F., Pantalone, A., Perazzo, L., ...&Buda, R. (2022). Snapping of the Upper Limb: a Clinical Overview. *Muscles, Ligaments and Tendons Journal*, *12*(3).

Nawrat-Szołtysik A.,Romaniszyn, P., Stępień, P., & Kawa, J. (2018, June). Video-Based Automatic Evaluation of the 360 Degree Turn Test. In *International Conference on Information Technologies in Biomedicine* (pp. 571-579). Springer, Cham.

Newman J, Hernandez, G., Baumann, K., Knight, S., Purrington, H., Gilgannon, M., &Cooper, D. L. (2018). Ranges and drivers of risk associated with sports and recreational activities in people with haemophilia: results of the Activity-Intensity-Risk Consensus Survey of US physical therapists. *Haemophilia*, *24*, 5-26.

OgourtsovaT. Luveta, J., Parks, R. M., Heery, D. M., Cheung, K. L., & Johnston, S. J. (2020). Invasive lobular breast cancer as a distinct disease: implications for therapeutic strategy. *Oncology and therapy*, *8*(1), 1-11.

Okita M, Mugii, N., Matsushita, T., Oohata, S., Yahata, T., Someya, F., ...&Hamaguchi, Y. (2019). Long-term follow-up of finger passive range of motion in Japanese systemic

sclerosis patients treated with self-administered stretching. *Modern rheumatology*, *29*(3), 484-490.

OlatundeHaque, H. F., Ahmed, A. S., Uddin, K. N., Afroz, F., Afroze, S. R., &Hoque, M. T. (2021). Spectrum of rheumatologic disorders among patients attending with musculoskeletal symptoms: experience from medicine outpatient department of a tertiary care hospital of Bangladesh. *BIRDEM Medical Journal*, *11*(2), 116-120.

ÖztürkN,Sertpoyraz, F. M.,. &Kirbiyik, E. G. (2019). Relationship between musculoskeletal pain and Vitamin D levels in elderly women. *Family Practice and Palliative Care*, *4*(2), 69-73

Paolucci, T, de Sire, A., &Invernizzi, M. (2021). Musculoskeletal rehabilitation: state-of-the-art. *Applied Sciences*, *11*(14), 6243.

Parmanto B.Nussbaum, R., Kelly, C., Quinby, E., Mac, A., &Dicianno, B. E. (2019). Systematic review of mobile health applications in rehabilitation. *Archives of physical medicine and rehabilitation*, *100*(1), 115-127.

Peretti, A., Amenta, F., Tayebati, S. K., Nittari, G., & Mahdi, S. S. (2017). Telerehabilitation: review of the state-of-the-art and areas of application. *JMIR rehabilitation and assistive technologies*, *4*(2), e7511.

PhadkePhadke, C. P., Vierira, L., Mathur, S., Cipriano Jr, G., Ismail, F., &Boulias, C. (2019). Impact of passive leg cycling in persons with spinal cord injury: a systematic review. *Topics in Spinal Cord Injury Rehabilitation*, *25*(1), 83-96.

PicelliEkiz, T., Ata, A. M., Kara, M., Gürçay, E., Chang, K. V., Sekizkardeş, M., ...&Franchignoni, F. (2020). Musculoskeletal ultrasound publications in rehabilitation journals: A EURO-MUSCULUS/USPRM update. *The Journal of the International Society of Physical and Rehabilitation Medicine*, *3*(1), 1.

Piña J.A,Cuesta-Barriuso, R., Gómez-Conesa, A., &López-. (2018). Manual and educational therapy in the treatment of hemophilic arthropathy of the elbow: a randomized pilot study. *Orphanet journal of rare diseases*, *13*(1), 1-8.

Pitsillides A.Javaheri, B., Carriero, A., Wood, M., De Souza, R., Lee, P. D., Shefelbine, S., &(2018). Transient peak-strain matching partially recovers the age-impaired mechanoadaptive cortical bone response. *Scientific reports*, *8*(1), 1-12..

Ramage JL Nath, R. K., &Somasundaram, C. (2021). Long-term Improvements of Neuroplastyand Scalene Muscle Resection in LTN-injured Winged Scapula Patients. *Plastic and Reconstructive Surgery Global Open*, *9*(2).

Roh YH Wen, H., Yang, H., & Xu, Y. (2019). Extreme bone lengthening by bone transport with a unifocaltibialcorticotomy: a case report. *BMC Musculoskeletal Disorders*, *20*(1), 1-

Saidi, A., Minoonejad, H., Seidi, F., &Alizadeh, M. (2019). Comparison of the Effect and Durability of Eccentric and Stretching Exercises with Dry Needling on Pain, Grip Strength, and Functional Disability in Athletes with Tennis Elbow. *The Scientific Journal of Rehabilitation Medicine*, *8*(4), 113-122.

Thomas, L. (2021). *Conventional Vs Robotic Stroke Therapy: Designing a Pilot study* (Doctoral dissertation, Arizona State University).

SarsakBuheji, M., &Hassani, A. (2020). Design of lean tele-rehabilitation services for post COVID-19 pandemic. *International Journal of Advanced Research in Engineering and Technology*, *11*(11), 1360-1371.

Sasaki K Shimura, T., Yamamoto, M., Kano, S., Kagase, A. I., Kodama, A., Koyama, Y., ...&Kozuma, K. (2017). Impact of the clinical frailty scale on outcomes after transcatheteraortic valve replacement. *Circulation*, *135*(21), 2013-2024

Segretin S Mu, X., Peng, W., Ou, Y., Li, P., Li, Z., & Wei, J. (2018). Non-surgical therapy for the treatment of chronic low back pain in patients with Modicchanges: A systematic review of the literature. *Heliyon*, *8*(7), e09658.

Seron, P., Oliveros, M. J., Gutierrez-Arias, R., Fuentes-Aspe, R., Torres-Castro, R. C., Merino-Osorio, C., ...& Sanchez, P. (2021). Effectiveness of telerehabilitation in physical therapy: A rapid overview. *Physical therapy*, *101*(6), pzab053.

Seven, B., Cobanoglu, G., Oskay, D., &Atalay-Guzel, N. (2019). Test–retest reliability of isokinetic wrist strength and proprioception measurements. *Journal of sport rehabilitation*, *28*(7).

Sirico F Tarantino, D., Sirico, F., Corrado, B., &Ruosi, C. (2021). Intra-articular hyaluronic acid injections and oral collagen supplementation for knee OA: A case report of an elite female soccer player. *Journal of Human Sport &Exercise*, *16*..

Sloane R.,Hoenig, H., Rubenstein, L. V., Horner, R., & Kahn, K. (2020). What is the role of timing in the surgical and rehabilitative care of community-dwelling older persons with acute hip fracture?. *Archives of Internal Medicine*, *157*(5), 513-520.

Srivastav and A. J. Samuel (2022) "E-Rehabilitation: One solution for patients with Parkinson's disease in COVID-19 era", Parkinsonism & Related Disorders, vol. 75. Parkinsonism & Related Disorders, pp. 128– 129

Tani, K., Shiraki, Y., Yamamoto, S., Kodaka, Y., & Kushiro, K. (2018). Whole-body roll tilt influences goal-directed upper limb movements through the perceptual tilt of egocentric reference frame. *Frontiers in Psychology*, *9*, 84.

Tieri, G., Morone, G., Paolucci, S., &Iosa, M. (2018). Virtual reality in cognitive and motor rehabilitation: facts, fiction and fallacies. *Expert review of medical devices*, *15*(2), 107-117.

Turan, Z., Topaloglu, M., &OzyemisciTaskiran, O. (2021). Is tele-rehabilitation superior to home exercise program in COVID-19 survivors following discharge from intensive care unit?-a study protocol of a randomized controlled trial. *Physiotherapy Research International*, *26*(4), e1920.

Tsymbal A., Wels, M., Kelm, B. M., Tsymbal, A., Hammon, M., Soza, G., Sühling, M., ...&Comaniciu, D. (2022, February). Multi-stage osteolytic spinal bone lesion detection from CT data with internal sensitivity control. In *Medical Imaging 2012: Computer-Aided Diagnosis* (Vol. 8315, pp. 317-324).

Vaquero-Picado A.Zviriaka, O., Rudenko, A., Karpenko, Y., Demchenko, L., &Kuksa, N. (2021). Assessment of posture and foot video-computer monitoring dynamics in the implementation of physical therapy program for 5-6-year-old children with hip dysplasia consequences. *Journal of Physical Education and Sport*, *21*, 3009-3016.

van Beek, J. J. W., van Wegen, E. E. H., Rietberg, M. B., Nyffeler, T., Bohlhalter, S., Kamm, C. P., ... &Vanbellingen, T. (2020). Feasibility of a home-based tablet app for dexterity training in multiple sclerosis: usability study. *JMIR mHealth and uHealth*, *8*(6), e18204.

Van Belle S, Scheerens, C., Chambaere, K., Pardon, K., Derom, E., Joos, G., ...&Deliens, L. (2018). Development of a complex intervention for early integration of palliative home care into standard care for end-stage COPD patients: A Phase 0–I study. *PloS one*, *13*(9), e0203326.2018).

Wang R Wille, C. M., Lenhart, R. L., Thelen, D. G., &Heiderscheit, B. C. (2020). Ability of sagittal kinematic variables to estimate ground reaction forces and joint kinetics in running. *journal of orthopaedic& sports physical therapy*, *44*(10), 825-830.

Weatherall V.Hardy, J., Baggott, C., Fingleton, J., Reddel, H. K., Hancox, R. J., Harwood, M., ... &Porrachia, A. C. (2019). Budesonide-formoterol reliever therapy versus maintenance budesonide plus terbutaline reliever therapy in adults with mild to

moderate asthma (PRACTICAL): a 52-week, open-label, multicentre, superiority, randomised controlled trial. *The Lancet*, *394*(10202), 919-928.)

Willy R., Mansfield, C. J., Vanetten, L., Willy, R., Di Stasi, S., Magnussen, R., & Briggs, M. (2019). The effects of needling therapies on muscle force production: a systematic review and meta-analysis. *journal of orthopaedic& sports physical therapy*, *49*(3), 154-170.

Worboys Steinhardt, N. Y. U. (2020). Telerehabilitation versus traditional rehabilitation of adults with upper-extremity orthopedic conditions: a systematic review.

Wu C. Chen, C. F., Hu, C. C., Wu, C. T., Chang, C. S., Hung, Y. P., ... & Chang, Y. (2021). Treatment of knee osteoarthritis with intra-articular injection of allogeneic adipose-derived stem cells (ADSCs) ELIXCYTE®: a phase I/II, randomized, active-control, single-blind, multiple-center clinical trial. *Stem cell research &therapy*, *12*(1), 1-12.

Yi R.Zhang, Z. Y., Tian, L., He, K., Xu, L., Wang, X. Q., Huang, L., ... & Liu, Z. L. (2022). Digital rehabilitation programs improve therapeutic exercise adherence for patients with musculoskeletal conditions: a systematic review with meta-analysis. *Journal of Orthopaedic& Sports Physical Therapy*, (0), 1-36.

Zwerus E. L Keijsers, R., van Lith, D. R., Koenraadt, K. L., Goossens, P., van den Bekerom, M. P., &Eygendaal, D. (2018). Validity and reliability of elbow range of motion measurements using digital photographs, movies, and a goniometry smartphone application. *Journal of Sports Medicine*, *2018*.