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PIP/DIP Joint Capsule Stiffness: Current Evidence For Effective Interventions

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This evidence project, submitted by

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has been approved and accepted in partial fulfillment of the requirements for the degree of

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Key Words: Proximal Interphalangeal Stiffness, Distal Interphalangeal Stiffness, PIP/DIP

Abstract

This research aimed to identify and analyze intervention approaches to remediate Proximal and Distal Interphalangeal (PIP/DIP) joint capsule stiffness and was performed to inform practice of hand therapists in an outpatient occupational therapy (OT) clinic. The treatment protocols were analyzed according to practicality for the practice and overall efficacy. Ten databases were searched to collect appropriate data based on a specific predetermined list of search terms. Articles were examined against specific inclusion and exclusion criteria, and sixteen were eventually selected for analysis. Six different intervention strategies emerged from the research including occupation-based practice, electromagnetotherapy, technology-assisted therapy, orthoses, and preparatory methods/modalities. No evidence was found to support one specific intervention strongly over another, rather each had a set of circumstances such as the type of hand condition and/or diagnosis that would warrant the use of that protocol. This suggests that it is important for practitioners who treat PIP/DIP joint capsule stiffness to be aware that there are a multitude of different treatment options available. Selecting one to use with a client will require clinical consideration of their client factors, disease/diagnosis factors, as well as clinic factors such as resources or therapist qualifications.

Executive Summary

We collaborated with Tomi Johnson, OTR/L, CHT and her practice of primarily hand therapy at the University of Washington Valley Medical Center. When beginning our communication, Tomi voiced her curiosity surrounding available treatments in the research for proximal and distal interphalangeal (PIP/DIP) joint stiffness. Her current practice standards for treating this condition were limited to low-load prolonged stretch, and she wondered if the research had progressed or changed and whether there were other new or experimental treatments available in the current research. Thus, together we formulated the following research question, "What are the existing rehabilitation protocols for reducing DIP/PIP joint capsule stiffness to improve function, either directly or indirectly, and how do they compare to each other in practicality and efficacy?"

Through our search of the literature, we found a few new treatment protocols that were shown to improve various aspects of PIP/DIP joint stiffness, whether that be pain, active/passive range of motion, or functional performance. The ones we eventually focused on for the knowledge translation component of our project were electromagnetotherapy, physical agent modalities/preparatory methods, 2-step orthosis technique, occupation-based interventions, and technology-assisted therapy. However, the few research studies explaining these various protocols did not have rigorous methods or high validity. As such, we concluded that no one protocol was supported more strongly than another by the current research, and that more research studies should be conducted in this area of inquiry to increase the evidence supporting practice standards for PIP/DIP joint capsule stiffness.

Tomi desired a practical way for the information we gathered to be presented to her for the knowledge translation component of the project, therefore we proposed and eventually

executed an informational booklet. The booklet describes the newer protocols that we identified in the research in terms of the articles that studied them, and provided resources for practitioners to access these articles if needed. With this approach, Tomi and her colleagues have a resource to turn to when they need ideas for intervention strategies, or are curious for what the current literature supports. This booklet serves as a launch pad for further inquiry by the practitioner, therefore encouraging and guiding evidence-based practice in action.

CRITICALLY APPRAISED TOPIC (CAT) PAPER

Focused Question

What are the existing rehabilitation protocols for reducing DIP/PIP joint capsule stiffness to improve function, either directly or indirectly, and how do they compare to each other in practicality and efficacy?

Prepared By

Ciara Caldwell, Chloe McNutt, Nicole Nguyen

Date Review Completed

11/27/2018

Professional Practice Scenario

An OTR/L specializing in hand therapy in an outpatient, orthopedic rehabilitation clinic has a client with DIP and PIP joint stiffness/tightness, and is wondering what interventions or modalities would be most appropriate for its treatment.

Search Process

Procedures for the selection and appraisal of articles

Inclusion Criteria

- Subjects with a hand injury or pathology
- Subjects with interphalangeal joint tightness or stiffness
- Subjects provided with some form of rehabilitation intervention
- Adults, as the population most commonly seen at the clinic are over 18 years old
- Published since 1980
- Full article available
- English language only to prevent misinterpretation of articles published in other languages
- Peer-reviewed articles only
- Articles AOTA level I-V, including qualitative articles

Exclusion Criteria

- Articles that only use invasive procedures (i.e. those that rely solely on surgical interventions)
- Articles with non-human subjects

Search Strategy

Categories	Key Search Terms
Patient/Client Population	*Osteoarthritis* *Rheumatoid AND arthritis* *trigger finger* *finger AND tightness* *finger AND fracture* *finger AND stiffness* *Arthritis* *PIP AND stiffness* *metacarpal AND tightness* *interphalangeal AND tightness* *mallet finger* *PIP AND DIP AND tightness* *Finger ROM*
Intervention	*Stretching treatment* *rehab, rehabilitation* *Conservative* *reducing finger stiffness* *finger AND tightness AND rehabilitation* *arthritis AND finger AND treatment* *stiffness AND reduction AND finger* *PIP stiffness AND reduction* *DIP stiffness AND reduction* *Osteoarthritis AND intervention AND hand* *scar AND mobilization* *tendon gliding* *active ROM* *Technology* *Assistive technology* *Electromagnetotherapy*

	Magnetotherapy *Pulsed electromagnetotherapy*
Comparison	*Occupation-based intervention* *Exercises* *Modalities* *Joint protection*
Outcomes	*Functional AND hand stiffness* *Range of motion*

Databases, Sites, and Sources Searched
CINAHL
ClinicalKey
ScienceDirect
EBSCOhost
Hand Clinics
Journal of Hand Surgery
Journal of Hand Therapy
American Journal of Occupational Therapy
Pubmed
Primo

Search Outcomes/Quality Control/Review Process

Research databases were divided equally among student researchers. Each student researcher recorded her article review process using the identified search terms. The PRISMA flow chart illustrates the process of article selection, including number of articles initially found (30,663), number of articles left after they were narrowed down by refining search terms and determining relevance to the research question (13,862), and the final number of articles selected (16).

Of the 42 articles with access to full-text, 24 not meeting the criteria were excluded. Non-human subjects was added to the exclusion criteria after an article with non-human subjects was retrieved from the CINAHL database, as this population does not apply to our research question.

The key contributors involved in this research process are the collaborator, Tomi Johnson, our chair, Chih-Huang Yu, and our mentor, George Tomlin.

PRISMA Flow Chart on Next Page

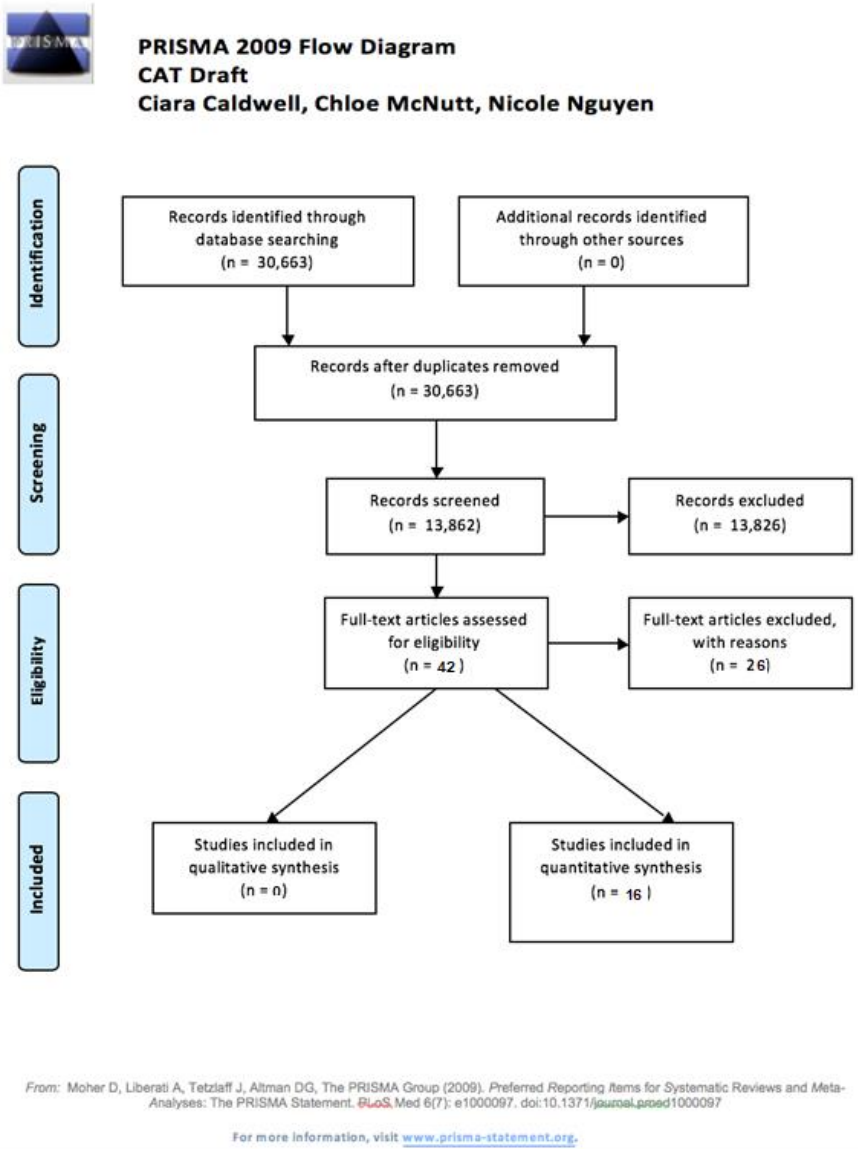


Figure 1. PRISMA Chart. Process of narrowing down applicable studies.

Results of Search

Summary of Study Designs of Articles Selected for the CAT Table

Pyramid Side	**Study Design/Methodology of Selected Articles**	**Number of Articles Selected**
Experimental	1 Meta-Analyses of Experimental Trials 6 Randomized Controlled Trials 2 Controlled Clinical Trials 0 Single Subject Studies	9
Outcome	0 Meta-Analyses of Related Outcome Studies 0 Individual Quasi-Experimental Studies w/ Covariates 0 Case-Control or Pre-existing Groups Studies 3 One Group Pre-Post Studies	3
Qualitative	0 Meta-Synthesis of Related Qualitative Studies 0 Group Qualitative Studies w/ more Rigor ___prolonged engagement with informants ___triangulation of data (multiple sources) ___ confirmation (peer/member-checking; audit trail) ___comparisons among individuals, w/ a person 0 Group Qualitative Studies w/ less Rigor 0 Qualitative Study on a Single Person	0

Descriptive	2 Systematic Reviews of Related Descriptive Studies 0 Association, Correlational Studies 0 Multiple Case Series, Normative Studies, Descriptive surveys 1 Individual Case Studies 1 Narrative	4
AOTA Levels I- 9 II- 2 III- 3 IV- 1 V- 1		*TOTAL number of articles* = 16

Summary of Key Findings.

Summary of Experimental Studies

Occupation-Based Interventions

One study found that Occupation-Based Intervention (OBI) in conjunction with conventional therapeutic exercises and paraffin bath, increased total active motion, COPM performance, and COPM satisfaction of hand injuries more than the control group that did not engage in OBI with TE and a physical modality (Che Daud et al., 2016).

Electromagnetotherapy (EMT)

Three studies using EMT indicated decreased joint stiffness and pain for subjects with rheumatoid arthritis (Kwolek et al., 2016) and diffuse connective tissue diseases (Usichenko & Herget, 2003), as well as significant improvements in joint stiffness for subjects with hand osteoarthritis when pairing EMT with AROM and resistive exercises (Kanat, Alp, & Yurtkuran, 2013). Subjects with arthritis reported experiencing significant improvement in mobility and pain after pulsed electromagnetic field therapy (Shaw et al., 2017). Currently, there are limited yet emerging studies to support this intervention.

Technology-assisted

Two studies examined the effect of mechanical devices for PROM and functional performance. Schwartz and Chafetz (2008) found that a continuous passive motion device may increase total active motion in subjects with tenolysis. However, its effect was no better than the conventional active range of motion exercises. Amaral et al. (2017) found the use of assistive technology (AT) for subjects with hand OA resulted in significant improvement in COPM scores of performance and satisfaction in their functional participation in meaningful occupations. These studies suggest technology-assisted therapy may have a positive impact on a patient's ability to return to meaningful occupations.

Orthoses

A randomized controlled study by Saito and Kaira (2016) on the use of a 2-step orthoses strategy for mallet finger resulted in improved DIP joint extension ROM, more so than a traditional orthosis protocol. Studies on the effectiveness of orthoses for reducing PIP/DIP joint stiffness were commonly found in the literature, but were mentioned as a well-known treatment protocol within practice of the project collaborator, therefore this review did not include articles describing typical use of orthoses to treat PIP/DIP stiffness.

Active Range of Motion and Resistive Putty Exercises

Evidence was found supporting the use of conventional AROM and resistive putty exercises for reducing edema and pain in 3/5 athletes with PIP joint stiffness.

Other

One study indicated delayed treatment of PIP joints leads to poor functional outcomes on subjects with PIP joint injuries (Roh et al., 2018) while another study examined how joint protection in addition to hand exercises increased hand function and grip strength (Stamm et al., 2002).

Summary of Outcome Studies

Technology-assisted

Gobbo et al. (2017) showed that robot assisted, passive hand joint mobilization alleviated stiffness, pain, spasticity, as well as increased hand function in patients' paretic hand joints post-stroke. However, more objective outcome

measures such as goniometry or standardized assessments should be used in addition to self-reports.

Summary of Qualitative Studies

No qualitative studies met the inclusion criteria.

Summary of Descriptive Studies

Descriptive studies provided support for using a variety of different preparatory methods and therapeutic modalities to decrease pain, adhesions, stiffness, and edema and increase A/PROM, stability, and desensitization in patients with PIP stiffness (Beasley et al., 2018; Douglass & Ladd, 2018; Hemsley, 2001; Valdes & Marik, 2010). Followed by traditional hand exercises and joint protection strategies, participants showed increased grip strength, function, ROM, as well as decreased pain (Beasley et al., 2018; Douglass & Ladd, 2018; Hemsley, 2001; Valdes & Marik, 2010). Lastly, appropriate adaptive equipment and orthotics may increase the functional ability of the hand with similar hand exercises and joint protection strategies.

Preparatory Methods and Modalities Reviewed:
A/PROM and putty strengthening exercises, retrograde massage, wound management, cryo/thermo/fluidotherapy, tendon gliding exercises, ultrasound, paraffin, contrast baths, neuromuscular electrical stimulation, continuous passive motion, buddy taping, static progressive/serial casting, and dynamic splinting/various orthoses.

Implications for Consumers

Consumers with hand injuries or pathologies that result in PIP and DIP joint tightness may experience a significant impact on their participation in meaningful activities and occupations. The results of this review suggest there may be beneficial protocols in existence that improve joint tightness as well as overall hand function, such as electromagnetotherapy and assistive technology. However, it is inconclusive which protocol is most effective due to insufficient evidence. Individuals with joint stiffness should continue to seek education on their injuries and course of rehabilitation and discuss the potential impacts of these interventions with their therapist.

Implications for Practitioners

Practitioners should be aware that there are a multitude of different treatment options for PIP/DIP joint stiffness described in the current research. These options include pairing A/PROM exercises with electromagnetotherapy, assistive-technology, and orthoses. There are various hand injuries and/or diagnoses that present with PIP/DIP stiffness as a symptom. These symptoms may impact daily activities in addition to being a social and psychological burden (Che Daud et al., 2016). Occupational therapists should be cautious in using these methods to achieve functional goals, because few studies measured functional outcomes. This allows occupational therapy's unique skill set to contribute to reduced PIP/DIP stiffness and increased quality of life for the client (Che Daud et al., 2016).

Implications for Researchers

Limited articles with varying levels of evidence and rigor specifically addressing our research question were found. Of these, few addressed functional outcomes of related measures. It is imperative that more rigorous studies examining the effect of PIP/DIP joint stiffness on engagement in functional activities/occupations are conducted, such research could provide evidence supporting occupation-based interventions in practice. Additionally, the few currently available studies on electromagnetotherapy and technology-assisted devices indicate its potential for reducing joint stiffness. As an emerging field, more studies with rigorous design are needed to demonstrate their immediate and long term effects on joint stiffness as well as functional outcomes.

Bottom Line for Occupational Therapy Practice/ Recommendations for Best Practice

There are limited yet emerging studies to support the use of several protocols in treating PIP/DIP stiffness. However, it is important to understand the client's individual needs and diagnosis to help the practitioners decide which treatment protocols to implement. DIP/PIP joint stiffness is a symptom of various diagnoses, therefore treatment for remediation is specific to the client's condition. However, through this search it was clear that there is not a definitive treatment method that is most effective for any one diagnosis. In other words, treatment of stiffness cannot currently be separated by diagnosis in the research. Additionally, there is little research to address protocols using functional interventions and functional outcomes for treatment of PIP/DIP stiffness. More evidence-based studies are needed in these areas to support the efficacy of occupation-based therapies.

Table Summarizing the *QUANTITATIVE* Evidence

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Schwartz & Chafetz 2008 *JHT* USA	Compare effective of Continuous Passive Motion (CPM) on pts post digital tenolysis/ capsulectomy w/limited TAM to those w/o CPM.	Nonrandomized, 2 grps/pre-post II E3 4/10	*N* = 36 (Tx = 15, m = 9; Ctrl = 21, m = 13) Incl: 1) dx of crush inj, metacarpal or phalanx fxs, tendon lacerations, jt inj, and/or jt contractures 2) open/closed reduction, tendon repair, and other proced Excl: 1) thumb inj 2) infection 3) jt fusion 4) digital nerve inj.	Tx: CPM daily w/ AROM/PROM exerc (10.21 wks; 25.7 visits) Ctrl: AROM exerc (11.42 wks; 18.54 visits) O= Goniometric TAM	-Both Tx and Ctrl experienced sig ↑ TAM. -No sig diff in TAM tx to ctrl (p = 0.29).	-Duration spent wearing CPM unknown -Lack of randomization

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Incl and Excl Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Hemsley 2001 *Athletic Therapy Today* USA	To identify non-surgical interv for hand inj incurred by athletes, examined through five descriptive case studies	Individual Case Studies IV D3	*N* = 5, 1 per case study 1) f, 15 yo, PIP jt contracture 2) m, 20 yo, spiral fx of 5th metacarpal 3) m, 21 yo, ulnar collateral lig partial tear 4) m, 19 yo, hook of hamate fx 5) f, 16 yo, TFCC tears incl: athletes excl: N/a	I= 1) Coban wrapping dist- prox, retrograde massage, dorsal splint block last 30° of ext for 3 mo, AROM PIP/DIP-ext & putty exerc = ↓ pain & edema, ↑ A/PROM 2) Coban wrapping, retrograde massage, Cryocuff, A/PROM & putty exerc = ↓ pain & edema, ↑ A/PROM 3) A/PROM & putty exerc, resting splint for 12 wks = returned to athletics 4) A/PROM exerc, scar massage, skin desensi = ↑ thumb stability & A/ROM, ↓ pain, edema, inflammation	A/PROM & putty exerc, retrograde massage, & orthoses contribute to ↓ pain & edema & ↑ A/PROM & stability in pts c̄ various hand injuries incurred through athletics	- incl/excl criteria of chosen case studies omitted -standardized assess data on pain, edema, hand fx not reported -outcome measures not clearly listed

				5) A/PROM & putty exerc, volar wrist splint, daily tendon gliding, retrograde massage, compression glove = ↑ pressure tolerance & A/PROM, ↓ pain, edema, sensitivity Outcome Measures: A/PROM exerc, edema measurement, pain and pressure tolerance		

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Gobbo et al. 2017 *BioMed Research Internat* Italy	Eval the immed effects of repetitive, robot-assisted hand PROM & acute effects on UE spasticity on subjects poststroke hemiparesis	Single-arm, pre-post study III O4	*N* = 23 (f = 10, m = 13) pts had subacute - chronic stroke severity M age: 60.4 ± 13.2 yo Incl: 1) first event of CVA 2) unilateral paresis 3) remain in sitting posture Excl: 1) bilateral impairment 2) cogn or behav dysf 3) finger flex contrac 4) neuropathic pain 5) inability to consent	I= Gloreha robotic system implemented passive jt mobil (isolated, pinch, synchronous) of pt paretic hand for 20 mins O= pts reported ↓ stiffness & UE heaviness in hand post-treatment; spasticity sig ↓ on MAS for wrist & fingers	Robot assisted, passive hand jt mobil alleviated stiffness, pain, & UE spasticity in hand & fingers for all participants, resulting in ↑ hand fx after one 20-min session Statistically sig improvements in spasticity and stiffness after tx in wrist (p = 0.001) and fingers (p = 0.004)	- no ctrl grp - pts not treated same hr each day - duration of symptom relief for pts not monitored after tx -tx intensity and duration inconsistent across participants -pt report as an outcome measure is weak in reliability and validity

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**

Douglass & Ladd 2018 *Hand Clinics* USA	To summarize lit surrounding available tx & modalities for PIP jt stiffness	Narrative Review V D4	*N* = 65 Articles from 1980 to 2016 Incl: n/a Excl: n/a	I= tendon gliding exerc, blocking splints, buddy taping, static progr/serial casting, dyn splinting, wound mgmt, scar mobil, edema ctrl, desensi, cryo/thermo/fluidotherapy, ultrasound, paraffin, contrast baths, NMES, CPM O: n/a	A/PROM exerc, orthoses, wound mgmt, edema cntl, modalities, & desensi tx ↓ stiffness, pain, adhesions, & edema of PIP jt & ↑ A/PROM & desensi	-lack of incl/excl criteria of selected articles -no descrip of participants in studies, demographic info, or cause of PIP inj -selection process of articles not explained -no outcome measures listed

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Saito & Kiara 2016 *JHT* USA	Compare 2-step orthosis method c̄ traditional tx of mallet finger	Randomized, 2 grp, pre-post test I E3 – E2 Prospective Controlled/ Randomized Clinical Trial	*N*=44 N=22 Ctrl N= 22 2-SO *n*= 26 m *n*= 18 f Incl: 1) diag Mallet finger c̄ or w/o fx 2) age 18+ 3) no contrain to orthosis immob for 6 or 12 wks. Excl: 1) open lesions 2) mallet fxs c̄ sublux of DIP 3) delayed tx for >2 wks	I= Ctrl: figure 8 orthosis c̄ DIP in hyperext worn 24 hrs/day, for 6 wks. 2-SO = orthosis c̄ PIP in flex & DIP in hyperext for 3 wks; then DIP in hyperext for 3 wks. Worn 24 hrs/day. Both: @ 6 wks AROM exerc for DIP, orthosis worn @ night & during finger exerc only. @ 8 wks, PROM for DIP, muscle strengthening, massage. @ 12 wks, use w/o restrictions on daily act.	@ 16 wks, extensor lag @ DIP was smaller for 2-SO grp than ctrl, c̄ effect size 2.20-3.67. 2-SO therefore associated c̄ ↑ improvement in ext ROM @ DIP. No sig. diff found btwn grps for all other measures.	-Incl only new cases so unknown impact on chronic mallet finger or bony origin of mallet finger.

				O=AROM of DIP flex & ext, VAS of pain, Abouna & Brown criteria.		
Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Roh et al. 2018 *JHT* Korea	Eval factors that influence outcomes of a specific intervention protocol for pts c̄ PIP jt inj that were treated conservatively.	Prospective Cohort II E3	*N* = 60 Incl: 1) conservative tx of PIP jt collateral lig inj btwn Sept 2013 & Oct 2015 Excl: 1) >1 finger inj 2) prior inj or abnormalities of cont hand 3) comorbid chronic pain condition 4) worker's compensation status	I= Buddy strapping of inj fingers (index, & middle or ring & little) worn continuously & 4 exerc protocols, 10 min each 5x/day for 3-4 wks. Exerc: 1. Making a fist 2. PIP & DIP flex into small fist 3. MCP flex & PIP/DIP ext 4. Finger abd.	Delayed tx sig associated c̄ poor fxnl outcomes (grip strength, stiffness, perceived disability). ↑ in age & inj severity associated c̄ ↓ grip strength up to 6 mo. F gender associated c̄ ↑ disability @ 3mo	-Only 1 questionnaire used to eval fx -Recording baseline data not possible, only internal ctrl for comparison. -Only 32% of variance in outcomes of the quickDASH scores were accounted for, meaning a number of other conditions related to hand fxn

				Measurements taken 3 & 6 mo post inj. Cont hand used as ctrl. O= finger TAM, grip strength, QuickDASH Factors assessed: age, sex, hand dominance, affected finger, type of inj, inj severity, time to tx, duration of buddy strapping, exerc training		were not measured in the study.

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Stamm et al. 2002 *Arthritis & Rheumatism* USA	Exam effect of jt protection & exerc on hand fxn of pts c̄ OA.	Randomized, 2 grps, pre-post test I E2	*N*=40 (tx = 20; m= 3, ctrl = 20; m = 2). Incl: OA Excl: 1) pts c̄ any rheumatic disease other than OA 2) elevated C-reactive protein levels 3) soft tissue swelling of the MCP, PIP, or DIP jts	I= Tx: JPE (instruction on protecting jts in addition to 7 hand exerc 10 x daily for 3 mo.) Ctrl: oral & written info about OA & a Dycem mat to use for opening jars, daily for 20 min. O= HAQ, pain and global hand fxn (VAS), grip strength	HAQ: no sig diff btwn grps VAS global hand fxn: sig greater gain in tx vs ctrl (p <.05) VAS pain: no sig diff btwn grps Grip: sig > in tx than ctrl grp (p <.05)	Retention of tx unknown Adherence to tx is self-reported

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Che Daud et al. 2016 *JHT* Malaysia	Exam effectiv of occupation-based interv (OBI) & therapeutic exerc (TE) for rehab of hand injs.	Randomized, 2 grps, pre-post test I	*N* = 40 (tx = 20; m=16, ctrl = 20, m=13) Incl: 1) bone, tendon, or peripheral nerve inj to hand, wrist, or forearm 2) not on any hand protocol 3) no commun or cogn deficits 4) able to read & write in Malay or Engl 5) consented to take part in the study Excl: 1) bilateral hand inj 2) brachial plexus, shoulder or elbow inj 3)	I = Tx: paraffin bath followed by 30 min OBI & 30 min TE 1x/wk for 4 wks (picking up small objects, typing on keyboard, & wiping/washing dishes & ROM/strengthening exerc) Ctrl: paraffin bath followed by 60 min TE only for 1x/wk for 4wks (ROM/strengthening exerc)	TAM: sig > in tx over ctrl grp (p = .01) COPM perfor & satisfaction: both grps ↑. Sig higher in tx than ctrl grp (p <.001) DASH: sig lower in tx than ctrl grp (p = .02) No sig diff found for other param.	Incl criteria is strict: the ability to read/write in Engl or Malay narrows the pool

			repetitive strain inj 4) burn inj	O= Fine & gross motor dexterity (Purdue Pegboard), TAM, grip strength, pinch strength, COPM, DASH		

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Kanat et al. 2013 *Complementary Therapies in Medicine* Turkey	Exam effectiv of magnetotherapy for hand OA.	Randomized, 2 grps, pre-post test I E2 6/10	*N*=50 (tx = 25; ctrl = 25) Incl: OA Excl: 1) oncologic problems 2) infectious d/o, metal implants 3) prev or existing hand fx	I= Tx: Magnetotherapy 10 days for 20 min/day c̄ AROM + resistive exerc for the hand Ctrl: sham magnetotherapy for 10 days for 20 min/day in addition to AROM + resistive exerc for the hand O= SF-36, pain (Likert scale), jt stiffness (Likert scale), Duruoz Hand OA Index, AUSCAN Hand OA Index, grip strength, pinch strength	Jt stiffness, pain, AUSCAN Hand OA, Duruoz Hand OA Index, & SF-36 in Pain, Social Fxn, & Vitality showed improvement in both grps. Sig more improvement in tx grp (p <.05) than the ctrl grp on all variables.	Lack of protocols for magnetotherapy such as dosing & freq

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence/**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Amaral et. al. 2017 *Rheumatology International* Germany	Eval the effectiveness of assistive technology (AT) devices as tx of HOA	RCT Randomized 2-grp, pre-post-test c̄ assessor blinding I E2 8/10	*N* = 39 interv = 19 ctrl = 20 Incl = dx of HOA, reported difficulty in ADLs Excl = surgical tx, hand infiltration, prev OT or PT, use of AT c̄ in 6 mo, dx of another rheumatic or musculoskeletal disease	Interv = 4 meetings c̄ guidelines on physiopathology, clinical aspect, tx for HOA, jt protection strategies, energy conservation guidelines. Then prescribed AT device, trained in use of AT device, used AT device for 3 mo. Ctrl = given guideline leaflet on HOA only	interv grp improved statistically significantly better on COPM perfor ($p \leq 0.05$) & satisfaction, and trends of greater improvement in occupational perfor, pain relief, & QoL.	More detail needed on type of AT Main researcher and pts not blinded No possibility to utilize placebo No accountability measure for AT use by pts in follow up period

Usichenko & Herget 2003 *European Journal of Pain* Germany	Eval pain relief effect of millimetre wave therapy (MWT) for tx of chronic jt pain for diffuse connective tissue diseases	Single grp Pre-Post test III O4	*N =12* (f = *9;* m=*3)* M age = *53.9* y/o Incl: diffuse connective tissue diseases in any region Excl: n/a	I: MWT 54-78 GHz on tender areas of the affected jts for 30-40 min per session, 5-10 sessions (median of 6). O: pain intensity (VAS), jt stiffness (5-point timescale), pt satisfaction (5 point rating scale)	Subjects reported sig ↓ in pain (p =.012), sig ↓ in jt stiffness (p = .008), and being satisfied post tx.	-small sample size -pilot study, need to be replicated c̄ a larger controlled study to measure effectiveness of MWT. -no excl criteria listed
Shaw et al. 2017 *Novel Techniques in Arthritis & Bone Research* Canada	Eval pulsed electromagnetic field therapy (PEMFT) on symptoms of arthritis such as pain, swelling, and immobility.	Single grp pre- post test IV O3	*N* = 5 (f=4; m=1) age = 60-72 yo Incl: OA recruited from a local chiropractor's office Excl: n/a	I: PEMFT: 2-30Hz 20 min daily, 2-3x weekly for 4 wks on affected area O: subjective rating of pain and immobility, ROM	3/5 subjects exp sig improvement in mobility, 4/5 subjects reported slight to sig reduc in pain & swelling.	Small # of N No excl criteria listed Pilot study, need to be replicated c̄ a larger controlled study No statistics listed

Kwolek et al. 2016 *Advances in Rehabilitation* Poland	Assess influence of static vs pulsed magnetic field on UL RA	Randomize, 2 grp, pre-post test I E2 6/10	*N* = 14 (f=10; m=4) *M* age = 57 yo (grp I = 8; grp II = 6) Incl: RA of the UL Excl: cardiovascular and respiratory system d/o	I: Grp I = 10 sessions of static magnetic field (MF-10) Grp II = 10 sessions of pulsed magnetic field @ 15 Hz O: severity & duration of morning stiffness, pain (VAS 0-100), disability level (HAQ-20), grip strength, hand volume, ROM of hand	Morning stiffness: No sig diff ↓ in *M* duration btwn grps (*p* >.05). Levels of Stiffness: *M* ↓ in severity levels. > ↓ in grp I than grp II, (*p* < *.05*). HAQ: No sig diff btwn grps in *M* outcome change (*p* >.05) VAS: ↓ in pain in both grps. No sig diff btwn grps (*p* >.05) Grip strength: Grp I no change (*p* > .05) & grp II exhibited ↑ in grip strength (*p* < .01). No sig diff btwn grps (*p* > .05). Hand volume: ↑ in volume in grp I (*p* =	Small # of *N* Duration (mins) of magnetic field tx not listed -Low study power, cannot draw conclusions about grip, pain, & stiffness

					.5014). Sig ↓ in volume in grp II (p < .01), sig diff btwn grps (p <.01). ROM: Grp I ↓ (p > .05), grp II ↑ (p =.0051),). Sig diff btwn grps (p <.01).	

Table Summarizing the *Meta-Analyses/Meta-Syntheses/Systematic Review* Evidence

Author, Year, Jrnl Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Number of Papers Included, Incl/ Excl Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Valdes & Marik 2010 *JHT* USA	Review existing lit on efficacy of conservative therapy techniques to treat OA of the hand.	Systematic Review I D1 Used SEQES and LOE to categorize articles.	*N*= 21 studies RCT's & cohort studies, Engl language, dx of OA, addressing conservative tx.	I= Heat or cold modalities, laser, jt protection, provision of adaptive device, orthotics. O: OL grip strength, pain VAS, Likert scale for pain, verbal rating scale 1-5 for pain, thumb & finger ROM, stiffness, Sollerman test of hand fx, Purdue pegboard, AMIS2, circum of fingers, dolorimeter, DASH, pt self-report, Health Assessment Questionnaire, Likert scale for fx, Cochin Hand Fx, AUSCAN, X-Ray, Green Test, Short form Health	Mod evid supp hand exer for ↑ grip strength, ↑ fxn ↑ ROM, ↓ pain Mod evid supp JPE & adaptive eq for ↑ fxn, ↓ pain. Weak evid supp parrafin for ↓ pain, ↑ ROM, ↑ fxn. Mod evid supp low cont heat wrap or steam tx for ↓ pain, ↑ grip strength. High/mod evid supp CMC orthotics for ↓ pain, ↑ fxn, mod ev. For ↑ grip strength.	-Mixed study types & strength of evidence makes it difficult to provide a solid concl about the protocols

				Survey, Moberg pick-up test, Dreiser functional index, topographic scoring.	Mod evid that laser tx if no better than placebo at ↓ pain, ↑ fxn.	
Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Number of Papers Included, Incl/ Excl Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Miller & Jerosch-Herold 2017 *JHT* UK	Review evid supp various hand edema tx on hand vol.	Meta-Analysis I E1	*N* = 10 studies Incl: Engl language, RCT's, or controlled trials, adults, recent UE musculoskeletal problem, CVA, post-surgery, active tx during subacute edema phase Excl: animal subjects, edema measured cellularly or visceral, edema due to pregnancy, measure acute or chronic edema only, medicinal product use, invasive methods.	I = kinesio taping, massage (retrograde & intermittent), normal fx. Use, strengthening, MLD, MEM, elevation, high-voltage pulsed ultrasound, cryo, NMS, positioning/orthosis, active/passive exerc, compression via string wrapping, isotoner glove, intermittent pneumatic, or Coban. O= circumferential (cm or mm), volumetry (mL) to quantify vol.	Low to mod evid supp combination of MEM & traditional tx. Little consensus in lit. on appropriate methods of traditional tx	Low to mod qual of studies.

Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Number of Papers Included, Incl/ Excl Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Beasley et al. 2018 *JHT* USA	Eval conservative therapeutic interv for the tx of OA finger jts.	Systematic review I DI Structured Effectiv for Qual Eval of a Study, level of evid, effect size.	*N* = 18 articles (dated 1979-2016; 5 databases) Incl: 1) arthritis dated 1979-2016 c̄ the PIP & DIP jts, IP jts of the thumb 2) adults ages 18+ 3) Engl language 4) published peer-reviewed empirical study Excl: 1) nonhuman subject 2) n/a to DIP, PIP, or IP jts 3) surgical cases 4) pharmaceutical studies 5) lack of conservative hand therapy interv	I= Thermal modalities (paraffin, balneotherapy c̄ & w/o magnetotherapy, & balneotherapy c̄ mud packs), low-level laser therapy, DIP orthosis, exerc (resistive, AROM, jt protection, exerc c̄ electromagnetic therapy), other (keyboarding, yoga, gloves) O=AUSCAN, Arthritis Self-efficacy Pain subscale, PSFS, pain, jt stiffness, pinch & grip	-mod qual evid for resistive hand exerc to ↑ grip strength & finger ROM. -high qual evid for electromagnetic therapy combined c̄ hand exerc (AROM & assistive) to ↓ pain & ↑ fxn. -high qual evid for hand exerc (AROM & resistive) combined c̄ jt protection to ↓ pain & ↑ activity perfor. - high qual evid for thermal modalities to ↓ pain & tenderness, ↑ grip & pinch strength, & hand fxn.	Incl of articles dated > 35 y/o (possibly outdated as tx protocols may have changed since 1979).

				strength, ROM, VAS, FIHOA	-mod to high qual evid for DIP orthoses to ↓ pain.	

Abbreviations:

A/PROM = active/passive range of motion
ADL = Activities of Daily Living
app = application
assess = assessment
behav = behavioral
btwn = between
$\overline{c}$ = with
cogn = cognitive
commun = communication
concl = conclusion
cont = continuous
contrain = contraindication,
COPM = Canadian Occupational Performance Measure
CPM = Continuous Passive Motion
cryo = cryotherapy
ctrl = control
CVA = cerebrovascular accident
d/o = disorder
DASH = Disability of Arm, Shoulder, and Hand
descrip = description
desensi = desensitization
diff = difference(s)
DIP = distal interphalangeal joint
dist = distal
dx = diagnosis
dyn = dynamic
effectiv = effectiveness
Engl = English
Eval = evaluate
evid = evidence
exam = examine
excl = exclusion
exerc = exercise
exp = experience
ext = extension
f = female
FIHOA = Functional Index for Hand OsteoArthritis
freq = frequency
fxn = function
fx(s) =fracture(s)
grp(s) = group(s)
HAQ = Health Assessment Questionnaire
HOA = hand osteoarthritis
hr = hour
immed = immediate
incl = inclusion
info = information
inj = injury
Intern Jrnl of Rheum Diseas = International Journal of Rheumatic Diseases
interv = intervention
JHT= Journal of Hand Therapy
JPE = joint protection and exercises
jt(s) = joint(s)
lig = ligament
limit = limitations
lit = literature
LOE = Level of Evidence
m = male
M = mean/average
Mand = Mandarin
MAS = Modified Ashworth Scale
MEM = manual edema mobilization
mgmt = management
min(s) = minute(s)
MLD = manual lymph drainage
mo = month
mobil = mobilization
mod = moderate
MWT = millimetre wave therapy
N = sample size
NMES = neuromuscular electrical stimulation

NMRT = nuclear magnetic resonance therapy
OA = osteoarthritis
OBI = Occupation-Based Intervention
occup activit = occupational activities
OT = occupational therapy
param = parameters
perfor = performance
phys dysf = physical dysfunction
PIP = proximal interphalangeal
prev = previous
proced = procedure
progr = progressive
prox = proximal
PSFS = Patient Specific Functional Scale
psychol = psychological
pt(s) = patient(s)
PT = physical therapy
QoL = quality of life
qual = quality
rec = recorded
rehab = rehabilitation
SEQES = Structured Evaluation of Study
SF-36 = Short Form-36
sig = significant
supp = supporting
TAM = Total Active Motion
TE = Therapeutic Exercises
TFCC = triangular fibrocartilage complex
tx = treatment
UL = upper limb
VAS = Visual Analog Scales
w/o = without
w/in = within
wks = weeks
yo = years old
yrs = year

References

Amaral, D. S., Duarte, A. L. B. P., Barros, S. S., Cavalcanti, S. V., Ranzolin, A., Leite, V. M. M., …Marques, C. D. L. (2017). Assistive devices: An effective strategy in non-pharmacological treatment for hand osteoarthritis: A randomized clinical trial. *Rheumatology International, 38*, 343-351. https://doi.org/10.1007/s00296-017-3892-1

Beasley, J., Ward, L., Knipper-Fisher, K., Hughes, K., Lunsford, D., & Leiras, C. (2018). Conservative therapeutic interventions for osteoarthritic finger joints: A systematic review. *Journal of Hand Therapy*, 0, 1-11. https://doi.org/10.1016/j.jht.2018.01.001

Che Daud, A. Z., Yau, M. K., Barnett, F., Judd, J., Jones, R. E., & Muhammad Nawawi, R. F. (2016). Integration of occupation based intervention in hand injury rehabilitation: A randomized controlled trial. *Journal of Hand Therapy, 29*(1), 30–40. https://doi.org/10.1016/j.jht.2015.09.004

Douglass, N. P., & Ladd, A. L. (2018). Therapy concepts for the proximal interphalangeal joint. *Hand Clinics, 34*, 289-299. https://doi.org/10.1016/j.hcl.2018.01.001

Gobbo, M., Gaffurini, P., Vacchi, L., Lazzarini, S., Villafane, J., Orizio, C., …Bissolotti, L. (2017). Hand passive mobilization performed with robotic assistance: Acute effects on upper limb perfusion and spasticity in stroke survivors. *BioMed Research International, 2017*, 1–6. https://doi.org/10.1155/2017/2796815

Hemsley, K. (2001). Rehabilitation of athletic hand injuries: Five case studies. *Athletic Therapy Today*, *6*(2), 19–24. https://doi.org/10.1123/att.6.2.19

Kanat, E., Alp, A., & Yurtkuran, M. (2013). Magnetotherapy in hand osteoarthritis: A pilot trial. *Complementary Therapies in Medicine, 21*, 603–608. https://doi.org/10.1016/j.ctim.2013.08.004

Kwolek, A., Zwolińska, J., Chojnacka, M., & Drużbicki, M. (2016). Influence of magnetic field parameters on therapy outcomes in patients with rheumatoid arthritis: Preliminary study. *Advances in Rehabilitation, 30*(2), 49–61. https://doi.org/10.1515/rehab-2015-0043

Miller, L. K., Jerosch-HeroldErlacher, L., C., & Sheepstone, L. (2017). Effectiveness of edema management techniques for subacute hand edema: A systematic review. *Journal of Hand Therapy*, *30*, 432–446. https://doi.org/10.1016/j.jht.2017.05.011

Roh, Y. H., Koh, Y. D., Go, J. Y., Noh, J. H, Gong, H. S., & Baek, G. H. (2018). Factors influencing functional outcome of proximal interphalangeal joint collateral ligament injury when treated with buddy strapping and exercise. *Journal of Hand Therapy*, *31*, 295–300. https://doi.org/10.1016/j.jht.2017.02.010

Saito, K., & Kihara, H. (2016). A randomized controlled trial of the effect of 2-step orthosis treatment for a mallet finger of tendinous origin. *Journal of Hand Therapy*, *29*, 433–439. https://doi.org/10.1016/j.jht.2016.07.005

Schwartz, D. A., & Chafetz, R. (2008). Continuous passive motion after tenolysis in hand therapy patients: A retrospective study. *Journal of Hand Therapy*, *21*, 261–267. https://doi.org/10.1197/j.jht.2007.12.004

Shaw, K., Symington, S., & Havas, M. (2017). Pilot study: Pulsed electromagnetic field therapy (PEMFT) alleviates symptoms of osteoarthritis. *Novel Techniques in Arthritis & Bone Research*, *1*(5), 1-8 Retrieved from https://juniperpublishers.com/ntab/NTAB.MS.ID.555571.php

Stamm, T. A., Machold, K. P., Smolen, J. S., Fischer, S., Redlich, K., Graninger, W., …Erlacher, L. (2002). Joint protection and home hand exercises improve hand function

in patients with hand osteoarthritis: A randomized controlled trial. *Arthritis & Rheumatism*, *47*(1), 44–49. https://doi.org/10.1002/art1.10246

Erlacher, L. (2002). Joint protection and home hand exercises improve hand function in patients with hand osteoarthritis: A randomized controlled trial. *Arthritis & Rheumatism*, *47*(1), 44–49. https://doi.org/10.1002/art1.10246

Usichenko, T. I., & Herget, H. F. (2003). Treatment of chronic pain with millimetre wave therapy (MWT) in patients with diffuse connective tissue diseases: A pilot case series study. *European Journal of Pain*, *7*(3), 289–294. https://doi.org/10.1016/S1090-3801(02)00125-8

Valdes, K., & Marik, T. (2010). A systematic review of conservative interventions for osteoarthritis of the hand. *Journal of Hand Therapy*, *23*, 334–351. https://doi.org/10.1016/j.jht.2010.05.001

Involvement Plan Proposal

Section I - Identification of Types of Knowledge Translation

Based on the findings of our research topic and discussion with our collaborator, our involvement plan implemented an informational booklet synthesizing current research-based interventions for several hand diagnoses and/or conditions that may cause distal interphalangeal and proximal interphalangeal joint capsule tightness. The use of this type of knowledge translation served to provide practitioners the current research on identified interventions and its effectiveness. One of the key components that will make it a successful tool is that the information explaining the research is concise, allowing the practitioner to quickly gain an understanding of a brief summary of relevant research.

Section II - Outline of Contextual Factors

Contextual factors that may have influenced the implementation of and adherence to the booklet were the individual personality or practice style factors of potential adopters across multiple departments, as our collaborator hopes to administer one manual to each of her department's three clinic sites in the future.

The potential adopters of this booklet were our collaborator, Tomi Johnson, and any members of her or her department's treatment team who provide hand therapy to a variety of patients. Factors such as awareness, knowledge/skill, attitudes, and concerns may have impacted their adoption and implementation of this booklet in that they could have been less ready to implement it in their own practice.

If hand therapy providers were not aware the manual exists, they would not reference it at the same rate of other providers, thus creating a potential gap in the consistency of healthcare services being administered across patients. Additionally, if the manual was not made to be user-

friendly, therapists may not have had a positive experience when using it, leading them to quickly discard the manual shortly after trying it.

If a potential adopter of the manual feels their current knowledge/skill is effective for providing relief for joint capsule stiffness, they may feel apprehensive towards a student-designed booklet that discusses any new interventions. Therefore, efforts were made to ensure the manual was not meant to replace a provider's experience or clinical judgment, but to allow for quick referencing of established interventions for both newer and seasoned therapists.

Section III – List of Tasks/Products

The overall product is an organized, cleanly bound manual that outlines several specific interventions based on the supported treatment options we found through our CAT research. This book was used as a reference for our collaborator and potentially related coworkers for quickly looking up evidence regarding an intervention and/or protocol. As such, the physical individual pieces of this project are outlined as follows:

1. Cover page
2. Table of contents
    a. Major sections include electromagnetotherapy, technology-assisted therapy, orthoses, edema treatment, preparatory methods, and occupation-based treatment.
3. Interventions and/or protocols
    a. Research surrounding the interventions were described
    b. Citations were provided that refer to the numbered reference section.
4. References
    a. Numbered to correspond to order of protocols
5. Review Outcomes of Implementation

a. Provided collaborator with survey to assess usage and effectiveness of the project

Section IV – Timeline

- March 11th - Submit involvement plan proposal
- April 8th - Draft of Booklet done with complete list of interventions and/or protocols, email to chair for feedback
- Once feedback/approval given from chair, email to collaborator for her feedback before printing
- April 19th - Meet with Collaborator to review product, make last minute changes if needed
- May 1st - Turn in use survey for chair feedback/approval
- May 3rd - Chair Returns booklet and use survey with feedback
- Week of May 6th - Final Defense (based on Chair's availability)
- May 6th - Email finished & approved booklet and use survey to collaborator
- May 7th - Poster turned in to Chair for approval
- May 8th - Proposed Skype Interview with collaborator, collaborator will return use checklist (IF AVAILABLE, if not then collaborator send feedback via email)
- May 8th - Information for Symposium Program Due
- May 10th - Chair Returns poster with feedback by end of day
- May 13th - Send Poster for Printing
- May 16th - Poster Symposium
- May 17th - Final Paper & Reflection

Section V – Evaluating Outcomes

We crafted a survey that we will distribute to our collaborator where we will ask her about the use of our project. Gaining such data provided us with a sense of whether the use of our project in actual practice was effective and beneficial for our collaborator and/or her coworkers. We included a scale for how strongly Tomi agrees with statements about the booklet, such as:

1. I would use this booklet in my setting
2. I find this booklet useful
3. I would recommend use of this booklet to my colleagues

Report on Knowledge Translation Activity

The student researchers initially decided upon providing the research collaborator a pamphlet that allowed readers to quickly and efficiently grasp the basis of the CAT project findings, with a brief overview of the current evidence regarding the interventions found within the literature. The pamphlet would be visually appealing and could be distributed to the collaborator's colleagues, coworkers, supervisors, students, and/or clients if anyone desired to read current evidence on interventions for PIP/DIP joint stiffness.

When this idea was presented to the research collaborator, she expressed a strong desire for a "protocol book" and not a pamphlet of our CAT findings. She prefered a protocol book with details of every intervention we found, step-by-step instructions, and recommendations for use during therapy with clients. She also wanted three copies of this book, one for herself and two to distribute to the other hand clinics at her place of employment. When asked what she would use the protocol book for, she expressed a desire to reference it for herself and others to guide clinical interventions with clients.

One of our concerns about the knowledge translation component of our project is that with such limited findings, we were unsure of how to translate our work with fidelity. Some of the issues we initially encountered was the ethical dilemma of making a protocol book based on low to moderate evidence of the interventions. By definition, a protocol book is meant to provide an understanding of the current standards of care. However, it was difficult to ethically create a book that may be distributed amongst clinicians and possibly outside of the clinic, based on sixteen articles that were not necessarily of strong evidence. In order to minimize liability and chances of clients/patients getting injured by following this protocol book, we decided to reformat our original book from instructional to more of a summary of our current literature

results of each intervention. By doing this, we can accurately present our findings and then allow the user(s) of our book to make their own decision on whether or not they want to explore more in depth about that specific intervention.

We acknowledge that there have been some barriers in creating this booklet and the outcome is not exactly what our collaborator originally requested. The outcome of the book consists of a summary of our research on the following interventions: electromagnetotherapy, technology-assisted therapy, orthosis, preparatory methods, active range of motion and resistive putty exercises, and occupation-based interventions. The book also briefly discusses hand conditions and/or diagnosis that may potentially benefit from the application of these interventions. Additionally, references and resources are provided with the interventions listed in case the user(s) is interested in learning more. The product is not meant to provide all the answers and does not make recommendations for choosing one strategy over another, but gives the clinician more information on the current available literature that may or may not support the listed interventions or protocols. The booklet is informative; however, practitioners should use their clinical judgement and expertise to make the final decision in treatment strategies.

Treating PIP & DIP Joint Capsule Stiffness

Compiled by Occupational Therapy Students at the University of Puget Sound
Chloe McNutt, OTS; Ciara Caldwell, OTS; & Nicole Nguyen, OTS

Spring 2019

TABLE OF CONTENTS

Disclaimer

This project was completed in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy at the University of Puget Sound. The treatment protocols listed are research-based, but all practitioners should use clinical reasoning and sound judgement to form intervention plans based on a client's specific client factors and performance abilities. This booklet is not meant to serve as a measure of standard practice, but rather a resource for further research into available intervention protocols.

Section 1: Electromagnetotherapy

Three studies using electromagnetic therapy (EMT) as the sole intervention reported decreased joint stiffness (measured by a self-reported scale) and pain (measured by a visual analog scale or 10 point likert scale) for subjects with arthritis (Shaw et al., 2017), rheumatoid arthritis (Kwolek et al., 2016) and diffuse connective tissue diseases (Usichenko & Herget, 2003). One study reported significant improvements in joint stiffness for subjects with hand osteoarthritis when pairing EMT with active range of motion and resistive exercises (Kanat, Alp, & Yurtkuran, 2013). Currently, there are limited yet emerging studies to support this intervention.

Conditions that may potentially benefit from EMT:

- Arthritis
- Diffuse connective tissue diseases
- Joint stiffness
- Joint Pain

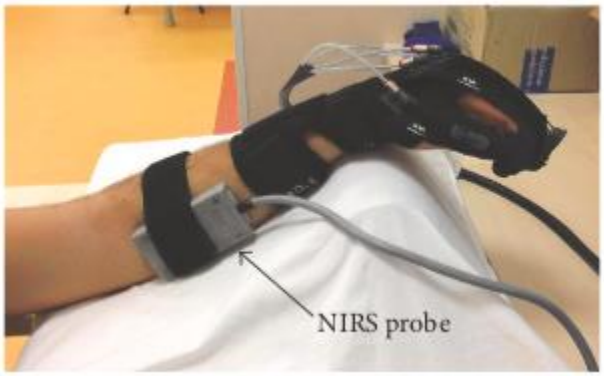
Additional resource:

More information on electromagnetic therapy can be found at DrPawluk.com. This resource can be used to help identify how to apply the device including information on duration, intensity, and frequency. Learn more about precautions, safety, and additional research related to the science behind the field and its current research on other conditions of the body:

https://www.drpawluk.com/education

Section 2: Technology-Assisted Therapy

Protocol: Gloreha Glove Mobilization



Robot Assisted Hand Mobilization Device
Gobbo et al., (2017)

Gobbo et al. (2017) showed that robot assisted, passive hand joint mobilization alleviated stiffness, pain, spasticity, as well as increased hand function in patients' paretic hand joints post-stroke. Outcomes were measured by the near-infared spectroscopy (NIRS) to evaluate blood flow to the forearm during mobilization. Additionally, the Modified Ashworth Scale (MAS) was used to monitor spasticity, and finally a self-report survey of sensation, stiffness, and pain. However, more objective outcome measures with stronger reliability related to joint mobility (such as goniometry) and sensation, as well as stronger validity should be implemented in addition to self-reports. Details of the use of the Gloreha Glove can be found in the article cited below.

Gobbo, M., Gaffurini, P., Vacchi, L., Lazzarini, S., Villafane, J., Orizio, C., … Bissolotti, L. (2017). Hand passive mobilization performed with robotic assistance: Acute effects on upper limb perfusion and spasticity in stroke survivors. *BioMed Research International*, *2017*, 1–6. https://doi.org/10.1155/2017/2796815

Protocol: Continuous Passive Motion (CPM) Device

Schwartz and Chafetz (2008) found that a continuous passive motion device may benefit subjects with tenolysis in increasing total active motion. However, its effect was no better than the conventional active range of motion exercises. Therefore, CPM can also be an effective alternative treatment method for remediating PIP/DIP Joint Capsule Tightness that results from other hand injuries or surgical repairs. Practitioners should be aware that there is no current research that supports the use of CPM instead of traditional AROM, therefore use of CPM should be approached with further inquiry on the potential benefits or disadvantages for a specific client's needs, abilities, and and resources of the practice.

OrthoRehab has also created a list of specific protocols for using CPM after surgical repair of many different injuries. The document can be found at this link: http://qalmedical.com/wp-content/uploads/sites/28/2013/08/CPM-Benefits-and-Protocols.pdf

Protocols associated with the following injuries as described by OrthoRehab may be of particular use for PIP/DIP joint capsule stiffness:

- Flexor tendon tenolysis
- Flexor tendon laceration repair
- Dupuytrens contracture release
- PIP Joint capsulectomy
- Digital Burns
- Digital Joint Arthroplasty: PIP
- Crush Injuries of the Hand

Schwartz, D. A., & Chafetz, R. (2008). Continuous passive motion after tenolysis in hand therapy patients: A retrospective study. *Journal of Hand Therapy*, *21*, 261–267.

Section 3: Orthoses

Protocol: 2-Step Method for Treatment of Mallet Finger

Saito and Kihara (2016) compared an alternative splinting procedure with figure of eight orthosis to treat 40 individuals with Mallet finger. Their study showed their protocol significantly improved extensor lag, stiffness, AROM in flexion & extension, and pain as measured by the visual analog scale (VAS). The protocol involves splinting the finger in a preliminary position of DIP mildly extended and PIP in 30 degrees of flexion for 2-3 weeks, then altering the splint for the remaining 3-4 weeks of recovery so that the DIP is mildly extended and the PIP is free to move. Details and photos of the protocol can be found in the article cited below in the Journal of Hand Therapy.

Saito, K., & Kihara, H. (2016). A randomized controlled trial of the effect of 2-step orthosis treatment for a mallet finger of tendinous origin. *Journal of Hand Therapy*, *29*, 433–439. https://doi.org/10.1016/j.jht.2016.07.005

Section 4: Preparatory Methods/Modalities

Research (Douglass & Ladd, 2018) showed that cryotherapy, thermotherapy, fluidotherapy, ultrasound, paraffin, and contrast baths decrease stiffness, pain, adhesions, and edema in PIP joints. Evidence (Valdes & Marik, 2010) was found supporting the use of paraffin wax for decreasing pain and increasing ROM and function in clients with osteoarthritis and low continuous heat wrap or steam treatment for reducing pain and increasing grip strength. Many high-quality studies (Beasley, et al. 2018) provided qualitative evidence supporting thermal modalities (paraffin, balneotherapy with and without magnetotherapy, & balneotherapy with mud packs) for reducing pain and tenderness and increasing grip/pinch strength and hand function in participants with arthritis in DIP, PIP, and IP joints.

Some protocol options for thermotherapy/cryotherapy/modalities can be found in the online publication **"Therapeutic Modalities" by the *American Academy of Physical Medicine and Rehabilitation*** (url: https://now.aapmr.org/therapeutic-modalities)

Some protocol options for balneotherapy can be found in the online publication **"Balneotherapy"**, a compilation of research publications supporting various hydrotherapies. Url: **https://www.sciencedirect.com/topics/medicine-and-dentistry/balneotherapy**

Beasley, J., Ward, L., Knipper-Fisher, K., Hughes, K., Lunsford, D., & Leiras, C. (2018). Conservative therapeutic interventions for osteoarthritic finger joints: A systematic review. *Journal of Hand Therapy*, 1-11. https://doi.org/10.1016/j.jht.2018.01.001

Douglass, N. P., & Ladd, A. L. (2018). Therapy concepts for the proximal interphalangeal joint. *Hand Clinics, 34*, 289-299. https://doi.org/10.1016/j.hcl.2018.01.001

Valdes, K., & Marik, T. (2010). A systematic review of conservative interventions for osteoarthritis of the hand. *Journal of Hand Therapy*, *23*, 334–351. https://doi.org/10.1016/j.jht.2010.05.001

Section 5: Conventional AROM and Resistive Putty Exercises

Hemsley (2001) found evidence supporting the use of AROM and resistive putty exercises for reducing edema and pain in 3/5 athletes with PIP joint contracture, spiral fracture of 5th metacarpal, or hook of hamate fracture.

Some protocol options for AROM/resistive putty exercises can be found in the patient education/online publication **"Thera-Putty Exercises" by The Ohio State University Wexner Medical Center** (2018). Url: https://patienteducation.osumc.edu/Documents/thra-put.pdf

Hemsley, K. (2001). Rehabilitation of athletic hand injuries: Five case studies. *Athletic Therapy Today*, *6*(2), 19–24. https://doi.org/10.1123/att.6.2.19

Section 6: Occupation-Based Interventions (In combination with other interventions)

One study examined the effects of incorporating Occupation-Based Interventions combined with use of paraffin bath and therapeutic exercises (passive, active, active assisted and strengthening activities) compared to paraffin bath and therapeutic exercises alone for 46 clients with various hand injuries (Che Daud et al., 2016). Participants in the experimental group were found to have significantly more improvement in total active motion and reduction of pain on the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire in comparison to the control group. Participants in the experiment group engaged in purpose activities such as picking up everyday small objects, typing on the keyboard, and wiping/washing dishes and then asked to perform these tasks during occupations for daily living.

Examples of purposeful activities that can be used in various occupations:

- Typing on a keyboard to send emails for work and school
- Wiping/washing dishes after having a meal
- Cutting food/meal preparation to make dinner for the family
- Playing cards at the weekly Poker Club

Therapeutic Benefits:

- Range of motion
- Fine motor
- Dexterity
- Reaching and pinching
- Hand manipulation
- Finger Isolation
- Hand/finger strength
- Bilateral coordination

References

Che Daud, A. Z., Yau, M. K., Barnett, F., Judd, J., Jones, R. E., & Muhammad Nawawi, R. F. (2016). Integration of occupation based intervention in hand injury rehabilitation: A randomized controlled trial. *Journal of Hand Therapy*, *29*(1), 30–40. https://doi.org/10.1016/j.jht.2015.09.004

Gobbo, M., Gaffurini, P., Vacchi, L., Lazzarini, S., Villafane, J., Orizio, C., …Bissolotti, L. (2017). Hand passive mobilization performed with robotic assistance: Acute effects on upper limb perfusion and spasticity in stroke survivors. *BioMed Research International*, *2017*, 1–6. https://doi.org/10.1155/2017/2796815

Kanat, E., Alp, A., & Yurtkuran, M. (2013). Magnetotherapy in hand osteoarthritis: A pilot trial. *Complementary Therapies in Medicine*, *21*, 603–608. https://doi.org/10.1016/j.ctim.2013.08.004

Kwolek, A., Zwolińska, J., Chojnacka, M., & Drużbicki, M. (2016). Influence of magnetic field parameters on therapy outcomes in patients with rheumatoid arthritis: Preliminary study. *Advances in Rehabilitation*, *30*(2), 49–61. https://doi.org/10.1515/rehab-2015-0043

Li, L., & Annaswamy, T. M. (2016). Therapeutic modalities. *American Academy of Physical Medicine and Rehabilitation*. Retrieved from https://now.aapmr.org/therapeutic-modalities/

OrthoRehab. (2002). *CPM benefits and protocols*. Retrieved from http://qalmedical.com/wp-content/uploads/sites/28/2013/08/CPM-Benefits-and-Protocols.pdf

Pawluk, W. (n.d.). *PEMF education*. Retrieved from https://www.drpawluk.com/education/

Saito, K., & Kihara, H. (2016). A randomized controlled trial of the effect of 2-step orthosis treatment for a mallet finger of tendinous origin. *Journal of Hand Therapy*, *29*, 433–439. https://doi.org/10.1016/j.jht.2016.07.005

Schwartz, D. A., & Chafetz, R. (2008). Continuous passive motion after tenolysis in hand therapy patients: A retrospective study. *Journal of Hand Therapy*, *21*, 261–267.

Shaw, K., Symington, S., & Havas, M. (2017). Pilot study: Pulsed electromagnetic field therapy (PEMFT) alleviates symptoms of osteoarthritis. *Novel Techniques in Arthritis & Bone Research*, *1*(5), 1-8. Retrieved from https://juniperpublishers.com/ntab/NTAB.MS.ID.555571.php

Usichenko, T. I., & Herget, H. F. (2003). Treatment of chronic pain with millimetre wave therapy (MWT) in patients with diffuse connective tissue diseases: A pilot case series study. *European Journal of Pain*, *7*(3), 289–294. https://doi.org/10.1016/S1090-3801(02)00125-8

Survey of Booklet

By: Ciara Caldwell, Chloe McNutt, and Nicole Nguyen

Please mark the degree to which you agree with each provided statement. The bottom of the survey can be used for any comments you have about the final product or the entire process.

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I would use this booklet in my setting.					
I find this booklet useful.					
I would recommend use of this booklet to my colleagues.					
The booklet is easy to read.					
The booklet met my expectations as a collaborator with UPS.					
The booklet is inclusive of current therapeutic interventions.					

Please describe how this booklet was useful or how it could be improved:

Additional comments:

Outline of Due Dates

The timeline of due dates for the various components of the project were outlined in the involvement plan proposal above. However the planned dates did not align with how the project was actually completed. On 4/15, when we received feedback from our Chairperson on our final version some flaws in the concept of the protocol book were brought to light. Our chair voiced concerns surrounding liability of the original design of the protocol book which was much more detailed in its description of the experimental treatments outlined in the research. Once this was discussed with the collaborator, the group made the decision to change the direction of the involvement plan project, keeping the booklet strictly to a presentation of research rather than a prescription of various methods for treatment in order to more accurately and safely reflect the material from the CAT.

Planned Dates	**Actual Completion**
March 11th: Submit involvement plan proposal	Turned in March 10th, received feedback on March 15th.
April 8th: Draft of Booklet done with complete list of protocols, email to chair for feedback	Turned in April 8th, received feedback on April 15th.
April 19th: Meet with Collaborator to review product, make last minute changes if needed	Meeting with collaborator canceled as discussed by Mentor and Chair.
May 1st: Turn in use survey for chair feedback/approval	Turned in May 1st, approved.
Week of May 6th: Final Defense (based on Chair's availability)	Scheduled for May 16th
May 6th: Email finished & approved booklet and use survey to collaborator	Turned in May 6th
May 7th: Poster turned in to Chair for approval	Turned in May 6th
May 8th: Proposed Skype Interview with collaborator, collaborator will return use checklist (IF AVAILABLE, if not then collaborator send feedback via email)	Booklet approval on May 13th

May 8th: Submit Final Paper (Draft)	Turned in May 8th, feedback received May 12th
May 8th: Information for Symposium Program Due	Abstract approved
May 10th: Chair Returns poster with feedback by end of day	Poster approved May 13th
May 13th: Send Poster for Printing	Poster sent for printing May 13th
May 16th: Poster Symposium	
May 17th: Final Paper & Reflection	

Statement of Outcome Monitoring Process

To measure the outcomes of our knowledge translation product, we created a survey to measure the usage and efficacy of our product by our collaborator. In our initial discussion about the topic, Tomi expressed that while her clinic uses several interventions for treating DIP/PIP joint capsule tightness she would be interested in discovering new and/or more effective ways. We acknowledge that our book is more so informational and a synthesis of research results, rather than instructional and protocol-based. As a result, the outcome we are monitoring is not whether the interventions we found were effective for our collaborator's clients but rather to monitor if our product was essential in providing knowledge to the clinician about the new and/or existing interventions. No survey was given in the initial stages to monitor the current level of knowledge regarding interventions, therefore we are not able to measure change pre and post knowledge translation of our product.

We anticipated that the outcome monitoring process could take up to 2-3 weeks in order to allow time for Tomi to review/use our product and then to complete the survey. Whether or not Tomi has the opportunity to review the booklet within the first two weeks is out of our control, rationalizing why we believe it should be extended to 2-3 weeks. Ideally, we want her to be able to show her colleagues the book and to ask for their opinions on the quality. She may also refer to the booklet more or less depending on the caseload she has and the presentation her clients have. At the end of her review, a survey will ask her to rate the quality of the book and to provide any additional comments she feels could use improvement.

Evaluation of Outcomes (2-4 pages)

Due to time constraints, evaluation of outcomes will not be documented.

Analysis of Overall Process of Entire Project

The process of completing this CAT project and designing a "protocol book" per our research collaborator's request has been both informative and challenging. Early successes in the research process include how the three student researchers established effective communication with one another, allowing them to consistently follow-up with each other while revising their first 47-page CAT paper. The student researchers also worked together frequently to organize individual academic, professional, and personal responsibilities to meet the needs of the research timeline and meetings with their chair, mentor, and collaborator. The student researchers were aided in this research process by their chair, Chih-Huang Yu, PhD, OTR/L, who gave insight to the publication process of research articles and challenged our critical thinking during the entirety of the CAT table organization, categorization, and design.

Challenges during the completion of this project began at the inception of the CAT paper, when the student researchers discovered a significantly limited presence of evidence-based research to answer the research question posed to them by their research collaborator: "What are the existing rehabilitation protocols for reducing DIP/PIP joint capsule stiffness to improve function, either directly or indirectly, and how do they compare to each other in practicality and efficacy?" Due to the limited number of databases available through the University of Puget Sound, there was a significant amount of time spent at University of Washington in order to access other available databases. However, even with an extensive list of key search words and access to other databases, the available peer-reviewed articles that addressed the research

question remained narrow. As a result, sixteen low to moderate strength publications were collected from a variety of databases to build a CAT table that provided the research collaborator with recommendations and insight for answering her research question.

The student researchers were originally requested to design a “protocol booklet” for all identified protocols for treating PIP/DIP joint capsule stiffness in a variety of clientele for the research collaborator to both use herself and distribute to three hand therapy clinics where her colleagues work. After much discussion regarding liability issues for the students, a booklet with some protocol information (based on the CAT research findings) was produced as the final product served to meet the needs of the research collaborator with a disclaimer that it should not be used in place of professional judgment and clinical reasoning when treating clients.

The overall process was informative in that it provided student researchers frequent opportunities to think critically, dissect information from a considerable amount of published research to identify relevant and evidence-based knowledge, and how to communicate professionally and efficiently with multiple contributors to this project. Each student researcher feels more skilled in collecting evidence-based research, thinking critically about the knowledge contained in published work, and how to translate this knowledge appropriately to others, including clients, during their future as an entry-level occupational therapy practitioner.

Recommendations For Follow-Up Project

The student researchers recommend any follow-up projects to this one be focused on the efficacy and evidence behind one intervention or designate one diagnosis to research effective protocols. It is difficult finding a considerable amount of strong evidence to support one intervention for reducing PIP/DIP joint stiffness across a variety of diagnoses, as the current collection of evidence keeps all protocol recommendations quite superficial and broad.

Occupational therapy practitioners must keep in mind that treatment should be client-centered in order to meet each individual's unique needs. Although one type of intervention could prove successful to a particular client, it may not equally meet the needs of another client. Future student researchers may have more success during their research process if they can identify effective interventions for one diagnosis that results in PIP/DIP joint stiffness, or research the evidence supporting a frequently used or new/emerging treatment.

Future student researchers and their collaborator on this topic may even benefit from expanding their evidence collection to qualitative studies and understanding how individuals' function is impacted due to limited upper extremity function from stiffness or other symptoms. This may provide a foundation for client-centered recommendations for occupational therapists and give readers more meaningful insight as to how clients are specifically limited with regards to function and occupational performance.

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