

**The Status of Lymphology
Education and Practice in Physical Therapy**

by

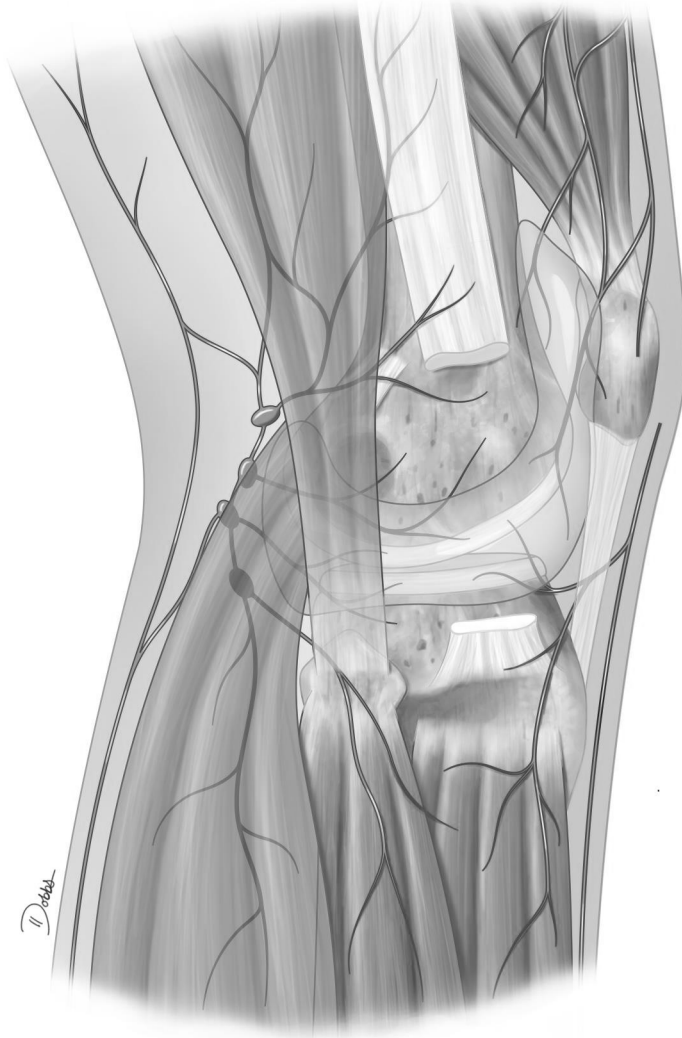
David Aaron Doublestein

**This dissertation is submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Physical Therapy)
At the University of Michigan-Flint**

August 25, 2021

Doctoral Committee:

| | | |
|--|--|-----------------------------|
| Associate Professor Cathy Larson, Co-chair | <i>Cathy A. Larson</i> _____ Signature | 09/13/2021 _____ Date |
| Associate Professor Amy Yorke, Co-chair | <i>Amy Yorke</i> _____ Signature | 09/13/2021 _____ Date |
| Professor Allon Goldberg | <i>Allon Goldberg</i> _____ Signature | 09/13/2021 _____ Date |
| Assistant Professor Bryan Spinelli, Thomas Jefferson University | <i>Bryan Spinelli</i> _____ Signature | 09/13/2021 _____ Date |



David Aaron Doublestein

ddouble@umich.edu

© David Aaron Doublestein 2021

DEDICATION

Dedicated to my father, who has inspired me to act justly, love mercy, and walk humbly with my God. To my mother, who has inspired me to be passionate about the human body and healthcare and has enveloped me in her management of breast cancer-related lymphedema.

ACKNOWLEDGEMENTS

By faith, I extend my deepest gratitude to my Heavenly Father who has walked beside me every day, encouraging me, providing peace, providing a firm foundation, and extending hope when this pilgrimage encountered many obstacles.

My wife. My perfect love. My Marty L. Doublestein. As I try to pen these words my soul weeps to express my love and gratitude for such a patient and uplifting godly woman. She have proven to be a rock that I could anchor to, while also being the wind within my sail that moved me forward. Her selfless sacrifices for my professional gains is unfathomable for even the most gracious of women. Solomon perfectly states, “An excellent wife who can find? She is far more precious than jewels. The heart of her husband trusts in her, and he will have no lack of gain. She does him good and not harm, all the days of her life.” – Proverbs 31:10-12.

The completion of this dissertation would not have been possible without the expertise of my co-chairs Dr. Cathy Larson and Dr. Amy Yorke, who have provided countless hours of reading, editing, counsel, and advising throughout this rigorous journey. I extend immense gratitude to my co-chairs for their dedication and perseverance into the investment of my knowledge, wisdom, and future. Dr. Goldberg and Dr. Spinelli complete a wonderful dissertation team which has challenged me toward new depths of scholarship. I am grateful for their contribution and for the cohesiveness of the dissertation team which advanced this dissertation despite the challenges and consequential rigor. I am mindful of Mohammed, the cohort of this second class of Ph.D. in Physical Therapy, who has remained true through this venture. I am grateful to have attended the University of Michigan–Flint, which has provided me staff and colleagues, ample resources, and research tools to actualize this doctor of philosophy. Christina Wixson has provided accurate administrative assistance to all involved and has helped facilitate the academic process. Amalie Helms and Li Morrow have been gracious assisting me in my research endeavors.

I also acknowledge my son Joshua and daughter-in-law Kaitlyn, family, and friends who have frequently inquired on my status, provided encouragement, and have prayed a warrior’s prayer multiple times over these years. A special thanks to my daughter, Jessica, who personally sacrificed and loved on her Daddy as he pursued his calling from God.

SUBJECT CATEGORIES

Education

| | |
|-----------------------------|------|
| Continuing Education | 0651 |
| Curriculum Development..... | 0727 |
| Health Education | 0680 |
| Higher Education..... | 0745 |
| Science Education | 0714 |

Health and Medical Sciences

| | |
|------------------------|------|
| Health Sciences | 0566 |
| Oncology..... | 0992 |
| Physical Therapy | 0382 |

TABLE OF CONTENTS

| | |
|---|---------------|
| <i>DEDICATION</i> | <i>ii</i> |
| <i>ACKNOWLEDGEMENTS</i> | <i>iii</i> |
| <i>SUBJECT CATEGORIES</i> | <i>iv</i> |
| <i>LIST OF TABLES</i> | <i>viii</i> |
| <i>LIST OF FIGURES</i> | <i>ix</i> |
| <i>LIST OF APPENDICES</i> | <i>x</i> |
| <i>PUBLICATION STATUS</i> | <i>xi</i> |
| <i>LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS*</i> | <i>xii</i> |
| <i>BROAD ABSTRACT</i> | <i>xiv</i> |
| | |
| CHAPTER I | - 1 - |
| BROAD INTRODUCTION | - 1 - |
| REFERENCES | - 8 - |
| | |
| CHAPTER II | - 10 - |
| Faculty Survey on the Status of Lymphology Education in Professional Doctor of Physical Therapy Programs | - 10 - |
| ABSTRACT | - 11 - |
| INTRODUCTION | - 12 - |
| METHODS..... | - 14 - |
| RESULTS..... | - 16 - |
| DISCUSSION AND CONCLUSIONS | - 17 - |
| DISCLOSURES | - 22 - |
| ACKNOWLEDGEMENTS | - 22 - |
| REFERENCES | - 23 - |

CHAPTER III..... - 44 -

**Effects of Manual Lymphatic Drainage Techniques on Conditions Affecting the
Musculoskeletal System: A Systematic Review - 44 -**

 ABSTRACT - 45 -

 INTRODUCTION - 46 -

 OBJECTIVES..... - 47 -

 SEARCH STRATEGY - 47 -

 ELIGIBILITY CRITERIA - 48 -

 DATA EXTRACTION - 48 -

 RESULTS..... - 49 -

 DISCUSSION..... - 53 -

 CONCLUSIONS - 54 -

 FUNDING - 55 -

 REFERENCES - 56 -

CHAPTER IV..... - 72 -

**Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer
Survivors with Breast Cancer Related Lymphedema - 72 -**

 ABSTRACT - 73 -

 INTRODUCTION - 74 -

 METHODS..... - 76 -

 RESULTS..... - 80 -

 DISCUSSION..... - 84 -

 LIMITATIONS..... - 91 -

 CONCLUSIONS - 91 -

 REFERENCES - 93 -

CHAPTER V..... - 165 -

Discussion of the Dissertation..... - 165 -

 OVERVIEW..... - 166 -

 SUMMARY OF STUDY RESEARCH DESIGNS AND RESULTS..... - 167 -

 SUMMARY OF RESULTS..... - 170 -

 LIMITATIONS OF THE DISSERTATION..... - 173 -

 FUTURE RESEARCH..... - 174 -

 DISSERTATION CONCLUSIONS..... - 177 -

 REFERENCES..... - 179 -

APPENDICES..... - 181 -

LIST OF TABLES

| | |
|---|-----|
| II.1. Characteristics of Faculty Survey Respondents | 30 |
| II.2. Characteristics of Respondents Responsible and Not Responsible for Teaching Lymphatic Content Within a Professional DPT Program | 31 |
| II.3. Hours of Lecture and Lab Education Devoted to Anatomy and Physiology, Pathophysiology and Examination | 32 |
| II.4. Descriptive Data on Hours of Lecture and Lab Professional DPT Education for Lymphatic Interventions..... | 33 |
| III.1. Characteristics of the Seven Included Studies | 62 |
| III.2. Summary of Key Findings..... | 63 |
| III.3. Summary of Qualitative Assessments | 65 |
| IV.1. Oncology Section Breast Cancer EDGE Task Force Upper-Quadrant Lymphedema Guideline, and Dutch Lymphedema Guideline Recommended Outcome Measures | 98 |
| IV.2. Demographic Characteristics | 100 |
| IV.3. Practice Characteristics..... | 102 |
| IV.4. Group Differences in Use of Outcome Measures in the 3 rd and 4 th Quartiles that Measure ICF Domains of Body Functions and Body Structures | 104 |
| IV.5. Group Differences in Use of Outcome Measures in the 3 rd and 4 th Quartiles that Measure ICF Domains of Activities and Participation | 106 |
| IV.6. Outcome Measures Divided in Quartile Probability Distributions | 107 |
| IV.7. Multicollinearity of Independent Variables | 110 |
| IV.8. Facilitators and Barriers to Use of Outcome Measures..... | 111 |
| IV.9. Group differences for Facilitators and Barriers to Use of Outcome Measures | 113 |
| IV.10. Unique Predictors of Use of Outcome Measures | 114 |

LIST OF FIGURES

| | |
|---|----|
| II.1. Frequency of Respondents Rating Didactic Material as Non-Entry-Level, Not Sure, and Entry-Level | 26 |
| II.2. Frequency of Respondents Rating Intervention Material as Non-Entry-Level, Not Sure, and Entry-Level | 28 |
| III.1. PRISMA Flow Diagram | 60 |

LIST OF APPENDICES

| | |
|--|-----|
| II.A. Survey on Lymphology Education in Professional Doctor of Physical Therapy Programs | 34 |
| III.A. Inclusionary Terms and Examples of Key Word Combinations | 68 |
| III.B. Operational Criteria of the PEDro Scale..... | 69 |
| III.C. Operational Definitions of GRADE’s Four Levels of Evidence | 70 |
| III.D. Operational Definitions of ACCP | 71 |
| IV.A. Survey on Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer Survivors with Breast Cancer-Related Lymphedema | 115 |
| V.A. Institutional Review Board Letters of Determination..... | 182 |
| V.B. PEERS Certifications | 185 |
| V.C. Use of Copyrighted Material | 186 |
| V.D. Conflict of Interest Declaration | 187 |

PUBLICATION STATUS

Study II. Doublestein DA, Larson CA, Yorke AM, Larson CA. Faculty survey on the status of lymphology education in professional doctor of physical therapy programs. *Rehabil Oncol.* 2021;39(3):58-66.

Study III. Doublestein D, Sublett S, Huang M. Effects of Manual Lymphatic Drainage Techniques on Conditions Affecting the Musculoskeletal System: A Systematic Review. *Orthop Phys Ther Pract.* 2020;32(2):92-101.

Study IV. Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer Survivors with Breast Cancer-Related Lymphedema Not Submitted

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS*

*In order of appearance

| | |
|--|--------|
| American Physical Therapy Association..... | APTA |
| Physical Therapist | PT |
| Doctor of Physical Therapy | DPT |
| Manual Lymphatic Drainage Techniques..... | MLdT |
| Range of Motion..... | ROM |
| Certified Lymphedema Therapists | CLTs |
| Breast Cancer Survivors | BCS |
| Breast Cancer-Related Lymphedema | BCRL |
| American Lymphoedema Framework Project | ALFP |
| Commission on Accreditation in Physical Therapy Education..... | CAPTE |
| National Physical Therapy Examination | NPTE |
| Protection, Rest, Ice, Compression, Elevation..... | PRICE |
| Mean Difference..... | MD |
| Confidence Interval | CI |
| Board of Directors | BOD |
| Outcome Measures | OMs |
| Evidence-Based Practice..... | EBP |
| Teaching Lymphology Content..... | TL |
| Not Teach Lymphology Content..... | NTL |
| Federation of State Boards of Physical Therapy | FSBPT |
| Department of Physical Therapy and Human Movement Science..... | DPTHMS |
| University of Southern California | USC |
| Statistical Package for the Social Sciences | SPSS |
| Standard Deviation | SD |
| Complete Decongestive Therapy | CDT |
| Deep Vein Thrombosis..... | DVT |
| Lymphology Association of North America..... | LANA |
| Quality of Life..... | QOL |
| Health Care Utilization | HU |
| Preferred Reporting Items for Systematic Reviews and Meta-Analysis | PRISMA |
| Physiotherapy Evidence Database..... | PEDro |
| Cumulative Index to Nursing and Allied Health Literature..... | CINAHL |

LIST OF ABBREVIATIONS, ACRONUMS, AND SYMBOLS – continued*

*In order of appearance

| | |
|---|-------------------|
| Manual Edema Mobilization..... | MEM |
| Oxford Centre for Evidence-based Medicine | OCEBM |
| Randomized Control Trial Study | RCT |
| Grading of Recommendations, Assessment, Development, and Evaluation..... | GRADE |
| American College of Chest Physicians..... | ACCP |
| Traditional Edema Management Techniques..... | TEM |
| Visual Analog Scale | VAS |
| Minimal Clinically Important Difference | MCID |
| Total Knee Arthroplasty | TKA |
| Nurses | RN |
| Athletic Trainers..... | ATC |
| Evaluation Database to Guide Effectiveness | EDGE |
| World Health Organization..... | WHO |
| International Classification of Functioning, Disability, and Health..... | ICF |
| Occupational Therapist..... | OT |
| Massage Therapist..... | MT |
| Health-related quality of life | HRQOL |
| Item-Level Content Validity Index | I-CVI |
| Active Range of Motion..... | AROM |
| Manual Muscle Test | MMT |
| Lymphedema Life Impact Scale..... | LLIS |
| Quick-Disabilities of the Arm, Shoulder, and Hand..... | <i>Quick</i> DASH |
| Upper Quadrant | UQ |
| Disabilities of the Arm Shoulder, and Hand..... | DASH |
| Upper Extremity | UE |
| Passive Range of Motion | PROM |
| Consensus-based Standards for the Selection of Health Measurement Instruments..... | COSMIN |
| International Society of Lymphology..... | ISL |
| Lymphedema Quality of Life..... | LYMQOL |
| Focus On Therapeutic Outcomes | FOTO |
| Centers for Medicare and Medicaid Services | CMS |
| Core Outcome Set..... | COS |
| Core Outcome Measures in Effectiveness Trials | COMET |

BROAD ABSTRACT

The objective of this three-manuscript dissertation is to examine how lymphology is integrated into the field of physical therapy, including professional Doctor of Physical Therapy (DPT) education and Post-Professional Physical Therapy practice. The overarching aim of this dissertation is to advance lymphology aptitudes among faculty, post-professional educators and clinicians, and students. Understanding current lymphology curriculum standards, clinical use of manual lymphatic drainage techniques (MLdT), and use of outcome measures related to breast cancer related lymphedema brings into focus the physical therapy profession attentiveness, or lack thereof, of a major body system, the lymphatic system, that effectuates fluid homeostasis and immunity.

Three independent studies embody the aim of this dissertation. The status of lymphology education in professional DPT programs was investigated in the first study with the aims to 1) describe current, typical lymphology content within professional DPT programs; and 2) identify whether lymphology content is perceived as entry-level material amongst professional DPT faculty who were responsible for teaching lymphology content and professional DPT faculty who did not teach lymphology content. The second study comprises a systematic review that investigated whether MLdT, in addition to conventional rehabilitation, for conditions affecting the musculoskeletal system, can decrease edema, and improve ROM, patient-reported outcomes, and healthcare utilization. The third study examined 1) OMs used by CLTs on BCS with BCRL and their differences between professions; 2) unique characteristic predictors for use of OMs; and 3) facilitators and barriers which influence CLTs use of OMs and their differences between professions.

Chapter one consists of the background for the aim of this dissertation and frames the purpose of the following individual studies contained in chapters II-IV. Each study contains a background/introduction, methods, results, and discussion sections. The final chapter (V) synthesizes the previous four chapters as a final discussion.

CHAPTER I

BROAD INTRODUCTION

The American Physical Therapy Association (APTA) vision statement, “Transforming society by optimizing movement to improve the human experience”¹ affirms the purpose of the physical therapy profession and physical therapists (PTs) alike. Identity, collaboration, and quality are guiding principles to accomplish the APTA vision statement.¹ Physical therapists uphold this quality by “embrac[ing] best practice standards in examination, diagnosis/classification, intervention and outcome measurement.”¹ They collaborate with “Interprofessional research approaches [that] ensure[s] evidence translates to practice and is consumer-centered.” These principles coalesce to form an identity in which the physical therapy profession promotes the movement system, described as “the integration of body systems that generate and maintain movement at all levels of bodily function.”¹

Integration of body systems in the physical therapy profession would consist of major body systems including cardiovascular, metabolic, gastrointestinal, endocrine, integumentary, musculoskeletal, neurological, genital and reproductive, renal and urologic, pulmonary, and lymphatic systems.^{2(p.26, 7C)} The lymphatic system interrelates the immune system and the circulatory system, but stands independently as a unique major body system.^{3,4} As a vital component of microcirculation, the lymphatic system maintains fluid homeostasis, and is responsible for the resolution of edema.^{4,5} The management of edema contributes to the APTA vision statement of transforming society through optimizing the movement system of humans which may be affected by many conditions affected by edema, albeit, integument, musculoskeletal, or neurological pathogenesis. The study and practice of lymphology concepts enhances the guiding principles of the APTA vision by integrating body systems, participating in interprofessional collaboration, and embracing evidence-based examination, diagnosis/classification, interventions, and outcome measurements. Physical therapists that engage lymphology concepts into their discipline are able to optimize human movement through edema management and thereby transform society by decreasing the continuum of disease and injury comorbidities related to the imbalance of interstitial fluid homeostasis.

Society is greatly affected by lymphedema whose prevalence worldwide is not fully known, but is estimated to affect 140-250 million people, and is a common disease in America,

affecting 1 in every 1,000 persons.⁶ Of these persons, secondary lymphedema affects approximately 99%.⁶ The most common cause of secondary lymphedema is lymphatic filariasis (a parasitic disease) which affects 120 million people in 80 countries, and is considered to be the second leading cause of permanent and long-term disability worldwide.⁷ Primary lymphedema is less common, affecting approximately 1 in every 100,000 persons of the American population.⁶ The incidence rate of breast cancer-related lymphedema (BCRL) ranges greatly but is approximately one in five breast cancer survivors.^{6,8,9} Lower extremity lymphedema makes up approximately 90% of patients with lymphedema worldwide due to filariasis, inguinal lymphadenectomy and/or radiation, obesity, primary lymphedema, or progressive end-stage chronic venous insufficiency.^{6,10} Approximately 50% of head and neck cancer survivors may develop lymphedema resulting from treatment for cancer.¹¹ A study conducted in the United Kingdom revealed that chronic edema resulted in >80% of sick leave affecting 9% of employment status.¹² Prospectively, crude prevalence of chronic edema in the United Kingdom over a 10 year period ranged from 1.33/1000 to 3.93/1000.^{12,13} While chronic edema was notably higher in men than women, only 3% was related to cancer or cancer treatment.¹³

Lymphology is the study of the lymphatic system, including its anatomy, physiology and pathology.¹⁴ The need for education pertaining to the lymphatic system and lymphedema is evident within the collective medical fields including, but not limited to, general practitioners, physical therapists, occupational therapists, speech-language pathologists, nurses, and surgeons.¹⁵ The American Lymphedema Framework Project (ALFP) identified the deficiency of education pertaining to the anatomy, physiology, and pathophysiology of the lymphatic system across medical disciplines, and the education of legislative and healthcare reform policy stakeholders.¹⁶ In 2017, Stanley Rockson, MD, professor of lymphatic research and medicine at Stanford University, poignantly stated in an editorial, that a deplorable lymphatic ignorance has arisen in the medical community.¹⁷ The physician notes that, “health care providers are ill-equipped to provide the care and solace that they [primary lymphedema patients] seek.”¹⁷ The International Lymphedema Framework suggests a lack of awareness about lymphedema and related disorders is unacceptable especially considering the decades of research that has occurred in the field of lymphology.¹⁸

Physical therapists provide interventions for limitations in movement and the pain that may occur from inflammatory processes or various profiles of edema (i.e. effusion, pitting

edema), while being guided by the chronological characterizations of tissue healing (e.g. acute, subacute, and chronic).^{19,20} Knowledge of the fundamentals of lymphology is important for physical therapists to provide safe and effective care to patients with various causes and classifications of edema. Professional DPT students should be knowledgeable about different edematous diseases, chronological edema modifications, and lymphatic classifications (i.e. dynamic insufficiency, mechanical insufficiency, combined insufficiency) in order to make appropriate differential diagnoses. This foundational knowledge would be considered an important component of a PT's clinical reasoning^{21,22} for proper edema treatment and rehabilitation choices (e.g. ice, elevation, manual lymph drainage, compression, exercise). Amid the vast spectrum of PT curriculums within the United States, a concern exists for adequate education pertaining to the lymphatic system.²³ To prepare professional DPT graduates in becoming effective clinical and scholarly practitioners, the Commission on Accreditation in Physical Therapy Education (CAPTE) requires that lymphology curriculum content should include examination, evaluation, diagnosis, and interventions of circulation (arterial, venous, lymphatic) and integumentary integrity.^{2(pp.28-29;7D19, 7D27)} Since 2018, the national physical therapy examination (NPTE) informs students of the importance of “movement analysis as related to the lymphatic system”, and the “interpretation of knowledge about diseases/conditions of the lymphatic system.”²⁴ Current trends of lymphology education in professional Doctorate of Physical Therapy programs is vital to the future profession as this field engages in the discipline of primary care. Investigating what is currently being taught and what is currently considered entry-level knowledge of lymphology for the primary care physical therapist may encapsulate the breadth and/or depth needed for clinical reasoning in patient-centered care. Therefore, the first study investigated the status of lymphology education in professional DPT programs with the aims to 1) describe current, typical lymphology content within professional DPT programs; and 2) identify whether lymphology content is perceived as entry-level material amongst professional DPT faculty who were responsible for teaching lymphology content and professional DPT faculty who did not teach lymphology content.

The examination blueprint descriptions of the NPTE, includes the importance of entry-level knowledge of adverse effects or complications on the lymphatic system, as a result of physical interventions upon the lymphatic system, or other systems.²⁴ While the term lymphedema appears to be unique and perhaps an isolated lymphatic morphology, sources have

argued that chronic edema better encapsulates the broad spectrum of edema and associated disorders as they relate to the “adverse effects” and “complications” of the lymphatic system.¹⁸ Edema emerges when lymphatic drainage capacity is overwhelmed by capillary filtration.¹⁸ In fact, in recent interpretations of the Starling’s model of human fluid homeostasis, there is evidence that capillary venous reabsorption is non-existent and that the lymphatic system may be solely responsible for macromolecule and fluid reabsorption of the interstitial spaces.²⁵ PRICE (protection, rest, ice/cryotherapy, compression, elevation) is a practical and intuitive theorem used to treat pain and inflammation on conditions affecting the musculoskeletal system. However, the evidence of effectiveness for such a construct is lacking.²⁶ Two of constituents of PRICE, ice and compression, have recently been examined to have limited clinical benefits. A meta-analysis reported that compression bandaging did not attain statistically significant differences ($p > 0.05$) in pain, swelling and range of motion.²⁷ Similarly, in a Cochrane systematic review, cryotherapy was noted to have very low quality evidence in improving pain (Mean Difference (MD)) = -1.32 points on a 10 point scale, 95%CI, -2.37 – -0.27) and knee range of motion (MD = +11.39 degrees of flexion, 95%CI 4.13 – 19.66), but had no significant benefit for swelling following total knee replacement.²⁸ Considering the role of the lymphatics with regards to the revised Starling’s model and aligning cryotherapy with the physiology of lymph transportation, intrinsic contractility of lymphatic vessels are adversely affected by cooling temperatures of 4-8 degrees Celsius and are unable to adapt to their optimal temperature contractility.²⁹ Even at a one-degree change from baseline tissue temperature, there was a decrease in contraction frequency (-2.08 cycles/minute) of the lymphatic vessels.²⁹ Being cognizant of the aforementioned warrants a systematic review examining the effects of manual lymph drainage techniques (MLdT) on conditions affecting the musculoskeletal system, which often are the recipient of PRICE interventions. Therefore, the second study, a systematic review, investigated whether MLdT, in addition to conventional rehabilitation, for conditions affecting the musculoskeletal system, can decrease edema, and improve ROM, patient-reported outcomes, and healthcare utilization. Examining these effects lends to the need for a core set of outcome measures for use in both the clinical setting and in research for a homogenous effect in the multidisciplinary field of physical therapy.

In the Guide for Physical Therapist Practice 3.0, the APTA describes skillsets that are a part of professional PT practices including examination, evaluation, and selection of

interventions pertaining to the lymphatic system.³⁰ Examination and re-examination of the peripheral circulation, including lymphedema, are considered minimum required skill sets per the APTA – Board of Directors (BOD).³¹ In 2006, the APTA Section on Research developed the Evaluation Database to Guide Effectiveness (EDGE) Task Force, commissioned to promote standardization of outcome measures (OMs) by identifying best OMs that were reliable, valid, and had good clinical utility for each practice area.³² Quantifiable OMs are an essential component of evidence-based practice (EBP) and are often incorporated in the examination of a disorder and the outcome assessment of interventions for related impairments and limitations.^{33,34} The results of these measures provide a foundation for clinical reasoning in the diagnosis, prognosis, and establishment of interventions and/or management of a health condition.³⁵ Standardized OMs are a key component to patient-centered care, value-based healthcare, and current value-based reimbursement models, especially in complex long-term conditions.³⁶ Value-based healthcare and reimbursement models seek to provide improved health-related outcomes relative to the cost of healthcare and is pivotal for the profession of PT aspiring to EBP. Through consistent use of examinations with standardized OMs and evidence-based interventions recommended in clinical practice guidelines, physical therapists achieve value-based outcomes that add value for their patient's health and improves the therapist-patient relationship.^{36,37}

Generally, physical therapists hold positive attitudes about EBP and believe that OMs enhance patient-provider and provider-payer communication, enhance examination thoroughness, and improve directing and focusing a plan of care.^{34,38} However, only 48% of physical therapists reported using OMs.³⁸ Investigating a multidisciplinary healthcare provider population, Burton et al.³⁹ assessed the use of OMs in stroke rehabilitation and found that 77% of nurses and 60% of physician used one OM weekly, compared to only 33% of physiotherapists, 33% of speech and language therapists, and 35% of occupational therapists at the same interval.³⁹ Use of OMs within specialty groups may demonstrate favorable trends as noted in a study investigating hand therapists, which reported that 92% had used patient-reported OMs.⁴⁰ These authors reported that hand specialist respondents that used more than one OM determined that they were able to better establish functional and physical limitations for their patients. Certified lymphedema therapists (CLT) are specialists who have completed 135 hours of education consisting of both 1/3 theoretical instruction and 2/3 practical training to examine,

evaluate, and select interventions pertaining to the lymphatic pathologies and associated impairments.⁴¹ Various medical professionals may be a CLT, including nurse (RN), occupational therapist (OT), certified occupational therapist assistant (COTA), physical therapist (PT), physical therapist assistant (PTA), physician (MD or DO), chiropractor (DC), massage therapist (MT), and certified athletic trainer (ATC).⁴¹ The comorbidities related to lymphatic pathologies include various musculoskeletal changes limiting range of motion and strength, difficulty reaching, increased fatigue and tissue volume, sensory impairments, pain, integument changes, and low self-esteem and quality of life perceptions.^{6,8,42-45} Identifying OMs with good psychometric properties for the examination on BCS with BCRL, including the associated comorbidities, benefits the physical therapist – CLT in application of an evidence-based approach addressing the impairments and limitations identified in the evaluation of the examination findings and in concert with the patient goals. While OMs have been recommended by the EDGE task force, the extent to which CLTs are using them is unknown. Furthermore, there is a lack of knowledge of the barriers and facilitators to the use of OMs by CLTs. An investigation addressing this gap of knowledge fosters further understanding of the physical therapist post-professional CLT and their continuum of lymphology exposure. Therefore, the third study examined 1) OMs used by CLTs on BCS with BCRL and their differences between professions; 2) unique characteristic predictors for use of OMs; and 3) facilitators and barriers which influence CLTs use of OMs and their differences between professions.

In summary, this three-manuscript dissertation takes the scholar, both lymphology naïve and experienced, on a journey investigating the breadth and depth of lymphology education and practice in the field of physical therapy. It is a journey that weaves from entry-level to post-professional knowledge and applications of lymphology, while being framed by the mission, vision, and guiding principles of the APTA. Use of MLdT in disciplines beyond oncology and wound care is still in its infancy in physical therapy but recent research is evidencing its use in orthopedics.^{46,47} However, the intervention of MLdT as a catch-all tool for edema is not sound in its theory and practice. In addition, employing MLdT without foundational lymphology knowledge diminishes the guidance in a physical therapist's clinical reasoning. Knowing when, why, and how to use MLdT requires standardized OMs to assess edema and its related comorbidities associated with body functions and structures, and a patient's limitations in activities and societal participation. Quality evidence for lymphology education and practice in

professional Doctor of Physical Therapy programs is presented in this dissertation. Closing remarks of the primary investigator in Chapter V reflects on what needed to be known, what has become evident, and what continues to be available to be explored.

REFERENCES

1. Vision Statement for the Physical Therapy Profession. American Physical Therapy Association. <https://www.apta.org/apta-and-you/leadership-and-governance/policies/vision-statement-for-the-physical-therapy-profession>. Published 2019.
2. *Commission on Accreditation in Physical Therapy Education. Accreditation Handbook. Evaluative Criteria PT Programs (Adopted October 26, 2004; Effective January 1, 2006; Revised December 7, 2017)*. Alexandria: American Physical Therapy Association; 2015. www.captionline.org.
3. Zawieja DC. Proceedings of a mini-symposium: Lymphedema: an overview of the biology, diagnosis, and treatment of the disease. Contractile physiology of lymphatics. *Lymphat Res Biol*. 2009;7(2):87-96.
4. Rockson S. The unique biology of lymphatic edema. *Lymphat Res Biol*. 2009;7(2):97-100.
5. Rockson SG. The lymphatics and the inflammatory response: Lessons learned from human lymphedema. *Lymphat Res Biol*. 2013;11(3):117-120. doi:10.1089/lrb.2013.1132
6. Greene A. Epidemiology and Morbidity of Lymphedema. In: *Lymphedema*. Switzerland: Springer International Publishing; 2015:33-34.
7. Hygiene-related diseases; Lymphatic Filariasis. Centers for Disease Control and Prevention. https://www.cdc.gov/healthywater/hygiene/disease/lymphatic_filariasis.html. Published 2016. Accessed October 4, 2020.
8. Bulley C, Coutts F, Blyth C, et al. Upper limb morbidity after treatment for breast cancer: A cross-sectional study of lymphedema and function. *Eur J Surg Oncol*. 2012;38(11):1141. doi:10.1016/j.ejso.2012.07.250
9. Zou L, Liu F, Shen P, et al. The incidence and risk factors of related lymphedema for breast cancer survivors post-operation: a 2-year follow-up prospective cohort study. *Breast Cancer*. 2018;25(3):309-314. doi:10.1007/s12282-018-0830-3
10. Eberhardt R, Raffetto J. Chronic Venous Insufficiency. *Circulation*. 2005;111(18):2398-2409.
11. Deng J, Ridner SH, Dietrich MS, et al. Prevalence of secondary lymphedema in patients with head and neck cancer. *J Pain Symptom Manage*. 2012;43(2):244-252. doi:10.1016/j.jpainsymman.2011.03.019
12. Moffatt CJ, Franks PJ, Doherty DC, et al. Lymphoedema: An underestimated health problem. *QJM*. 2003;96(10):731-738. doi:10.1093/qjmed/hcg126
13. Moffatt CJ, Keeley V, Franks PJ, Rich A, Pinnington LL. Chronic oedema: A prevalent health care problem for UK health services. *Int Wound J*. 2017;14(5):772-781. doi:10.1111/iwj.12694
14. Foeldi E, Dimakakos EP. Interdisciplinary lymphology: The best place for each discipline in a team. *Int J Low Extrem Wounds*. 2012;11(1):28-30.
15. Wang K, Piller N, Conway N, et al. International Lymphoedema Framework Australia - Emerging Issues and the Way Forward. *J Lymphoedema*. 2014;9(1):36-40.
16. Armer J, Feldman J, Fu M, et al. ALFP : Identifying issues in lymphoedema in the US. *J Lymphoedema*. 2009;4(2):3-9.
17. Rockson SG. Lymphatic medicine: Paradoxically and unnecessarily ignored. *Lymphat Res Biol*. 2017;15(4):315-316. doi:10.1089/lrb.2017.29033.sr
18. Moffatt C, Keeley V, Quéré I. The concept of chronic edema – A neglected public health

- issue and an international response: The LIMPRINT study. *Lymphat Res Biol*. 2019;17(2):121-126. doi:10.1089/lrb.2018.0085
19. Robi K, Jakob N, Matevz K. The physiology of sports injuries and repair processes. In: *Current Issues in Sports*. Department of Orthopedic Surgery, University Medical Center Maribor, Slovenia; 2013:43-86. http://cdn.intechopen.com/pdfs/44614/InTech-The_physiology_of_sports_injuries_and_repair_processes.pdf. Accessed April 2, 2017.
 20. Lebec M, Jogodka C. The physical therapist as a musculoskeletal specialist in the emergency department. *J Orthop Sport Phys Ther*. 2009;39(3):221-229.
 21. Edwards I, Jones M, Carr J, Braunack-Mayer A, Jensen GM. Clinical reasoning strategies in physical therapy. *Phys Ther*. 2004;84(4):312-330. <http://www.ncbi.nlm.nih.gov/pubmed/15049726>. Accessed October 13, 2018.
 22. Jensen GM, Gwyer J, Shepard KF. Expert practice in physical therapy. *Phys Ther*. 2000;80(1):28-43. <http://www.ncbi.nlm.nih.gov/pubmed/10623958>. Accessed October 13, 2018.
 23. Augustine E, Corn M, Danoff J. Lymphedema management training for physical therapy students in the United States. *Cancer*. 1998;83(12):2869-2873.
 24. NPTE-PT Test Content Outline, Effective January 2018. Supplemental Materials for the Physical Therapist Practice Examination and Assessment Tool; Physical Therapist National Physical Therapy Examination. http://www.fsbpt.org/Portals/0/documents/free-resources/ContentOutline_2018PTT_20170126.pdf. Published 2018. Accessed December 10, 2018.
 25. Levick JRR, Michel CC. Microvascular fluid exchange and the revised Starling principle. *Cardiovasc Res*. 2010;87(2):198-210. doi:10.1093/cvr/cvq062
 26. Van Den Bekerom M, Struijs P, Blankevoort L, Welling L, Van Dijk CN, Kerkhoffs G. What is the evidence for rest, ice, compression, and elevation therapy in the treatment of ankle sprains in adults? *J Athl Train*. 2012;47(4):435-443. doi:10.4085/1062-6050-47.4.14
 27. Liu P, Mu X, Zhang Q, Liu Z, Wang W, Guo W. Should compression bandage be performed after total knee arthroplasty? A meta-analysis of randomized controlled trials. *J Orthop Surg Res*. 2020;15(1):52-61. doi:10.1186/s13018-019-1527-9
 28. Adie S, Naylor JM, Harris IA, et. al. et. al. Cryotherapy after total knee arthroplasty a systematic review and meta-analysis of randomized controlled trials. *J Arthroplasty*. 2010;25(5):709-715. doi:10.1016/j.arth.2009.07.010
 29. Solari E, Marcozzi C, Negrini D, Moriondo A. Temperature-dependent modulation of regional lymphatic contraction frequency and flow. *Am J Physiol - Hear Circ Physiol*. 2017;313(5):ajpheart.00267.2017. doi:10.1152/ajpheart.00267.2017
 30. Guide to Physical Therapist Practice 3.0. <http://guidetoptpractice.apta.org/>. Published 2016. Accessed September 11, 2018.
 31. *Minimum Required Skills of Physical Therapist Graduates at Entry-Level; BOD G11-05-10-49*. Alexandria, VA: American Physical Therapy Association; Board of Directors; 2005:18.
 32. Levangie P, Oncology MF-R, 2013 U. Oncology Section Task Force on breast cancer outcomes: An introduction to the EDGE Task Force and clinical measures of upper extremity function. *Rehabil Oncol*. 2013;30(4):6-10. <https://journals.lww.com/transplantjournal/01893697-201331010-00003.fulltext>. Accessed April 29, 2020.
 33. Duncan PW, Jorgensen HS, Wade DT. Outcome measures in acute stroke trials: A

- systematic review and some recommendations to improve practice. *Stroke*. 2000;31(6):1429-1438. doi:10.1161/01.STR.31.6.1429
34. Jette DU, Bacon K, Batty C, et al. Evidence-based practice: Beliefs, attitudes, knowledge, and behaviors of physical therapists. *Phys Ther*. 2003;83(9):786-805. doi:10.1093/ptj/83.9.786
 35. Fulk G, Field-Fote EC. Measures of evidence in evidence-based practice. *J Neurol Phys Ther*. 2011;35(2):55-56. doi:10.1097/NPT.0b013e31821ba134
 36. Elf M, Flink M, Nilsson M, Tistad M, von Koch L, Ytterberg C. The case of value-based healthcare for people living with complex long-term conditions. *BMC Health Serv Res*. 2017;17(1):24. doi:10.1186/s12913-016-1957-6
 37. Teisberg E, Wallace S, O'Hara S. Defining and implementing value-based health care: As strategic framework. *Acad Med*. 2020;95(5):682-685. doi:10.1097/ACM.00000000000003122
 38. Jette DU, Halbert J, Iverson C, Miceli E, Shah P. Use of standardized outcome measures in physical therapist practice: Perceptions and applications. *Phys Ther*. 2009;89(2):125-135. doi:10.2522/ptj.20080234
 39. Burton L-J, Tyson S, McGovern A. Staff perceptions of using outcome measures in stroke rehabilitation. *Disabil Rehabil*. 2013;35(10):828-834. doi:10.3109/09638288.2012.709305
 40. Valdes K, MacDermid J, Algar L, et al. Hand therapist use of patient report outcome (PRO) in practice: A survey study. *J Hand Ther*. 2014;27(4):299-308. doi:10.1016/J.JHT.2014.07.001
 41. LANA Certified Lymphedema Therapist Candidate Information Booklet (CIB). Lymphology Association of North America. <https://www.clt-lana.org>. Published 2017. Accessed September 10, 2018.
 42. Paskett ED. Breast cancer-related lymphedema: Attention to a significant problem resulting from cancer diagnosis. *J Clin Oncol*. 2008;26(35):5666-5667. doi:10.1200/JCO.2008.19.0850
 43. Kerckhove N, Collin A, Condé S, Chaletex C, Pezet D, Balayssac D. Long-term effects, pathophysiological mechanisms, and risk factors of chemotherapy-induced peripheral neuropathies: A comprehensive literature review. *Front Pharmacol*. 2017;8:86. doi:10.3389/fphar.2017.00086
 44. Kneis S, Wehrle A, Freyler K, et al. Balance impairments and neuromuscular changes in breast cancer patients with chemotherapy-induced peripheral neuropathy. *Clin Neurophysiol*. 2016;127(2):1481-1490. doi:10.1016/j.clinph.2015.07.022
 45. Zenville NR, Nudelman KNH, Smith DJ, et al. Evaluating the impact of chemotherapy-induced peripheral neuropathy symptoms (CIPN-sx) on perceived ability to work in breast cancer survivors during the first year post-treatment. *Support Care Cancer*. 2016;24(11):4779-4789. doi:10.1007/s00520-016-3329-5
 46. Pichonnaz C, Bassin J-P, Lécureux E, et al. Effect of manual lymphatic drainage after total knee arthroplasty: A randomized controlled trial. *Arch Phys Med Rehabil*. 2016;97(5):674-682. doi:10.1016/j.apmr.2016.01.006
 47. Ebert J, Joss B, Jardine B, Wood D. Randomized trial investigating the efficacy of manual lymphatic drainage to improve early outcome following total knee arthroplasty. *Arch Phys Med Rehabil*. 2013;94(11):2103-2111.

CHAPTER II

Faculty Survey on the Status of Lymphology Education in Professional Doctor of Physical Therapy Programs

David A. Doublestein, PT, PhD(c)

Amy Yorke, PT, PhD

Cathy Larson, PT, PhD

Rehabilitation Oncology, 2021; 39(3): 58-66.

ABSTRACT

Background and Purpose: The lymphatic system is vital for fluid homeostasis, waste removal, immunity, and tissue healing. It can be impacted by multiple diseases and traumatic processes seen by physical therapists across practice settings; hence, lymphology education in professional (entry-level) Doctor of Physical Therapy (DPT) programs is needed. Information about professional DPT lymphology education has not been conducted for 20 years. The purposes of this study were to 1) describe current, typical lymphology content within professional DPT programs; and 2) identify whether lymphology content is perceived as entry-level material amongst professional DPT faculty who were responsible for teaching lymphology content (TL) and professional DPT faculty who did not teach lymphology content (NTL). **Subjects:** Professional DPT faculty (n=43) in the US who taught or did not teach lymphology curriculum. **Methods:** Cross-sectional online survey research design. Descriptive data was gathered on lymphology content, hours, and curriculum standings. Chi-square test assessed relationships between faculty status and entry-level lymphology curriculum status. Spearman rank correlation coefficient assessed relationships between teaching hours and entry-level status. **Results:** Variability exists across curricula in range of hours devoted to didactic (0.4-14.1 hours) and laboratory (0-10 hours) instruction pertaining to lymphology. Individual curriculum contents were predominantly considered entry-level material. **Limitations:** Response rate was limited. **Conclusion:** Consistent lymphology curriculum content and format are lacking within the professional DPT programs that participated in the survey, indicating opportunities for advancements in entry-level lymphology education and investigation into best educational practices for teaching this content.

INTRODUCTION

Lymphology is the study of the lymphatic system, including its anatomy, physiology and pathology.¹ The lymphatic system is part of the immune system and the circulatory system, but stands independently as a unique system of the body.^{2,3} The lymphatic system transports lymphatic loads (i.e. water, protein, long chain fatty acids, hyaluronan, and cell fragments) to the venous system.^{2,4-6} As a vital component of microcirculation, the lymphatic system maintains fluid homeostasis, and is responsible for the management of edema.^{3,7} In 2018, the blue print of the National Physical Therapy Examination (NPTE) changed by partitioning the lymphatic system from the cardiovascular and pulmonary systems as a separate body system, essential for clinical application of knowledge required of professional PT practitioners.^{8,9} Knowledge of the fundamentals of lymphology is important for physical therapists to provide safe and effective care to patients with various causes and classifications of edema.

The most recent survey research on lymphedema management content in physical therapy programs was conducted in 1998. The authors reported that designated curricular content about lymphatics (89%) and lymphedema (73%) was being taught in physical therapy programs, but that far less content on the specifics of anatomy and physiology (42%) , and innovative treatment techniques (48%) were included.¹⁰ Currently, there is a need to have a more contemporary understanding of what is being taught in professional (entry-level) DPT lymphology curricula.

The professional DPT curriculum content includes clinical sciences pertaining to the major systems of the body.¹¹ These systems include the cardiovascular, metabolic, gastrointestinal, endocrine, integumentary, musculoskeletal, neurological, genital and reproductive, renal and urologic, pulmonary, and lymphatic systems.^{11(p.26, 7C)} To prepare professional DPT graduates in becoming effective clinical and scholarly practitioners, the Commission on Accreditation in Physical Therapy Education (CAPTE) mandates that there should be content and learning experiences related to these systems, coupled with “system interactions, differential diagnosis, and the medical and surgical conditions across the lifespan commonly seen in physical therapy practice”.^{11(p.26,7C)} CAPTE requires that lymphology curriculum content should include examination, evaluation, diagnosis, and interventions of circulation (arterial, venous, lymphatic) and integumentary integrity.^{11(pp.28-29;7D19, 7D27)} In the Guide for Physical Therapist Practice 3.0, the American Physical Therapy Association (APTA)

describes skillsets that are a part of professional PT practices including examination, evaluation, and selection of interventions pertaining to the lymphatic system.¹² Examination and re-examination of the peripheral circulation, including lymphedema, are considered minimum required skill sets per the APTA – Board of Directors (BOD).¹³ According to the APTA Section of Women’s Health, professional PT graduates addressing the integument system should have a mastery level of lymphatic anatomy, proficiency level of lymphatic physiology, and a familiar level of lymphatic pathophysiology and management.¹⁴

The 2018 NPTE content outline, provided by the Federation of State Boards of Physical Therapy (FSBPT), indicates that the lymphatic system comprises up to eight test items out of a possible 191 body systems items pertaining to examination, intervention, and foundations for evaluation, differential diagnosis, and prognosis.^{8,9} The NPTE content outline informs faculty and students of the importance of “movement analysis as related to the lymphatic system”, and the “interpretation of knowledge about diseases/conditions of the lymphatic system.”⁸ The examination blueprint descriptions of the NPTE, includes the importance of entry-level knowledge of adverse effects or complications on the lymphatic system, as a result of physical interventions upon the lymphatic system, or other systems.⁸ Lymphedema affects one in every thousand Americans,¹⁵ and while lymphology is not a large portion of the body systems items on the NPTE, the incidence of varied clinical presentations in physical therapy appears to substantiate its curricular distinction.

Physical therapists provide interventions for limitations in movement, and the pain that may occur from inflammatory processes or various profiles of edema (i.e. effusion, pitting edema), while being guided by the chronological characterizations of tissue healing (e.g. acute, subacute, and chronic).^{16,17} Professional DPT students should be knowledgeable about different edematous diseases, chronological edema modifications, and lymphatic classifications (i.e. dynamic insufficiency, mechanical insufficiency, combined insufficiency) in order to make appropriate differential diagnoses. This foundational knowledge would be considered an important component of a PT’s clinical reasoning^{18,19} for proper edema treatment and rehabilitation choices (e.g. ice, elevation, manual lymph drainage, compression, exercise). In addition, best evidence physical therapy intervention for the lymphatic system, are to be understood under the premise of anatomy and physiology for rehabilitation, health promotion, and physical performance.⁹ Preparing professional DPT students for clinical reasoning strategies

should include evidenced-based, entry-level skill sets for the intervention of various kinds of edema within the various stages of healing, which might consist of manual lymphatic techniques and compression bandaging.²⁰⁻²⁶ Providing best-practice treatment methods for the type of edema and prevailing physiological conditions, has been reported to be safe, effective, and improves quality of life outcomes.²⁷⁻²⁹

According to Sander and Perdomo,³⁰ there has been a lack of literature investigating curriculum models that integrate management into the professional DPT curriculum. These authors investigated two models developed to integrate edema management into the professional PT curriculum. According to Sander and Perdomo,³⁰ The Northwestern University Department of Physical Therapy and Human Movement Science (DPTHMS), and the University of Southern California (USC) have demonstrated higher rankings than other programs on the FSBPT examination in the areas of cardiovascular and pulmonary, and lymphatic systems. Northwestern University DPTHMS administers a separate forty-hour course combining lymphatic and integumentary dysfunctions, twenty of which are spent in examination and intervention skills for edema/lymphedema. USC administers 29 hours in edema management integrated throughout several courses in the program's three-year curriculum. In both curriculum styles, didactic anatomy, physiology and pathology information is enhanced through training in skill sets pertaining to examination and intervention (including manual lymph drainage and short stretch compression bandaging) which required approximately 10-13 class hours.³⁰ While this case study outlines distinguishable perspectives on content and instructional guidelines for edema and lymphedema management, there exists gaps of what content is currently taught or expected to be taught, who teaches the content, and across which disciplines.

The purposes of this study were to 1) describe the current lymphology content within professional DPT programs; and 2) identify whether lymphology content is perceived as entry-level material amongst professional DPT faculty who were responsible for teaching lymphology content (TL) and professional DPT faculty who did not teach lymphology content (NTL).

METHODS

Email addresses of program directors from accredited professional DPT programs in the US were retrieved from the CAPTE website. Survey links were emailed to program directors of 221 professional DPT programs (October 2017 – December 2017), who in turn were requested to disseminate the survey link through email to all of their faculty. Two follow-up emails were

disseminated during this time interval. Survey responses were separated into two groups: TL and NTL. The inclusion of NTL subjects was determined to offer non-biased interdisciplinary opinions about entry-level curriculum content status on lymphology, whose physiological affect crosses disciplines in professional DPT curricula. A total of 53 surveys were returned (24% response rate). Participants could choose to not to answer survey questions, which resulted in missing data. Ten surveys were incomplete, leaving 43 surveys with complete data sets for analysis. Thirty-five separate universities were represented. Descriptive data are presented in Table II.1. The areas of acquired specialty certifications **and the primary practice** patterns that respondents taught were partitioned into TL and NTL respondents (Table II.2).

A cross-sectional survey research design was implemented. Using a 37-item online Faculty Survey on Lymphology through Qualtrics® software, Version 2018 (Qualtrics, LLC, Provo, Utah) (Appendix II.A), information was gathered about the current status of lymphology education in the respondent's professional DPT program and overall curriculum content in programs in the U.S. education. Questions concerning the characteristics of the survey respondents, professional DPT lymphology curriculum content, format, and hours of instruction were included in the survey. Face validity of the survey was attested by the primary investigator and a collaborative colleague via its design based on similar studies.^{10,31} Consultation with colleagues in the field of survey research (n = 3), lymphology (n = 4), and generalist (n = 2) resulted in questionnaire modifications. An agreement amongst these colleagues (n = 6) on the final survey instrument conferred the content validity of the survey instrument. The questionnaire was pilot tested by four professional DPT faculty, two of which had teaching experience with lymphology, as well as two certified lymphedema therapists. Feedback on the pilot testing promoted modifications to the final survey. The study was approved by the Health Sciences and Behavioral Sciences Institutional Review Board of the University of Michigan - Flint.

Data were analyzed using SPSS® version 24 (Armonk, NY). Descriptive statistics are presented as means \pm standard deviations (SD), frequencies (%), and where appropriate, interquartile ranges. The Chi-square test of independence was used to determine if there were significant relationships between faculty status (TL and NTL) and perceptions on entry-level status of curriculum topics. Across all analyses, the alpha level of significance was set at 0.05.

RESULTS

Information collected on content taught on lymphology within professional DPT programs was obtained from TL. Ninety-two percent ($n = 35$) of respondents reported that lymphatics anatomy and physiology was taught at their professional DPT program. Lymphatics anatomy and physiology was taught in four courses including, anatomy (52.6%, $n = 20$), integumentary (47.4%, $n = 18$), pathophysiology (44.7%, $n = 17$), and cardiopulmonary (34.2%, $n = 13$). Ninety-two percent ($n = 35$) of respondents reported that their programs taught lymphatic pathophysiology and that it was taught in one of three courses including integumentary (44.7%, $n = 17$), pathophysiology (47.4%, $n = 18$), and cardiopulmonary (26.3%, $n = 10$). Table II.3 presents the descriptive data related to the hours spent teaching anatomy, physiology, and pathophysiology of the lymphatic system, as well as lecture hours and lab hours taught on examination. Types of edema most frequently taught were mechanical insufficiency (86.8%, $n = 33$), dynamic insufficiency (73.7%, $n = 28$), combined insufficiency (68.4%, $n = 26$), and lipedema (57.9%, $n = 22$); while chronic venous insufficiency (CVI) was less frequently taught (39.5%, $n = 15$). Ninety percent ($n = 34$) of respondents reported that their professional DPT programs taught on examination pertaining to lymphatics. Examination including circumferential measurements, special tests, volumetric measurement, and integument was taught in the integumentary course (44.7%, $n = 17$), followed by cardiopulmonary (28.9%, $n = 11$), and musculoskeletal (21.1%, $n = 8$); while an assortment of other courses (39.5%, $n = 15$) were also mentioned. Ninety-five percent ($n = 36$) of the TL respondents reported teaching interventions pertaining to lymphology in the integumentary (47.4%, $n = 18$), and cardiopulmonary (31.6%, $n = 12$) courses; while other courses (34.2%, $n = 13$) were also stated. Types and frequency of interventions taught included compression devices (84.2%, $n = 32$), multi-layer compression bandaging (78.9%, $n = 30$), skin care (78.9%, $n = 30$), therapeutic exercises (78.9%, $n = 30$), manual lymphatic techniques (68.4%, $n = 26$), and sequential compression pumps (65.8%, $n = 25$). Table II.4 presents the descriptive data related to the hours spent teaching various interventions related to the topic of lymphology.

Respondents somewhat agreed to strongly agreed that the subject matters of anatomy and physiology (88.4%, $n = 38$), pathophysiology (90.7%, $n = 39$) of the lymphatic system, and examination of the lymphatic system (81.4%, $n = 35$) was entry-level material. Figure II.1 presents frequencies of additional specific didactic content that was further analyzed for entry-

level content. Opinions from all respondents (TL and NTL) regarding if interventions should be included in professional DPT programs varied. Pertaining to didactic education of manual lymphatic techniques and multi-layer compression bandaging, 58.1% ($n = 25$) and 58.1% ($n = 25$), respectively of the respondents somewhat to strongly agreed that the content material was entry-level. More specific intervention frequencies are presented in Figure II.2. Perceptions about the entry-level status of discrete curriculum topics (e.g. anatomy, pathophysiology, examinations, compression bandaging, and manual lymph drainage) were not significantly different between TL and NTL.

Insert figures II.1 and II.2 here

Respondents similarly reported four main challenges in integrating lymphology into professional DPT programs, those being lack of time (62.8%, $n = 27$), lack of expertise (44.2%, $n = 19$), content undervalued by students (37.2%, $n = 16$), and content undervalued by faculty (37.2%, $n = 16$). Thirty percent of the respondents ($n = 13$) also reported that lymphology material was beyond entry-level knowledge. Observed strategies to integrate the subject matter of lymphatics into professional DPT programs included 1) Consultation with credentialed therapist (s) about the subject matter (65.1%, $n = 28$), 2) Credentialed liaison/adjunct instructor to teach the subject (60.5%, $n = 26$), and 3) offered supervised clinical education experiences with either lymphedema clinics or clinics that have a certified lymphedema therapist (32.6%, $n = 14$).

DISCUSSION AND CONCLUSIONS

Survey results from this study identified current lymphology content within professional DPT programs, and indicate that programs most frequently teach on lymphology intervention, followed by anatomy, physiology, pathophysiology, and to a lesser extent examination content. Peripheral circulation examination and reexamination (including lymphedema) are considered a minimum required skill set by the APTA – BOD.¹³ CAPTE¹¹ emphasizes the knowledge base of examination, evaluation, and diagnosis of the lymphatics; whereas, the NPTE⁸ may include topics related to examination, differential diagnosis, prognosis, and interventions. Lymphology content is taught mostly in the integument course, followed by pathophysiology, and cardiopulmonary courses. While lymphatics are present in the integument system and most tissues of the body, its independent significance is evident and recognized by the FSBPT.⁹ Additional lymphology content within the respondent's professional DPT programs focused on

teaching about mechanical insufficiency of the lymphatic system, but less about dynamic insufficiency and combined insufficiency. Lipedema and CVI which involve lymphatic insufficiency classifications were taught in only a few programs.

The current study offers evidence that there has been an increase (76.3%) in curricular content devoted to contemporary intervention techniques (manual lymph drainage, skin care, exercise, and compression bandaging) since the survey results (48%) from 1998. As this study reports, the frequency of teaching about compression devices (garments and bandage alternatives) took precedence to other interventions. These compression devices are typically considered for patient use in self-management, rather than a source of intervention during the more intensive decongestive PT treatments.

Survey results from this study identified entry-level status of lymphology content within professional DPT programs. Across most didactic lymphology curriculum topics, respondents have a unified perception of what constitutes entry-level lymphology material (Figure II.1). Those topics that varied in opinion lend more to uncertainty than to non-entry-level status. Respondents in this survey labeled most of the didactic curriculum as being entry-level including anatomy (suprafascial and subfascial), physiology, and lymphedema pathophysiology (including its comorbidities). Lipedema and micro-circulation were considered entry-level; albeit, the frequency taught was less than other topics. Pathophysiology of CVI was considered entry-level; however, not all programs taught CVI content. A majority of respondents perceived that didactic education on Kinmonth classifications¹⁵ of primary lymphedema were either not entry-level material or unsure of the entry-level status. For the purposes of clinical reasoning and differential diagnosis, understanding various diseases of the lymphatic system, and having the skillsets of lymphatic examination, evaluation, and diagnosis would align with their importance as indicated by CAPTE¹¹ and the APTA – BOD.¹³ Professional DPT students may benefit from the knowledge of Kinmonth primary lymphedema classifications since it provides a framework for differential diagnoses and clinical reasoning for proper intervention or referral. For example, in the case of adolescent onset primary lymphedema (i.e. praecox), the manifested edema is often attributed to other causes (e.g. trauma) and dismissed by professionals,³² which may lead to advancement of the disease without proper intervention or referral.

This survey provided evidence that respondents varied in opinion as to whether the intervention of complete decongestive therapy (CDT) was entry-level education, but trended

toward non-entry-level status. However, individual components of CDT (i.e. manual lymphatic techniques, compression bandaging, compression garments) trended toward entry-level status (Figure II.2). Compression garment and device interventions were largely considered entry-level content. Despite evidence for its guarded and adjunct use for the treatment of lymphedema,³³⁻³⁵ sequential pneumatic compression pumps were considered entry-level status. Consideration should be taken of where (cardiovascular versus lymphatic system), and how this education is best delivered, since sequential pneumatic compression pumps are indicated for DVT prevention and post-thrombotic syndrome, despite lack of dosage protocols and treatment strategies.³⁶

The extent to which professional DPT curricula are currently meeting lymphology educational requisites is determined by the individual programs. However, inconsistency of the didactic and laboratory hours are noted in this study. While it is expected that individual curricula would have variability in educational hours, the range (didactic = 0.40-14.10 hours and laboratory = 0.00-10.00 hours) is broad (Table II.3 and II.4).

Similar to the cardiovascular system, the physiological importance that the lymphatic system provides to the integument, muscles, nerves, joints, periosteum, and central nervous system warrants consideration of both its placement and timetable in a curriculum. The breadth of lymphology topics indicates that lymphology curricula could extend across practice patterns, but this may prove to be a difficult task for professional DPT programs. Augustine, et al.¹⁰ reported that the main challenges for faculty with integrating lymphology into professional DPT programs included lack of time, expertise, and that the content was undervalued, which this current study reaffirms in reporting four main challenges in integrating lymphology into professional DPT program. Sander and Perdomo³⁰ also seem to echo a similar viewpoint, stating that a key to successful delivery of edema and lymphedema management material was the availability of faculty members trained in the management of lymphedema. Affording professional DPT students specialized clinical rotation opportunities with certified lymphedema clinicians may fill the gap in scenarios in which these trained faculty members are unavailable or to augment the current lymphology education.

This study had limitations in methodology and response rate. First, recruitment of faculty who were involved in the lymphology curriculum allowed for more than one faculty member per university to respond to the survey. This may have resulted in a duplication of quantitative data for these university's curricula; however, consideration should be given that their summative

individual responses may have also been an accurate representation of the curriculum. Second, FSBPT data on the NPTE scores pertaining to lymphology content are combined with cardiopulmonary scores and does not afford the ability to assess the national outcome averages pertaining to the lymphatic content alone. Third, web-based surveys yield less response than other modes of survey delivery, and on average, yield an expected 35% response rate, or approximately a third of the surveys administered.³⁷⁻³⁹ Therefore, using a 35% response rate, we initially expected a sample size of approximately 80 representatives from a larger pool of accredited professional DPT programs in the United States, assuming that all these programs deliver a lymphology curriculum. Despite reminder email notifications to the program directors to enhance participation, the response rate (24%) was marginal. Unfortunately, this low response rate and limited geographical representation would not allow us to generalize the outcomes. Regardless of the inclusivity efforts imbedded in the survey instructions and email reminders, a significant disproportion of TL to NTL respondents (Table II.2) occurred.

This survey investigation concerning lymphology content in professional DPT programs establishes a foundation in which future studies are warranted. To ensure safe and effective entry-level physical therapy practice, future studies may consider investigating DPT programs that offer specialist certifications and those that offer lymphology education without certification. Interviews with individual faculty members may clarify the reasons for the variability of hours devoted to lecture and lab, and towards anatomy, physiology, pathophysiology, examination and intervention content. As FSBPT data emerges beyond 2018, future research may consider analyzing survey curriculum data with national outcome data. In addition, a future study may consider repeating this study in other health care professions curricula including physical therapist assistant and occupational therapy. Methodology of a similar survey should attempt to improve response rates of national surveys that isolate a specific field of study within a particular discipline of medicine. The opportunity for discussions about appropriate curriculum placement and content on lymphology exists across practice patterns. The International Lymphedema Framework has developed the Lymphoedema Education Benchmark Statements, which were developed as a reference and guideline to, “foster global consistency and governance in relation to lymphoedema education.”⁴⁰ These statements may prove to be a foundational resource for future deliberations amongst professional DPT programs to establish consistency and governance of curricula that can align with international standards. Pre-existing guidelines from the

Lymphology Association of North America (LANA[®]), pertaining to the number of hours that is expected for examination candidacy have been established since 1998. LANA[®] recommends that certified lymphedema therapist candidates have 135-classroom hours with 1/3 theoretical instruction and 2/3 practical lab work,⁴¹ which could be considered beyond entry-level lymphology education, but could serve as a foundation for future deliberations to establish commonality in time and content across professional DPT curricula. While specialty certifications may not be expected for professional DPT students, a thorough comprehension of the lymphatic system, lymphedema, and chronic edema⁴² management may need to be explicated. A structured process (e.g. modified Delphi) could be used among experts to make recommendations on professional DPT lymphology education content and practices.

In conclusion, according to the analyses of these survey responses, consistent content, and format (didactic and laboratory hours) is lacking with regards to lymphatic system examination skills, and intervention techniques within the professional DPT programs. The variability of hours was significant, with one program's cumulative hourly investment in lymphology content to be two hours, while another school's cumulative hours were forty (Figure II.3). The rationale for this unexpected variability was not investigated in this study. The cumulative hours for professional DPT lymphology curriculum content may depend on the overall objective. If a curriculum's lymphology content is focused upon the disease of lymphedema, with the expectation that an entry-level PT can confidently employ patient referral or pursue CDT specialization later, then fewer hours consisting mainly of didactic education may be sufficient. Whereas, if the premise is that the lymphatic system is involved in all types of edema (e.g. dynamic, static, and combined lymphatic insufficiencies), in all stages of healing (e.g. acute, subacute, chronic), affecting multiple tissues (e.g. integument, musculoskeletal, and neurological), and seen across all patient populations and practice settings, then a greater number of education hours may be expected. Although NPTE lymphatic system results are unavailable for analysis, inconsistencies in curriculum topics and hours of didactic and lab hours may result in educational gaps. There is evidence for opportunities in developing optimal and congruous professional entry-level lymphology education in order to provide patient centered evidence-based lymphatic examinations and interventions. Mixed method research might allow further exploration of the variability of hours and further description of professional DPT education practice as it relates to lymphology.

DISCLOSURES

No external funding was required for this study. No financial conflicts of interest to disclose.

ACKNOWLEDGEMENTS

We are grateful to Bryan Spinelli, PT, PhD, OCS, CLT-LANA and Allon Goldberg, PT, PhD for their assistance in reviewing and editing the manuscript.

REFERENCES

1. Foeldi E, Dimakakos EP. Interdisciplinary lymphology: The best place for each discipline in a team. *Int J Low Extrem Wounds*. 2012;11(1):28-30.
2. Zawieja DC. Proceedings of a mini-symposium: Lymphedema: an overview of the biology, diagnosis, and treatment of the disease. Contractile physiology of lymphatics. *Lymphat Res Biol*. 2009;7(2):87-96.
3. Rockson S. The unique biology of lymphatic edema. *Lymphat Res Biol*. 2009;7(2):97-100.
4. Olszewski WL, Jain P, Ambujam G, Zaleska M, Cakala M. Anatomical distribution of tissue fluid and lymph in soft tissues of lower limbs in obstructive lymphedema - hints for physiotherapy. *Phlebology*. 2009;16(3):283-289.
5. Olszewski WL, Jain P, Ambujam G, Zaleska M, Cakala M. Where do lymph and tissue fluid accumulate in lymphedema of the lower limbs caused by obliteration of lymphatic collectors? *Lymphology*. 2013;42(3):105-111.
6. Roberts MA, Mendez U, Gilbert RJ, Keim AP, Goldman J. Increased hyaluronan expression at distinct time points in acute lymphedema. *Lymphat Res Biol*. 2012;10(3):122-128.
7. Rockson SG. The lymphatics and the inflammatory response: lessons learned from human lymphedema. *Lymphat Res Biol*. 2013;11(3):117-120. doi:10.1089/lrb.2013.1132
8. NPTE-PT Test Content Outline, Effective January 2018. Supplemental Materials for the Physical Therapist Practice Examination and Assessment Tool; Physical Therapist National Physical Therapy Examination. http://www.fsbpt.org/Portals/0/documents/free-resources/ContentOutline_2018PTT_20170126.pdf. Published 2018. Accessed December 10, 2018.
9. *Supplemental Materials for the Physical Therapist Practice Examination and Assessment Tool; Physical Therapist National Physical Therapy Examination*. Alexandria: Federation of State Boards of Physical Therapy; 2017.
10. Augustine E, Corn M, Danoff J. Lymphedema management training for physical therapy students in the United States. *Cancer*. 1998;83(12):2869-2873.
11. *Commission on Accreditation in Physical Therapy Education. Accreditation Handbook. Evaluative Criteria PT Programs (Adopted October 26, 2004; Effective January 1, 2006; Revised December 7, 2017)*. Alexandria: American Physical Therapy Association; 2015.
12. Guide to Physical Therapist Practice 3.0. <http://guidetoptpractice.apta.org/>. Published 2016. Accessed September 11, 2018.
13. *Minimum Required Skills of Physical Therapist Graduates at Entry-Level; BOD G11-05-10-49*. Alexandria, VA: American Physical Therapy Association; Board of Directors; 2005:18.
14. American Physical Therapy Association Section on Women's Health. Guidelines for Women's health content in Professional Physical Therapist Education: 2014 Update. <http://www.womenshealthapta.org/wp-content/uploads/2014/05/SoWH-DPT-Curricular-Content-Guide-2014-1.pdf>. Published 2014. Accessed September 11, 2018.
15. Greene A. Epidemiology and Morbidity of Lymphedema. In: *Lymphedema*. Switzerland: Springer International Publishing; 2015:33-34.
16. Robi K, Jakob N, Matevz K. The physiology of sports injuries and repair processes. In: *Current Issues in Sports*. Department of Orthopedic Surgery, University Medical Center Maribor, Slovenia; 2013:43-86.

17. Lebec M, Jogodka C. The physical therapist as a musculoskeletal specialist in the emergency department. *J Orthop Sport Phys Ther.* 2009;39(3):221-229.
18. Edwards I, Jones M, Carr J, Braunack-Mayer A, Jensen GM. Clinical reasoning strategies in physical therapy. *Phys Ther.* 2004;84(4):312-330.
19. Jensen GM, Gwyer J, Shepard KF. Expert practice in physical therapy. *Phys Ther.* 2000;80(1):28-43.
20. Tan I-C, Maus EA, Rasmussen JC, et al. Assessment of lymphatic contractile function after manual lymphatic drainage using near-infrared fluorescence imaging. *Arch Phys Med Rehabil.* 2011;92(5):756-764.
21. Harris R, Piller N. Three case studies indicating the effectiveness of manual lymph drainage on patients with primary and secondary lymphedema using objective measuring tools. *J Bodyw Mov Ther.* 2003;7(4):213-221.
22. Jessen NA, Munk ASF, Lundgaard I, Nedergaard M. The lymphatic system: A beginner's guide. *Neurochem Res.* 2015;40(12):2583-2599.
23. Kessler T, de Bruin E, Brunner F, Vienne P, Kissling R. Effect of manual lymph drainage after hindfoot operations. *Physiother Res Int.* 2003;8(2):101-110. doi:10.1002/pri.277
24. Finnane A, Janda M, Hayes SC. Review of the evidence of lymphedema treatment effect. *Am J Phys Med Rehabil / Assoc Acad Physiatr.* 2015;94(6):483-498.
25. Härén K, Backman C, Wiberg M. Effect of manual lymph drainage as described by Vodder on oedema of the hand after fracture of the distal radius: A prospective clinical study. *Scand J Plast Reconstr Surg Hand Surg.* 2000;34(4):367-372. doi:10.1080/028443100750059165
26. Davies V. The effects of compression garments on recovery. *J Strength Cond Res.* 2009;23(6):1786-1794.
27. Cemal Y, Jewell S, Albornoz CR, Pusic A, Mehrara BJ. Systematic review of quality of life and patient reported outcomes in patients with oncologic related lower extremity lymphedema. *Lymphat Res Biol.* 2013;11(1):14-19.
28. dos Santos Crisóstomo RS, Costa DSA, de Luz Belo Martins C, Fernandes TIR, Armada-da-Silva PA. Influence of manual lymphatic drainage on health-related quality of life and symptoms of chronic venous insufficiency: A randomized controlled trial. *Arch Phys Med Rehabil.* 2015;96(2):283-291.
29. Kim S, Yi C, Kwon O. Effect of complex decongestive therapy and the quality of life in breast cancer patients with unilateral lymphedema. *Lymphology.* 2007;40(3):143-151.
30. Sander AA, Perdomo M. Integrating edema management into entry-level doctor of physical therapy curriculum: A case report. *Rehabil Oncol.* 2018;36(1):56-63.
31. Schreiber J, Goodgold S, Moerchen VA, Remec N, Aaron C, Kreger A. A description of professional pediatric physical therapy education. *Pediatr Phys Ther.* 2011;23(2):201-204. doi:10.1097/PEP.0b013e318218f2fe
32. Moffatt CJ, Murray SG. The experience of children and families with lymphoedema - A journey within a journey. *Int Wound J.* 2010;7(1):14-26. doi:10.1111/j.1742-481X.2010.00657.x
33. Uzkeser H, Karatay S, Erdemci B, Koc M, Senel K. Efficacy of manual lymphatic drainage and intermittent pneumatic compression pump use in the treatment of lymphedema after mastectomy: a randomized controlled trial. *Breast Cancer.* 2015;22(3):300-307. doi:10.1007/s12282-013-0481-3
34. Armer JM, Hulett JM, Bernas M, Ostby P, Stewart BR, Cormier JN. Best-practice

- guidelines in assessment, risk reduction, management, and surveillance for post-breast cancer lymphedema. *Curr Breast Cancer Rep.* 2013;5(2):134-144. doi:10.1007/s12609-013-0105-0
35. Lee BB, Andrade M, Antignani PL, et al. Diagnosis and treatment of primary lymphedema. Consensus document of the International Union of Phlebology (IUP)-2013. *Int Angiol.* 2013;32(6):541-574.
 36. Hillegass E, Puthoff M, Frese EM, et al. Role of physical therapists in the management of individuals at risk for or diagnosed with venous thromboembolism: Evidence-based clinical practice guideline. *Phys Ther.* 2016;96(2):143-166. doi:10.2522/ptj.20150264
 37. Manfreda K, Bosnjak M, Berzelak J, Haas I, Vehovar V. Web surveys versus other survey modes: A meta-analysis comparing response rates. *J Mark Res Soc.* 2008;50(1):79.
 38. Shih T, Fan X. Comparing response rates from web and mail surveys: A meta-analysis. *Field methods.* 2008;20(3):249-271.
 39. Cook C, Heath F, Thompson R. A meta-analysis of response rates in web-or internet-based surveys. *Educ Psychol Meas.* 2000;60(6):821-836.
 40. Lymphoedema Education Benchmark Statements. International Lymphoedema Framework. <https://www.lympho.org/lebs/>. Published 2019. Accessed June 20, 2019.
 41. LANA Certified Lymphedema Therapist Candidate Information Booklet (CIB). Lymphology Association of North America. <https://www.clt-lana.org>. Published 2017. Accessed September 10, 2018.
 42. Moffatt C, Keeley V, Quéré I. The concept of chronic edema—A neglected public health issue and an international response: The LIMPRINT study. *Lymphat Res Biol.* 2019;17(2):121-126. doi:10.1089/lrb.2018.0085

Figure II.1. Frequency of Respondents (n = 43) Rating Didactic Material as Non-Entry-Level, Not Sure, and Entry-Level.

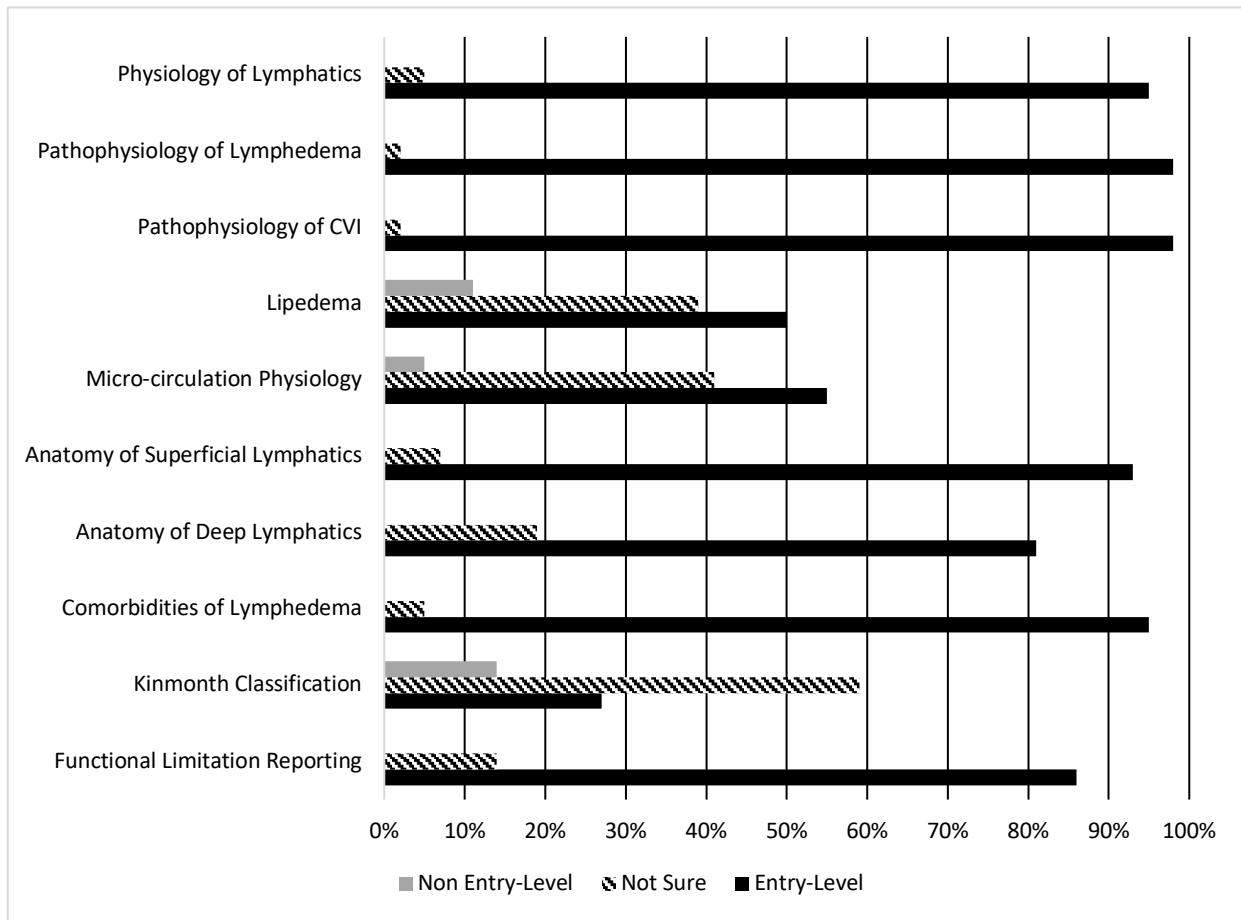


Figure II.2. Frequency of Respondents (N = 43) Rating Intervention Material as Non Entry-Level, Not Sure, and Entry-Level.

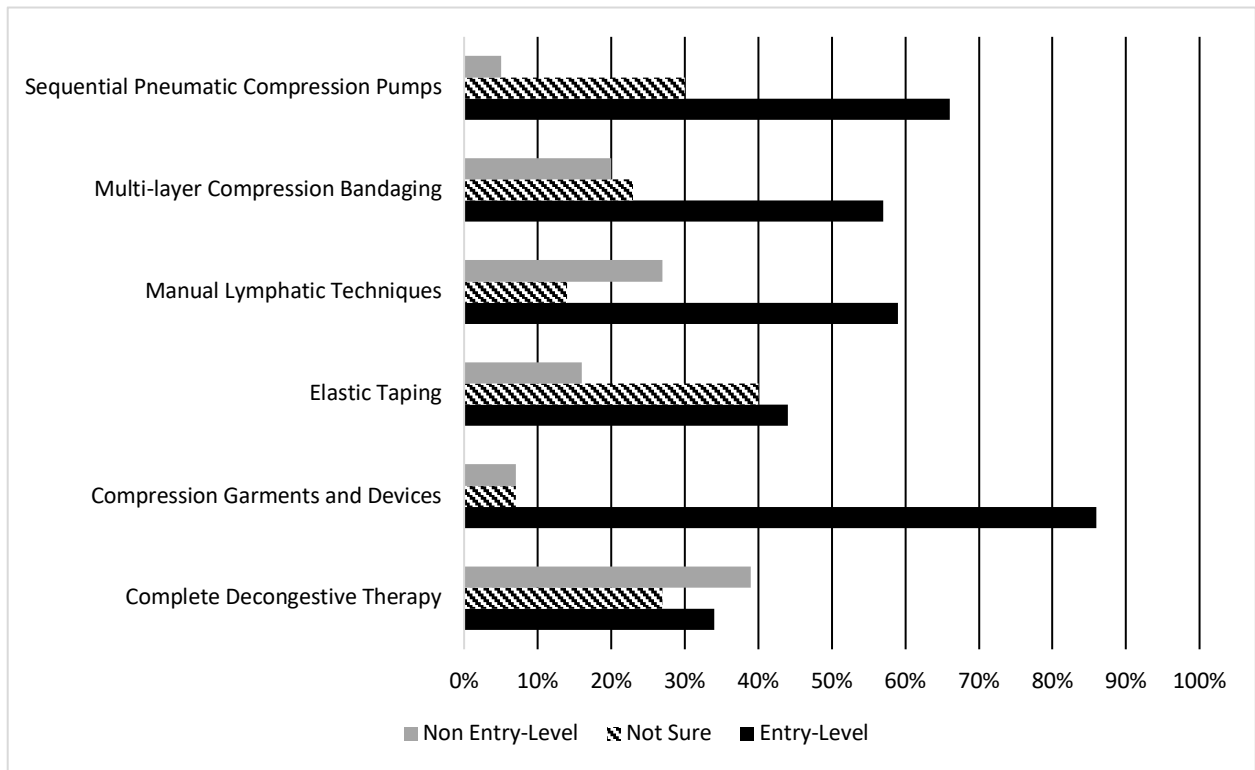


Table II.1. Characteristics of Faculty Survey Respondents.

| Age – (years) [N = 42*] | n (%) |
|---|--------------|
| 31-40 | 3 (7.0) |
| 41-50 | 18 (41.9) |
| 51-60 | 12 (27.9) |
| 61 or older | 9 (20.9) |
| Gender [N = 42*] | |
| | n (%) |
| Female | 32 (74.5) |
| Male | 9 (20.9) |
| Preferred not to answer | 1 (2.3) |
| Location of Teaching Institution [N =43] | |
| | n (%) |
| West | 8 (18.6) |
| Midwest | 14 (32.6) |
| South | 12 (27.9) |
| Northeast | 9 (20.9) |
| Type of Teaching Institution [N = 42*] | |
| | n (%) |
| Private | 17 (39.5) |
| Public | 25 (58.2) |
| Employment Status [N = 42*] | |
| | n (%) |
| Full Time | 40 (93.1) |
| Part Time | 1 (2.3) |
| Occasional | 1 (2.3) |
| Job Position** | |
| | n (%) |
| Adjunct/Liaison | 3 (7.0) |
| Assistant Professor | 14 (32.6) |
| Associate Professor | 15 (34.9) |
| Clinical Professor/Director | 3 (7.0) |
| Curriculum Coordinator | 2 (4.7) |
| Director of professional DPT Program | 6 (14.0) |
| Professor | 7 (16.3) |
| Other | 3 (7.0) |
| Currently in Clinical Practice [N = 43] | |
| | n (%) |
| Yes | 30 (69.8) |
| No | 13 (30.2) |
| *One survey did not complete demographic information (2.3%) | |
| **Respondents may have more than one job position | |

Table II.2. Characteristics of Respondents Responsible and Not Responsible for Teaching Lymphatic Content Within a Professional DPT Program

| Faculty Teaching Lymphatic Content (TL)* | n=38 | Faculty Not Teaching Lymphatic Content (NTL)* | n=5 |
|--|--------------|--|--------------|
| Specialty | n (%) | Specialty | n (%) |
| Cardiovascular and Pulmonary | 5 (13.2) | None | 3 (60) |
| Lymphedema | 16 (42.1) | Orthopedics | 1 (20) |
| Women's Health | 2 (5.3) | Neurology | 1 (20) |
| Wound Care | 6 (13.5) | | |
| None | 4 (10.5) | | |
| Orthopedics | 6 (15.8) | | |
| Geriatrics | 4 (10.5) | | |
| Neurology | 2 (5.3) | | |
| Other | 3 (7.9) | | |
| | | | |
| Primary Area of Practice of Faculty Teaching Lymphatic Content* | n (%) | Primary Area of Practice of Faculty Not Teaching Lymphatic Content* | n (%) |
| Cardiovascular/Pulmonary | 13 (34.2) | Cardiovascular/Pulmonary | 1 (20) |
| Integumentary | 22 (57.9) | Musculoskeletal | 2 (40) |
| Musculoskeletal | 12 (31.6) | Neuromuscular | 3 (60) |
| Neuromuscular | 10 (26.3) | Geriatrics | 1 (20) |
| Pediatrics | 3 (7.9) | Other | 1 (20) |
| Women's Health | 5 (13.2) | | |
| Geriatrics | 8 (21.1) | | |
| Other | 10 (26.3) | | |

*Respondents were allowed to choose more than one option.

Table II.3. Hours of Lecture and Lab Education Devoted to Anatomy and Physiology, Pathophysiology and Examination

| | Anatomy & Physiology Lecture Hours n=33 | Pathophysiology Lecture Hours n=34 | Lecture Hours Examination n=29 | Lab Hours Examination n=25 |
|----------------|--|---|---|---|
| Mean | 2.8 | 2.5 | 1.6 | 2.0 |
| Median | 2.0 | 1.7 | 1.0 | 1.0 |
| SD | 2.8 | 2.7 | 1.4 | 2.1 |
| Minimum | 0.5 | 0.4 | 0.5 | 0.5 |
| Maximum | 14.0 | 14.1 | 6.1 | 8.1 |

Table II.4. Descriptive Data on Hours of Lecture and Lab Professional DPT Education for Lymphatic Interventions.

| Curriculum Content | | Mean | Median | SD | Minimum | Maximum |
|---------------------------|----------------------|-------------|---------------|-----------|----------------|----------------|
| Compression Devices | Lecture Hours (n=31) | 0.73 | 0.50 | 0.75 | 0.10 | 2.70 |
| | Lab Hours (n=25) | 0.99 | 0.50 | 1.33 | 0.00 | 6.10 |
| Manual Lymph Drainage | Lecture Hours (n=31) | 1.03 | 0.70 | 1.01 | 0.00 | 3.20 |
| | Lab Hours (n=28) | 1.95 | 1.00 | 2.19 | 0.00 | 8.00 |
| Compression Bandaging | Lecture Hours (n=31) | 0.68 | 0.50 | 0.63 | 0.10 | 2.80 |
| | Lab Hours (n=30) | 1.38 | 1.00 | 1.34 | 0.00 | 6.40 |
| Sequential Pneumatic Pump | Lecture Hours (n=28) | 0.56 | 0.30 | 0.64 | 0.10 | 2.70 |
| | Lab Hours (n=21) | 0.79 | 0.40 | 0.99 | 0.00 | 4.00 |
| Skin Care | Lecture Hours (n=29) | 0.88 | 0.50 | 1.14 | 0.10 | 4.00 |
| | Lab Hours (n=23) | 1.13 | 0.50 | 1.68 | 0.00 | 8.00 |
| Therapeutic Exercise | Lecture Hours (n=29) | 1.16 | 0.60 | 1.33 | 0.10 | 5.00 |
| | Lab Hours (n=25) | 1.50 | 0.50 | 2.11 | 0.00 | 10.00 |

Appendix II.A. Survey on Lymphology Education in Professional Doctor of Physical Therapy Programs.

1. Do you teach ANY of the following **lymphatic** content within an entry-level PT program?
Anatomy and physiology Pathophysiology Examination Interventions
 - Yes
 - No

2. Which of the following lymphatic content are you responsible for teaching within the institution's entry-level PT program? Select all that apply.
 - Anatomy of the lymphatic system (e.g. capillary, pre-collector, collector, lymphangion, nodes, watersheds, etc.)
 - Physiology of the lymphatic system (e.g. lymphangiomotoricity, insufficiencies, etc.)
 - Pathophysiology of the lymphatic system (e.g. lymphedema, lipolymphedema, Stage 3 chronic venous insufficiency, etc.)
 - Examination of the lymphatic system (e.g. circumferential measurements, special tests, volumetric measurements, integument, etc.)
 - Interventions of the lymphatic system (e.g. manual lymphatic techniques, bandaging, pneumatic pumps, etc.)

3. Is the subject matter of **anatomy and physiology** of the lymphatic system taught at this institution's entry-level PT program?
 - Yes
 - No
 - Unsure

4. What course (s) is this material taught in? Select all that apply.
 - Anatomy
 - Cardiopulmonary
 - Integumentary
 - Neuromuscular
 - Musculoskeletal
 - Pathophysiology
 - Physiology
 - Other, describe: _____

5. Approximately, how many hours are spent in lecture on the topic of lymphatic system **anatomy and physiology**?

| | |
|-------------------------------------|--|
| Please select hours using slide bar |  |
|-------------------------------------|--|

6. Is the subject matter of **pathophysiology** of the lymphatic system taught at this institution's entry-level PT program?
- Yes
 - No
 - Unsure

7. What course (s) is this material taught in? Select all that apply.

- Anatomy
- Cardiopulmonary
- Integumentary
- Neuromuscular
- Musculoskeletal
- Pathophysiology
- Physiology
- Other, describe: _____

8. Approximately, how many hours are spent in lecture on the topic of **pathophysiology** of the lymphatic system?

| | |
|---|--|
| Please select hours using the slide bar |  |
|---|--|

9. Please select the types of edema that are taught at this institution's entry-level PT program. Select all that apply.

- Combined Insufficiency
- Dynamic Insufficiency - Edema
- Lipo-lymphedema (lipedema)
- Mechanical Insufficiency - Lymphedema
- Phlebo-lymphodynamic edema (CVI)
- Phlebo-lymphostatic edema (CVI)
- Other, describe: _____

10. Is the subject matter of **examination** of the lymphatic system (e.g. circumferential measurements, special tests, volumetric measurements, integument, etc.) taught at this institution's entry-level PT program?
- Yes
 - No
 - Unsure

11. What course (s) is this material taught in? Select all that apply.

- Anatomy
- Cardiopulmonary
- Integumentary
- Neuromuscular
- Musculoskeletal
- Pathophysiology
- Physiology
- Other, describe: _____


12. The coursework on **examination** of lymphatic system (e.g. circumferential measurements, special tests, volumetric measurements, integument, etc.) includes:

- Overview of material - lecture
- Application of the techniques - lab
- Other, describe: _____

13. Approximately, how many lab hours are utilized to teach about **examination** for the lymphatic system (e.g. circumferential measurements, special tests, volumetric measurements, integument, etc.)?

| | |
|------------------------------------|--|
| Please select hours with slide bar |  |
|------------------------------------|--|

14. Approximately, how many lecture hours are utilized to teach about **examination** for the lymphatic system (e.g. circumferential measurement, special tests, volumetric measurements, integument, etc.)?

| | |
|-------------------------|--|
| Click to write Choice 1 |  |
|-------------------------|--|

15. Is the subject matter of **interventions** for the lymphatic system taught at this institution's entry-level PT program?

- Yes
- No

16. What course (s) is this material taught in? Select all that apply.

- Anatomy
- Cardiopulmonary
- Integumentary
- Neuromuscular
- Musculoskeletal
- Pathophysiology
- Physiology
- Other, describe: _____







17. Please select which lymphatic **interventions** that are taught at this institution's entry-level PT program. Select all that apply.

- Compression Devices (garments, night-time garment, devices, etc.)
- Manual lymphatic techniques
- Multi-layer compression bandaging
- Sequential pneumatic compression pump
- Skin care
- Therapeutic exercises
- Other, describe: _____







18. Please identify if the coursework on the following **interventions** include lecture, lab, or both.

| | Lecture | Lab |
|--|-----------------------|-----------------------|
| Compression Devices (garments, night-time garments, devices, etc.) | <input type="radio"/> | <input type="radio"/> |
| Manual lymphatic techniques | <input type="radio"/> | <input type="radio"/> |
| Multi-layer compression bandaging | <input type="radio"/> | <input type="radio"/> |
| Sequential pneumatic compression pump | <input type="radio"/> | <input type="radio"/> |
| Skin care | <input type="radio"/> | <input type="radio"/> |
| Therapeutic exercises | <input type="radio"/> | <input type="radio"/> |

19. Approximately, how many lab hours are utilized to teach about the following lymphatic **interventions**?

| | |
|--|--|
| Compression Devices (garments, night-time garments, devices, etc.) |  |
| Manual Lymphatic Techniques |  |
| Multi-layer compression bandaging |  |
| Sequential pneumatic compression pump |  |
| Skin care |  |
| Therapeutic exercises |  |

20. Approximately, how many lecture hours are utilized to teach about the following lymphatic **interventions**?

| | |
|--|--|
| Compression Devices (garments, night-time garments, devices, etc.) |  |
| Manual Lymphatic Techniques |  |
| Multi-layer compression bandaging |  |
| Sequential pneumatic compression pump |  |
| Skin care |  |
| Therapeutic exercises |  |

21. What is **your opinion** about the following statements?

| | Strongly Agree | Somewhat Agree | Neutral | Somewhat disagree | Strongly Disagree | Not Sure |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| The didactic education about the anatomy and physiology of the lymphatics is entry-level PT material. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The didactic education about the pathophysiology lymphatic system is entry-level PT material. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The skill set training in examination of the lymphatic system (e.g. circumferential measurements, special tests, volumetric measurements, integument, etc.) is entry-level PT material. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The skill set training in interventions of the lymphatic system consisting of manual lymphatic techniques is entry-level PT material. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| The skill set training in interventions of the lymphatic system consisting of multi-layer compression bandaging is entry-level PT material. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

22. Please indicate if you consider the following **didactic** content matters as either entry-level material, non-entry-level material, or not sure for PT programs.

| | Entry-Level | Not Sure | Non Entry-Level |
|--|-----------------------|-----------------------|-----------------------|
| Anatomy of the deep lymphatics (joint capsule, periosteum, tendon, muscle) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Anatomy of the superficial lymphatics | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Comorbidities of lymphedema | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional limitation reporting | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Lymphedema classification | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Micro-circulation physiology | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Lipedema | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Pathophysiology of chronic venous insufficiency | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Pathophysiology of lymphedema | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Physiology of the lymphatics | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

23. Please indicate if you consider the following lymphatic **intervention** topics as either entry-level or non-entry-level material for PT programs.

| | Entry-Level | Not Sure | Non Entry-Level |
|---------------------------------------|-----------------------|-----------------------|-----------------------|
| Complete Decongestive Therapy | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Compression garments and devices | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Elastic taping | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Manual lymphatic techniques | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Multi-layer compression bandaging | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sequential pneumatic compression pump | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

24. Considering the integration of lymphology in the entry-level PT programs, which of the following challenges have you observed or are aware of? Select all that apply.

- Content is undervalued by faculty
- Content is undervalued by students
- I have not observed or aware of any challenges
- Lack of expertise
- Lack of resources
- Lack of time
- Material is beyond entry-level knowledge
- Material does not integrate into current curriculum
- Other, describe: _____

25. Which of the following strategies have you observed or are aware of being adapted to integrate the subject matter of lymphatics into the entry-level PT programs? Select all that apply.

- Consulted with credentialed therapist (s) about the subject matter
- Credentialed liaison/adjunct instructor to teach the subject
- Designated a faculty member to teach on the subject matter in all courses where the subject is taught
- I have not observed or aware of any strategies being adapted
- Offered elective courses pertaining to lymphatics
- Offered supervised clinical education experiences with either lymphedema clinics or clinics that have a certified lymphedema therapist
- Provided training for faculty member
- Other, describe: _____

26. How would you grade the content adequacy of the lymphology curriculum in the entry-level PT programs in the United States?



- 1 (F)
- 2 (D)
- 3 (C)
- 4 (B)
- 5 (A)

27. Identify the geographical region that the institution you teach at is located.

- Midwest
- Northeast
- South
- West

28. Which category best describes this institution?
- Private Institution
 - Public institution
29. What is your age in years?
- 18 - 24
 - 25 - 30
 - 31 - 40
 - 41 - 50
 - 51 - 60
 - 61 or older
30. What is your gender orientation?
- Female
 - Male
 - Prefer not to answer
 - Transgender
31. Do you currently provide physical therapy clinical care for a patient population?
- Yes (23)
 - No (24)
32. Identify which patient population (s) you provide physical therapy for. Select all that apply
- Cardiopulmonary
 - Geriatrics
 - Integumentary
 - Neuromusculoskeletal
 - Oncology
 - Orthopedics
 - Pediatrics
 - Sports Medicine
 - Women's Health (18)
 - Other, describe: (17) _____

33. Please select any of the following areas that you have acquired specialty certifications? Select all that apply.

- Cardiovascular and Pulmonary
- Clinical Electrophysiology
- Geriatrics
- Lymphedema
- Neurology
- Oncology
- Orthopedics
- Pediatrics
- Sports Medicine
- Women's Health
- Wound Care
- None of the above
- Other, describe: _____

34. What position(s) do you hold within the academic institution that you are employed? Select all that apply.

- Adjunct/Liaison Member
- Assistant Professor
- Associate Professor
- Clinical Professor
- Curriculum Coordinator of the PT program
- Director of the PT program
- Professor
- Other, describe: _____

35. What is your academic employment status?

- Full Time
- Part Time
- Occasional
- No formal appointment

36. How many years have you been a faculty member at your current institution employment?

| | |
|------------------------------------|--|
| Please select years with slide bar |  |
|------------------------------------|--|

37. What primary practice patterns do you teach? Select all that apply.

- Cardiovascular/Pulmonary
- Geriatrics
- Integumentary
- Musculoskeletal
- Neuromuscular
- Pediatrics
- Women's Health

Other, describe: _____

CHAPTER III

Effects of Manual Lymphatic Drainage Techniques on Conditions Affecting the Musculoskeletal System: A Systematic Review

David A. Doublestein, PT, PhD(c)

Sandy Sublett, PT, DPT

Min Huang, PT, PhD

Orthopaedic Physical Therapy Practice. 2020; 32(2): 92-101.

ABSTRACT

Background: Manual lymphatic drainage techniques (MLdT) have received interest for their efficacy in orthopedic rehabilitation and sports medicine. Strength of the body of evidence for using MLdT on conditions affecting the musculoskeletal system is not established. **Purpose:** To determine whether MLdT in addition to conventional rehabilitation on conditions affecting the musculoskeletal system, can decrease edema, and improve ROM, patient-reported outcomes, and healthcare utilization. **Methods:** Studies published between 2007 and 2018, with similar outcome measurements, were grouped for analysis. Strength of the body of evidence was determined by using the Cochrane GRADE guidelines, and the American College of Chest Physicians guidelines. **Findings:** There is moderate support for the use of MLdT for conditions affecting the musculoskeletal system as effective interventions to reduce pain, and improve patient-reported outcomes pertaining to functional activities and quality of life (QOL). MLdT are moderately effective treatment methods associated with lower healthcare utilization, edema reduction, and improving ROM. **Conclusions:** Moderate evidence was observed supporting the efficacy of MLdT in combination with conventional rehabilitation interventions for the treatment of conditions affecting the musculoskeletal system. Future research is needed to provide stronger evidence to support the use of MLdT for patients with conditions affecting the musculoskeletal system, and to determine which interventions concurrent with MLdT produce best outcomes.

INTRODUCTION

Inflammatory responses secondary to orthopedic disorders involve the lymphatic system with clinical presentations including non-infectious lymphangitis, lymphangiospasm, and lymphadenitis.¹ Subsequently, an altered cellular environment may lead to the proliferation of hyaluronan, fibrinogen, and irregular collagen that advance fibrosis and scar tissue.^{2,3} Unmanaged edema promotes less favorable states of repaired tissue that is prone to subsequent injury, or is less functional than the uninjured tissue state.² Therapists in orthopedic practice are routinely required to select edema management interventions, which requires sound clinical reasoning.

Many modalities have been utilized within the rehabilitation field to address edema and pain resulting from orthopedic disorders, including but not limited to ice, elevation, compression, electrical stimulation, ultrasound, and massage.⁴⁻¹⁰ The effectiveness of these modalities in reducing edema remains inconclusive. Additionally, their physiologic effect on the lymphatic system have not been fully explicated.^{5,6,9,11} Manual lymphatic drainage techniques (MLdT) can decrease edema and are one of the four components of complete decongestive therapy, which is considered the “gold standard” treatment for lymphedema.¹²⁻¹⁴ MLdT are gentle and rhythmic soft tissue techniques that stimulate the lymphatic structures without promoting erythema or inflammation^{1,15,16}, while supporting the absorption of excess fluid, protein, and waste products. The abolishment of an inflammatory reaction and associated edema is not expected from MLdT because this requires multifaceted treatment interventions. Although preliminary studies provide evidence to the effects of MLdT,¹⁵⁻¹⁷ the mechanism for these effects are still under investigation. From a physiological perspective, the gentle pressure and stretching components of MLdT stimulate the intrinsic and extrinsic lymph pumps, which increases lymph velocity via the contraction of smooth muscles within the lymph collector vessel.¹⁸ Manual lymphatic drainage techniques have demonstrated an effect on improving the contractility of the lymphatics as visualized by indocyanine green, near-infrared fluorescence imaging.¹⁹

In addition to edema reduction, MLdT are recognized for decreasing pain by stimulating a general parasympathetic response for the patient, resulting in general relaxation.^{17,20,21} The absorption of nociceptive chemical stimulants, such as lactic acid, cytokines, and inflammatory mediators, from the interstitial environment as a result of MLdT may have an analgesic

effect.^{1,22,23} The rhythmic, intermittent, and gentle pressures of MLdT stimulate the large diameter, non-nociceptive nerve fibers and decrease pain.²⁴

Manual lymphatic drainage techniques have received interest in orthopedic rehabilitation and sports medicine.^{25,26} A 2009 systematic review concluded that manual lymphatic drainage techniques were effective when combined with conventional musculoskeletal therapies, in sports medicine and rehabilitation. The authors concluded that MLdT are particularly useful in reducing edema and enzyme serum levels associated with acute skeletal muscle cell damage.²⁶ Another review also confirmed the effectiveness of MLdT for patients with musculoskeletal edema in orthopedic injuries.²⁵ Although these previous reviews have provided some evidence of the benefits of MLdT pertaining to reducing musculoskeletal edema from acute orthopedic and sports-related injuries; the body of evidence on the effects of MLdT on range of motion (ROM), patient-reported outcomes pertaining to pain, functional activities and quality of life (QOL), and health care utilization (HU) have yet to be explored.

OBJECTIVES

The primary objective of this systematic review was to examine if the addition of MLdT to conventional rehabilitation interventions in people with conditions affecting the musculoskeletal system were effective in decreasing edema, and improving ROM and patient-reported outcomes. A secondary objective was to examine outcomes specifically related to edema, pain, ROM, functional outcomes, QOL, and HU between interventions with and without MLdT.

SEARCH STRATEGY

This systematic review used the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) format.²⁷ An extensive literature probe was conducted from 09/07/17 through 04/07/18 using the following electronic databases: PEDro (via University of Sydney), CINAHL (via EBSCO), PubMed (via U.S. National Library of Medicine), Cochrane Library (via Wiley Online Library), Scopus (via Elsevier), Physical Therapy & Sports Medicine Collection (via GALE CENGAGE Learning), and Google Scholar. Key search terms included *lymph*, *lymphatic*, *mobilization*, *drainage*, *manual*, *orthopedic*, *musculoskeletal*, *edema*, *oedema*, *knee*, *foot*, *ankle*, *hip*, *back*, *neck*, *shoulder*, *elbow*, *wrist*, and *hand*. Filters included *[NOT] lymphedema*, *[NOT] cancer*, *human subjects*, *clinical trials*, *case reports*, *retracted publications*, and *controlled trials*. Examples of key word combinations are outlined in Appendix III.A.

ELIGIBILITY CRITERIA

Screening of titles and abstracts were conducted by the principal investigator and co-investigator, using study selection-criteria, designed by the authors for guidance. Occasions in which there were discrepancies, a third reviewer also completed the screening for inclusion. Criteria for initial inclusion included those articles written in English, with a publication date range of 01/01/2007 through 05/15/2018. Due to a dearth of peer-reviewed journal articles on MLdT and conditions affecting the musculoskeletal system, the primary search included randomized trials, non-randomized controlled cohort studies, case-series, and case-control studies. The population of interest were human subjects aged five years or older with a confirmed condition affecting the neuromusculoskeletal system, not limited to a specific body region. The working definition for conditions affecting the musculoskeletal system was a result of searching for inclusionary terms under this broad heading.²⁸⁻³¹ Inclusionary terms for conditions affecting the musculoskeletal system are listed in Appendix III.A. These broadly-based definitions, enabled searching for relevant literature to expand multiple methods of MLdT, as well as, multiple conditions that are commonly seen within orthopedic rehabilitation practices.

The intervention inclusion criteria included, manual interventions from frequently reported MLdT, including Vodder technique, manual lymph drainage, Chikly technique, lymph drainage therapy, Artzberger technique, manual edema mobilization (MEM), or Leduc technique.³²⁻³⁶ Techniques that stimulated the lymphatics from a light touch, rhythmic, skin tractioning method, not directly associated with a specific tenet, were also included in the study selection. MLdT may have been used as a stand-alone treatment or concomitant with other modalities, other than those in the exclusion criteria.

Studies that were anecdotal, descriptive, expert opinions, or qualitative designs were excluded. Conditions, such as cancer, lymphedema, lympho-lipedema, and chronic venous insufficiency were excluded.

DATA EXTRACTION

Data extraction from the included studies was conducted independently by the principal investigator and the co-investigator, using a template adapted from the Cochrane Handbook for Systematic Reviews of Intervention – A.6.1 characteristics of included studies for systematic reviews.³⁷ Discrepancies were resolved with a third reviewer. The characteristics of interest included the authors, level of evidence, validity scale, participants, conditions affecting the

musculoskeletal system, aims of the study, intervention group, control group, outcomes, key findings, and conclusions. The information on other conventional interventions were added to the characteristics template. The level of evidence was determined using the 2011 Oxford Centre for Evidence-based Medicine (OCEBM).³⁸ The PEDro scale, was used to determine the internal validity of the randomized controlled trial (RCT) studies.³⁹⁻⁴¹ The PEDro scale operational criteria are outlined in Appendix III.B. The PEDro scores for each study were given individually by the authors, and discrepancies resolved by a third author. Upon scores finalization, studies were given a descriptive terminology quality rating, ranging from poor to excellent as previously developed by Foley, et al.⁴² The studies were grouped, based on similar outcomes data, for the synthesis of the body of evidence. The strength and quality of the body of evidence was determined by using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) guidelines.⁴³⁻⁴⁶ Using GRADE methodology levels of evidence (Appendix III.C), outcomes from the studies were assessed based on their limitations, heterogeneity, directness, and publication bias. Using operational definitions and guidelines from the American College of Chest Physicians (ACCP)^{46,47} the level of evidence was further evaluated. (Appendix III.D).

RESULTS

The initial literature search resulted in retrieving 112 published articles. Duplicates were removed. Screening of the remaining 97 articles based on the title and abstract, resulted in the removal of 82 articles. A total of 15 articles met the inclusion criteria and were included for a full text review. A total of five articles^{24,48-51} met eligibility criteria, and were included in the analyses (Figure III.1). The kappa value for interrater agreement for manuscript selection was considered substantial⁵² at 0.77.

Insert figure III.1 here

Various tenets of MLdT were described in the literature, as well as various outcomes and their measures. All studies included in the analyses had RCT research design. Inadequate blinding of subjects, and of intervention therapists were noted in all the studies, as well as a lack of intention-to-treat analysis. Four out of five studies had a “good” rating of methodological quality (internal validity) according to the PEDro scale (Table III.1), and categorical ratings.⁴² The kappa value of 0.70 for interrater agreement for PEDro scores was considered substantial.⁵²

A low scoring RCT study⁵⁰ was included, as it offered information pertaining to the auxiliary intervention of compression.

Three of the included studies focused on the effects of MLdT in acute orthopedic disorders, specifically postoperative knee arthroplasty and transtibial amputation.^{48,50,51} The study by Knygsand-Roenhoej and Maribo focused on subacute edema resulting from distal radius fracture.⁴⁹ The remaining study focused on the effect of MLdT in a chronic condition.²⁴ Homogeneous outcomes of the studies included edema, ROM, patient-reported outcomes on pain, function, and QOL, and HU. A summary of the key findings is presented in Table III.2, and a summary of qualitative assessments is shown in Table III.3.

BENEFITS OF MLdT ON EDEMA

Various edema measurement methods were employed in the studies, including Volumeter, bioimpedance, and circumferential measurements. Minimal clinically important difference (MCID) of edema measurements in breast cancer related lymphedema patients have been analyzed. In this population, MCID values for circumferential measurement range from 0.37 to 0.71 centimeter, and percent volume change range from 1.5% to 3.5%.⁵³ MCID values have not been established for edema in conditions affecting the musculoskeletal system. Pichonnaz et al.,⁵¹ and Ebert et al.,⁴⁸ reported a lack of significant changes in edema following MLdT. An increase in edema from the second to the seventh day during the MLdT treatment period has been reported.⁵¹ Edema increased by 1.9% in the group receiving 30 minutes of MLdT in addition to conventional treatment, compared to 4.1% in the control group receiving 30 minutes of relaxation training in addition to conventional treatment.⁵¹ Topuz et al. found statistically significant reduction ($p < 0.05$) in circumferential measurements in patients who received complete decongestive physiotherapy (CDP).⁵⁰ In their study, multilayer short-stretch compression therapy was used in addition to MLdT.⁵⁰ In comparison with traditional edema management techniques (TEM) (i.e. elevation, compression, and functional training), non-statistically significant reduction in edema following three ($p = 0.31$) and six weeks ($p = 0.31$) of MLdT was reported.⁴⁹ However, edema reduction was achieved with significantly fewer edema treatment sessions ($p = 0.03$) with MLdT (14.1 sessions) compared to TEM techniques (19.2 sessions).⁴⁹ In summary, studies providing MLdT alone or adding MLdT to a conventional treatment protocol have demonstrated effectiveness in reducing edema.

BENEFITS OF MLdT ON RANGE OF MOTION

Both MLdT and TEM improved active ROM ($p < 0.01$) for thumb opposition and fingertip to palm distance, but the difference between groups was not significant at six weeks ($p = 0.32$) and nine weeks ($p = 0.23$) follow-up.⁴⁹ Studies of patients with TKA have demonstrated improvements in ROM following MLdT.^{48,51} In the study by Ebert et al.,⁴⁸ a significant increase in knee flexion active ROM was observed in the group receiving MLdT ($p = 0.031$) compared to controls who did not receive MLdT. Similarly, Pichonnaz et al. found that knee flexion contracture was more than 2° less prevalent in the MLdT group compared to the control group at 3 months post TKA, although the difference between groups did not reach statistical significance ($p = 0.07$).⁵¹ In summary, three out of seven included studies measured ROM and all reported significant improvements in ROM with adding MLdT to the treatment.

BENEFITS OF MLdT ON PATIENT-REPORTED OUTCOMES

Pain

In the studies included for the review, pain was measured using a standard Visual Analog Scale (VAS), or a numeric pain scale. Pain scales have been analyzed for MCID with various patient populations and disorders, and therefore should be considered context-specific, and interpreted appropriately to avoid any misguidance.⁵⁴ MCID improvements in pain, represented on a ten centimeter (100 mm) visual analog scale have also been noted to range widely from 8 mm to 40 mm.⁵⁴ Diagnosis may also influence the MCID; noted when comparing TKA pain levels measuring a 22.6 mm MCID;⁵⁵ whereas, in systemic sclerosis MCID was represented by 32.02 mm.⁵⁶ In this review, comparing the effect on pain levels post-distal radius fracture, during rest and activity, both MLT and TEM techniques decreased pain levels, but showed no statistically significant overall mean differences between groups (rest = 0.40, $p = 0.30$; activity = 0.22, $p = 0.42$).⁴⁹ Similarly studies in patients post-TKA did not find differences between MLdT and TEM.^{48,51} Pichonnaz et al.⁵¹ noted a significant decrease in pain immediately after the application of 4 out of 5 MLdT treatment sessions, but it was not statistically significant between groups 3 months postoperative at rest (9.0 mm, $p = 0.52$) and during gait activities (16.7 mm, $p = 0.06$), and the reduction in pain did not meet or exceed the MCID for pain levels.⁵⁵ Ekici et al.²⁴ noted significant and progressive decreases in fibromyalgia pain levels with both MLdT and massage groups, but no significant difference in pain levels between groups at the end of 5 weeks of treatment was found ($p = 0.06$). The improvements in pain remained stable from the

first treatment till the end of the study. In summary, 4 out of 5 studies measured pain levels and all reported effectiveness in reducing pain with providing MLdT alone or adding MLdT to a conventional treatment, however, not all improvements were statistically significant in comparison to controls.

Other Self-Reported Outcomes

Various self-reported outcome measurement tools on functional activities and QOL were utilized across the studies. Using an investigator designed questionnaire, Knygsand-Roenhoej and Maribo⁴⁹ found statistically significant improvements in activities of daily living that were seen after three weeks of MEM ($p = 0.03$) compared to TEM techniques, but the improvements plateaued at the sixth and ninth weeks follow-up. Tying shoelaces, eating with a knife and fork, peeling potatoes, and cutting a slice of bread were among the activities included in the questionnaire.⁴⁹ The study of patients post-TKA by Ebert et al.⁴⁸ reported improvements in QOL as measured by the Knee Injury and Osteoarthritis Outcome Score questionnaire, with significant time effect ($p < 0.001$), but without significant group or interaction effects. In comparison, another study of patients post-KA observed that MLdT had no significant effect on self-reported knee function as measured by Knee Society Score questionnaire ($p = 0.90$), and the Western Ontario and McMaster Universities Osteoarthritis Index ($p = 0.50$).⁵¹ Patients with fibromyalgia treated with MLdT demonstrated significant improvements in the total score of Fibromyalgia Impact Questionnaire ($p = 0.01$), and scores in areas of feeling more rested in the morning ($p = 0.006$), and less anxiety ($p = 0.060$), compared to those treated with connective tissue massage.²⁴ In summary, 4 out of 5 included studies reported on self-reported outcomes, in which 2 reported effectiveness in improving either functional activities or QOL, when providing MLdT alone or adding MLT to a conventional treatment. Not all improvements were statistically significant in comparison to controls.

BENEFITS OF MLdT ON HEALTHCARE UTILIZATION

Two studies addressed the efficacy of MLdT from a framework of HU. Healthcare Utilization can be associated with appropriate or inappropriate treatment, frequent or infrequent visits, and of high or low cost. In comparison with TEM, significantly fewer sessions for edema treatment were required with MEM ($p = 0.03$), in order to decrease subacute arm/hand edema.⁴⁹ In geriatric patients post transtibial amputation, the application of complete decongestive therapy, consisting of MLdT and reusable, multilayer short-stretch compression bandages,

resulted in a significantly shorter transition period to a permanent prostheses ($p < 0.05$); compared to single use, multi-application compression bandages.⁵⁰ In summary, a decrease in medication costs for migraine patients, a decrease in total number of visits for individuals with hand/arm edema, and a decrease in the cost of supplies for individuals using permanent prostheses have been reported. Therefore, MLdT may lower HU in selected patient conditions.

DISCUSSION

Summary of Evidence

Moderate evidence supports the use of MLdT for decreasing edema in acute, subacute, and chronic healing phases of conditions affecting the musculoskeletal system. While studies pertaining to acute edema evidenced a lack of volume reduction with MLdT, one study⁵¹ reported less increase in edema compared to the control group. Reduction in girth⁵⁰ suggested that acute edema may benefit from MLdT, when the addition of auxiliary multilayer short-stretch compression bandaging and exercises is incorporated. Compression was one key treatment which appeared to influence the outcomes of one study;⁴⁹ all subjects in the control group utilized compression by means of Coban® and Isotoner® gloves, whereas, the MEM intervention group used a “low-stretch bandage system if needed.”⁴⁹

Moderate evidence suggests the use of MLdT for improving ROM after TKA. This evidence seems to be antithetical with the lack of significant edema reduction noted in two studies.^{48,51} One author⁵¹ suggested that their improved ROM observations may be attributed to the slight decrease in edema, mechanical effects of MLdT during popliteal maneuvers, prevention of fibrosis through protein reabsorption, or simply through relaxation.

Moderate evidence promotes the use of MLdT for decreasing pain and improving outcomes pertaining to functional activities and QOL. While MLdT do not present with superiority in decreasing pain levels compared to other forms of manual therapy techniques, there seems to be preliminary evidence that these techniques may afford a quicker and more stable analgesic effect.⁵¹ Similar to the effects on pain level outcomes, MLdT are not superior in improving self-reported functional or QOL outcomes compared to other treatment measures.

Moderate evidence supports the use of MLdT for improving HU. Patient advocacy requires rehabilitation therapists to be responsible with the delivery of evidence-based practice. In these preliminary studies, MLdT promoted the use of less medication and supplies, and fewer treatment sessions.^{49,50}

Limitations and Strengths

While the available body of literature pertaining to orthopedics and MLdT continues to build, there are limited high quality evidence studies encompassing the broad spectrum of conditions affecting the musculoskeletal system, which poses the inevitable random error of significant heterogeneity of included studies. The diversity of study populations, outcome measures, and study designs may lead the intended audience to question the applicability of the summary of the evidence provided. In addition, the low number of participants included in the studies render results that are not necessarily generalizable. However, the notable heterogeneity embodies the orthopedic practice of rehabilitation specialists, which establishes this systematic review true and applicable to orthopedic practice diversity. Another limitation that arises from a dearth of literature, is the uncertainty of gathering all related studies. Finally, there may have been studies with non-significant or inconclusive data, which have not been published, that would have influenced the overall results.

CONCLUSIONS

There was moderate support for using MLdT for conditions affecting the musculoskeletal system as effective interventions to reduce pain, and improve function and/or QOL. This review also affirms that MLdT are effective treatment methods associated with lower HU. Pertaining to ROM improvement and edema reduction, the results of this study suggest that MLdT with auxiliary therapies may be effective, and certainly not ineffective or harmful. However, due to moderate methodological quality of the included studies, the evidence-based practice of MLdT should only proceed with clinical expertise and the patient values in perspective. While the studies represented in this review demonstrated heterogeneity, their differences are an appropriate generalizable outcome for orthopedic therapy practices. Since the first similar systematic review by Vairo et al²⁶ there has been an increase number of randomized clinical trials pertaining to MLdT. However, the need for further RCTs and cohort studies are warranted, to understand the attributes, benefits, and limitations of MLdT. Standardized measurements are imperative to these future studies, and researchers are advised to consider homogenous methodology with previous studies. In addition, research on MCID for edema pertaining to conditions affecting the musculoskeletal system would make significant clinical and comparative lymphedema research contributions. Future research is needed to provide stronger evidence to support the use of MLdT for patients with conditions affecting the musculoskeletal system, and

provide evidence as to which auxiliary interventions concurrent with MLdT produce best outcomes.

FUNDING

No external funding was obtained for this study. No financial conflicts of interest to disclose.

REFERENCES

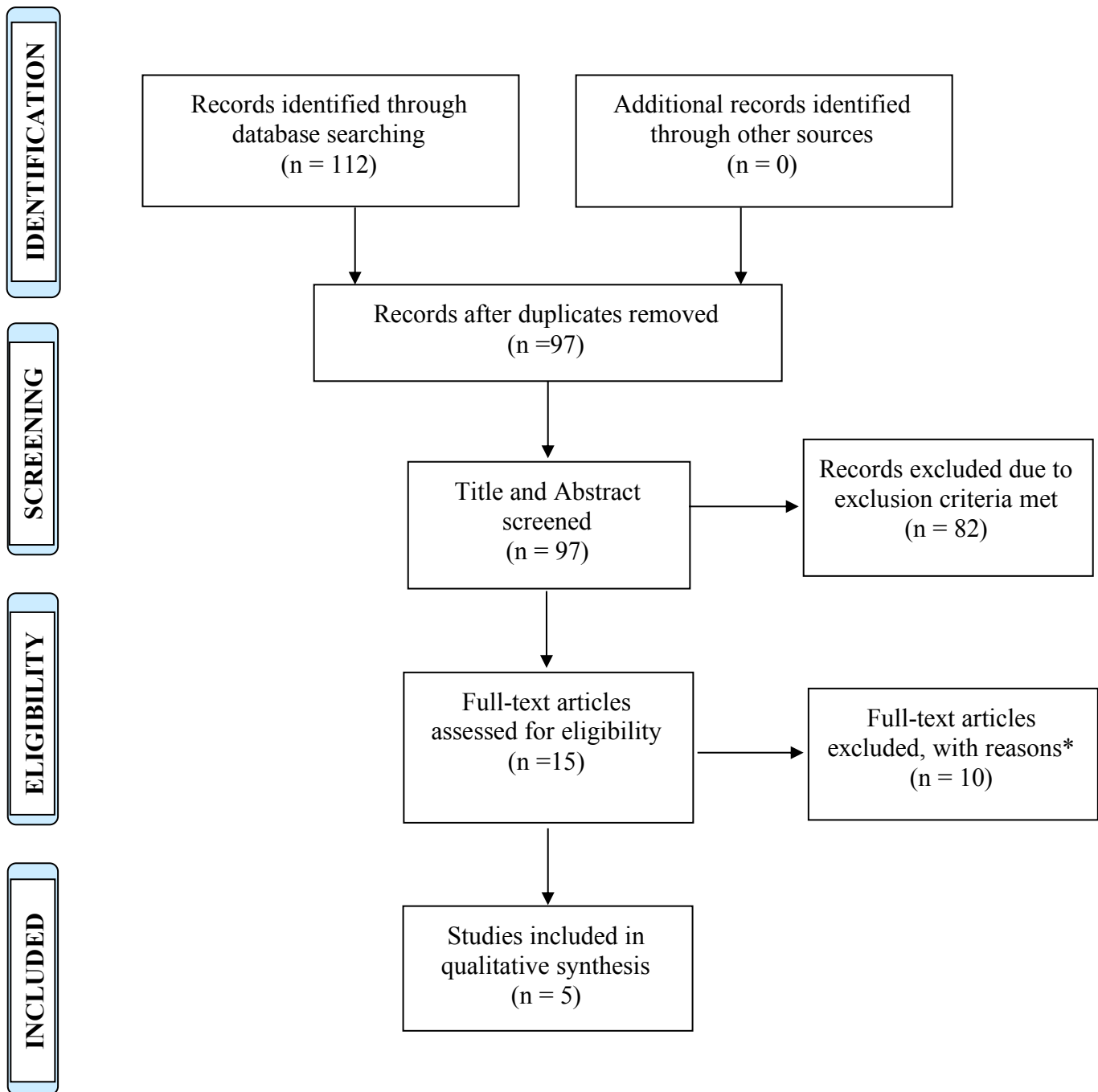
1. Földi M, Földi E, Kubik S. *Textbook of Lymphology*. 1st ed. Germany: Elsevier; 2003.
2. Villeco JP. Edema: A silent but important factor. *J Hand Ther*. 2012;25(2):153-162. doi:10.1016/j.jht.2011.09.008
3. Levick JR, Michel CC. Microvascular fluid exchange and the revised Starling principle. *Cardiovasc Res*. 2010;87:198-210.
4. Lake DA, Wofford NH. Effect of therapeutic modalities on patients with patellofemoral pain syndrome. *Sport Heal A Multidiscip Approach*. 2011;3(2):182-189. doi:10.1177/1941738111398583
5. Snyder AR, Perotti AL, Lam KC, Bay RC. The influence of high-voltage electrical stimulation on edema formation after acute injury: A Systematic Review. *J Sport Rehabil*. 2010;19(4):436-451. doi:10.1123/jsr.19.4.436
6. Van Den Bekerom M, Struijs P, Blankevoort L, Welling L, Van Dijk CN, Kerkhoffs G. What is the evidence for rest, ice, compression, and elevation therapy in the treatment of ankle sprains in adults? *J Athl Train*. 2012;47(4):435-443. doi:10.4085/1062-6050-47.4.14
7. Bleakley C, McDonough S, MacAuley D. The use of ice in the treatment of acute soft-tissue injury. *Am J Sports Med*. 2004;32(1):251-261. doi:10.1177/0363546503260757
8. Stöckle U, Hoffmann R, Schütz M, von Fournier C, Südkamp NP, Haas N. Fastest reduction of posttraumatic edema: Continuous cryotherapy or intermittent impulse compression? *Foot Ankle Int*. 1997;18(7):432-438. doi:10.1177/107110079701800711
9. Breger Stanton D, Lazaro R, MacDermid J. A systematic review of the effectiveness of contrast baths. *J Hand Ther*. 2009;22(1):57-70. doi:10.1016/J.JHT.2008.08.001
10. Coté DJ, Prentice WE, Hooker DN, Shields EW. Comparison of three treatment procedures for minimizing ankle sprain swelling. *Phys Ther*. 1988;68(7):1072-1076.
11. Adie S, Naylor JM, Harris IA, al. et, al. et. Cryotherapy after total knee arthroplasty a systematic review and meta-analysis of randomized controlled trials. *J Arthroplasty*. 2010;25(5):709-715. doi:10.1016/j.arth.2009.07.010
12. Uzkeser H, Karatay S, Erdemci B, Koc M, Senel K. Efficacy of manual lymphatic drainage and intermittent pneumatic compression pump use in the treatment of lymphedema after mastectomy: a randomized controlled trial. *Breast Cancer*. 2015;22(3):300-307. doi:10.1007/s12282-013-0481-3
13. Mazzotti E, Bartoletti R, Sebastiani C, Scoppola A, Marchetti P. The complete decongestive therapy to treat lymphedema in post-breast cancer surgery and its relationships with patients psychological and physical characteristics: A pilot study. *J Cancer Treat Res*. 2015;3(3):37-41. doi:10.11648/j.jctr.20150303.13
14. Norton S. Lymphedema 101. *Wound Care Advis*. 2012;1(4):30-34. http://woundcareadvisor.com/wp-content/uploads/2012/11/Lmph_N-D12.pdf. Accessed February 18, 2018.
15. Williams A. Manual lymphatic drainage: exploring the history and evidence base. *Br J Community Nurs*. 2010;15(4):S18-S24.
16. Korosec BJ. Manual lymphatic drainage therapy. *Home Heal Care Manag Pract*. 2004;16(6):499-511. doi:10.1177/1084822304264618
17. Ochalek K, Grądalski T. The use of manual lymph drainage in vascular diseases. *Acta Angiol*. 2011;17(3):189-198.
18. Zawieja DC. Contractile physiology of lymphatics. *Lymphat Res Biol*. 2009;7(2):87-96.

19. Tan I-C, Maus EA, Rasmussen JC, et al. Assessment of lymphatic contractile function after manual lymphatic drainage using near-infrared fluorescence imaging. *Arch Phys Med Rehabil.* 2011;92(5):756-764.
20. Kim S-J, Kwon O-Y, Yi C-H. Effects of manual lymph drainage on cardiac autonomic tone in healthy subjects. *Int J Neurosci.* 2009;119(8):1105-1117.
21. Shim J-M, Yeun Y-R, Kim H-Y, Kim S-J. Effects of manual lymph drainage for abdomen on the brain activity of subjects with psychological stress. *J Phys Ther Sci.* 2017;29(3):491-494. doi:10.1589/jpts.29.491
22. Bakar Y, Coknaz H, Karli U, Semsek O, Serin E, Pala OO. Effect of manual lymph drainage on removal of blood lactate after submaximal exercise. *J Phys Ther Sci.* 2015;27(11):3387-3391. doi:10.1589/jpts.27.3387
23. Vranova M, Halin C. Lymphatic vessels in inflammation. *J Clin Cell Immunol.* 2014;05(04):1-11. doi:10.4172/2155-9899.1000250
24. Ekici G, Bakar Y, Akbayrak T, Yuksel I. Comparison of manual lymph drainage therapy and connective tissue massage in women with fibromyalgia: A randomized controlled trial. *J Manipulative Physiol Ther.* 2009;32(2):127-133.
25. Majewski-Schrage T, Snyder K. The effectiveness of manual lymphatic drainage in patients with orthopedic injuries. *J Sport Rehabil.* 2016;25(1):91-97. doi:10.1123/jsr.2014-0222
26. Vairo GL, Miller SJ, McBrier NM, Buckley WE. Systematic review of efficacy for manual lymphatic drainage techniques in sports medicine and rehabilitation: An evidence-based practice approach. *J Man Manip Ther.* 2009;17(3):80E-90E.
27. Moher D, Liberati A, Tetzlaff J, Altman DG, Group TP. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med.* 2009;6(7):e1000097. doi:10.1371/journal.pmed.1000097
28. HealthStatus - Orthopedic Disorders. HealthStatus LLC. https://www.healthstatus.com/health_blog/back-shoulder-joint-pain/orthopedic-disorders/. Published 2017. Accessed September 20, 2017.
29. Physical Therapy Web; Physical Therapy Articles and Resources - Conditions, Injuries and Diseases Treated by Physical Therapists. <http://physicaltherapyweb.com/conditions-injuries-diseases-treated-physical-therapists/>. Published 2017. Accessed September 20, 2017.
30. John Hopkins Medicine - Health Library. The Johns Hopkins University, The Johns Hopkins Hospital, and Johns Hopkins Health System. http://www.hopkinsmedicine.org/healthlibrary/conditions/orthopaedic_disorders/common_orthopedic_disorders_85,P00907. Published 2017. Accessed September 20, 2017.
31. University of Rochester Medical Center. Common Orthopedic Disorders. <https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=85&contentid=P00907>. Published 2017. Accessed January 1, 2017.
32. Leduc O, Leduc A. Manual Lymph Drainage (Leduc Method). In: Byung-Boong Lee, John Bergan SGR, ed. *Lymphedema: A Concise Compendium of Theory and Practice*. London: Springer; 2011:245-250.
33. Chikly B. A controlled comparison between manual lymphatic mapping (mlm) of plantar lymph flow and standard physiologic maps using lymph drainage therapy (ldt). *Qual Prim Care.* 2015;23(1):46-50.
34. Kasseroller RG. The Vodder School: The Vodder Method. *Cancer.* 1998;83(12):2840-

- 2842.
35. Artzberger S. Edema reduction techniques: A biologic rationale for selection. In: Cooper C, ed. *Fundamentals of Hand Therapy: Clinical Reasoning and Treatment Guidelines for Common Diagnoses of the Upper Extremity*. St. Louis, Missouri: Mosby Elsevier; 2007:36-52.
 36. Howard SB, Krishnagiri S. The use of manual edema mobilization for the reduction of persistent edema in the upper limb. *J Hand Ther*. 2001;14(4):291-301. doi:10.1016/S0894-1130(01)80008-9
 37. Higgins J, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions*. 5.1.0. The Cochrane Collaboration, 2011; 2011. www.handbook.cochrane.org.
 38. Oxford Centre for Evidence-Based Medicine. OCEBM levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". <http://www.cebm.net/index.aspx?o=5653>. Accessed January 1, 2017.
 39. Sherrington C, Herbert RD, Maher CG, Moseley AM. PEDro. A database of randomized trials and systematic reviews in physiotherapy. *Man Ther*. 2000;5(4):223-226. doi:10.1054/math.2000.0372
 40. Elkins MR, Moseley AM, Sherrington C, Herbert RD, Maher CG. Growth in the Physiotherapy Evidence Database (PEDro) and use of the PEDro scale. *Br J Sports Med*. 2013;47(4):188-189. doi:10.1136/bjsports-2012-091804
 41. de Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. *Aust J Physiother*. 2009;55(2):129-133. doi:10.1016/S0004-9514(09)70043-1
 42. Foley NC, Teasell RW, Bhogal SK, Speechley MR. Stroke rehabilitation evidence-based review: Methodology. *Top Stroke Rehabil*. 2003;10(1):1-7. doi:10.1310/Y6TG-1KQ9-LEDQ-64L8
 43. Balshem H, Helfand M, Schünemann H, et al. GRADE guidelines: 3. Rating the quality of evidence. *J Clin Epidemiol*. 2011;64(4):401-406. doi:10.1016/J.JCLINEPI.2010.07.015
 44. An algorithm was developed to assign GRADE levels of evidence to comparisons within systematic reviews. *J Clin Epidemiol*. 2016;70:106-110. doi:10.1016/J.JCLINEPI.2015.08.013
 45. Guyatt GH, Oxman AD, Schünemann HJ, Tugwell P, Knottnerus A. GRADE guidelines: A new series of articles in the Journal of Clinical Epidemiology. *J Clin Epidemiol*. 2011;64(4):380-382. doi:10.1016/j.jclinepi.2010.09.011
 46. Eden J, Levit L, Berg A, Morton S, eds. *Finding What Works in Health Care: Standards for Systematic Reviews*. Washington: National Academies Press; 2011. <https://www.nap.edu/catalog/13059/finding-what-works-in-health-care-standards-for-systematic-reviews>. Accessed August 12, 2018.
 47. Guyatt G, Gutterman D, Baumann M, et al. Grading strength of recommendations and quality of evidence in clinical guidelines. *Chest*. 2006;129(1):174-181.
 48. Ebert J, Joss B, Jardine B, Wood D. Randomized trial investigating the efficacy of manual lymphatic drainage to improve early outcome following total knee arthroplasty. *Arch Phys Med Rehabil*. 2013;94(11):2103-2111.
 49. Knygsand-Roehoej K, Maribo T. A randomized clinical controlled study comparing the effect of modified manual edema mobilization treatment with traditional edema technique in patients with a fracture of the distal radius. *J Hand Ther*. 2011;24(3):184-194. doi:10.1016/j.jht.2010.10.009

50. Topuz S, Ülger Ö, Bakar Y, Şener G. Comparison of the effects of complex decongestive physiotherapy and conventional bandaging on edema of geriatric amputees: a pilot study. *Top Geriatr Rehabil.* 2012;28(4):275-280.
51. Pichonnaz C, Bassin J-P, Lécureux E, et al. Effect of manual lymphatic drainage after total knee arthroplasty: A randomized controlled trial. *Arch Phys Med Rehabil.* 2016;97(5):674-682. doi:10.1016/j.apmr.2016.01.006
52. McHugh M. Interater reliability: the kappa statistic. *Biochem Medica.* 2012;22(3):276-282.
53. Chen Y-W, Tsai H-J, Hung H-C, Tsauo J-Y. Reliability study of measurements for lymphedema in breast cancer patients. *Am J Phys Med Rehabil.* 2008;87(1):33-38. doi:10.1097/PHM.0b013e31815b6199
54. Olsen MF, Bjerre E, Hansen MD, et al. Pain relief that matters to patients: systematic review of empirical studies assessing the minimum clinically important difference in acute pain. *BMC Med.* 2017;15(1):35. doi:10.1186/s12916-016-0775-3
55. Danoff JR, Goel R, Sutton R, Maltenfort MG, Austin MS. How much pain is significant? Defining the minimal clinically important difference for the visual analog scale for pain after total joint arthroplasty. *J Arthroplasty.* 2018;33(7):S71-S75.e2. doi:10.1016/J.ARTH.2018.02.029
56. Daste C, Rannou F, Mouthon L, et al. Patient acceptable symptom state and minimal clinically important difference for patient-reported outcomes in systemic sclerosis: A secondary analysis of a randomized controlled trial comparing personalized physical therapy to usual care. *Semin Arthritis Rheum.* 2019;48(4):694-700. doi:10.1016/j.semarthrit.2018.03.013

Figure III.1. PRISMA Flow Diagram.



* One study was a protocol with embedded MLT text. One study was dismissed due to its case series design. Three studies focused on the physiological effects of MLT not related to an orthopedic disorder. One study had English abstract but foreign manuscript. Two studies did not align with conditions affecting the musculoskeletal system definition.

Table III.1. Characteristics of the Seven Included Studies.

| Author | Level of Evidence (OCEBM) | Experimental Design | Internal Validity Scale (PEDro) | Rating* |
|--|----------------------------------|----------------------------|--|----------------|
| Knygsand-Roehoej K, et al. (2011) | 2 | RCT | 6/10 | Good |
| Pichonnaz C, et al. (2011) | 2 | RCT | 7/10 | Good |
| Ebert D, et al. (2013) | 2 | RCT | 7/10 | Good |
| Ekici G, et al. (2009) | 2 | RCT | 7/10 | Good |
| Topuz S, et al. (2012) | 2 | RCT | 4/10 | Fair |
| <i>OCEBM = Oxford Centre of Evidence Based Medicine, RCT = Randomized Clinical Trial, PEDro = Physiotherapy Evidence Database</i> <i>*Excellent – 9-10, Good = 6-8, Fair = 4-5, Poor = below 4⁴⁰</i> | | | | |

Table III.2. Summary of Key Findings.

| Author | Participants | Intervention | Conventional Interventions |
|---|--|--|--|
| Knygsand-Roehoej, et al. (2011) | 29 patients, 72% Females with average age 64, 5-8 weeks after unilateral distal radius fracture, treated with plaster cast, internal or external fixation, and with a diagnosis of subacute edema. | n = 14; 3x/wk for 4 weeks and then 2x/wk for 2 weeks consisting of Modified MEM, HEP, low stretch bandage if needed, Isotoner glove daily. | Therapy for ROM and strengthening, HEP. |
| Pichonnaz, et al. (2016) | 56 patients diagnosed status post TKA, 65% women with a mean age of 71. | n = 29; 5 thirty minutes sessions of MLD (Strossenreuther method) per working day from 2nd day to 7th day post operatively. | Postoperative hospital-based rehabilitation protocol = ROM, strengthening, CPM, gait training, and cryotherapy. |
| Ebert, et al. (2013) | 43 patients/53 knees (72% males) with a mean age of 70 years, diagnosed status post TKA. | n = 24, 30 minutes of MLD and remedial postoperative orthopedic massage techniques, on postoperative days 2, 3, and 4. | Postoperative hospital-based rehabilitation protocol = ROM, strengthening, CPM, gait training, and cryotherapy. |
| Ekici, et al. (2009) | 53 women with a mean age of 38 years, diagnosed with fibromyalgia. | n = 26 females; 5x/wk for 3 weeks consisting of 45 minutes of MLD therapy. | None |
| Topuz, et al. (2012) | 11 patients, mean age 67 years, diagnosed postoperative transtibial amputee. | n = 5; Received CDP and diaphragmatic breathing. | Stretching, dynamic stump exercises, isometrics, and isotonics. The CDP was instructed to conduct diaphragmatic breathing. |
| <p><i>Complete Decongestive Physiotherapy (CDP), Continuous Passive Motion (CPM), Fibromyalgia Impact Questionnaire (FIQ), Health Related Quality of Life (HRQoL), Home Exercise Program (HEP), Manual Edema Mobilization (MEM), Manual Lymph Drainage (MLD), Quality of Life (QOL), Range of Motion (ROM), Total Knee Arthroplasty (TKA), Visual Analog Scale (VAS).</i></p> | | | |

Table III.2 Continued. Summary of Key Findings.

| Author | Outcomes | Key Findings | Conclusions |
|---|---|--|---|
| Knygsand-Roenhoej, et al. (2011) | Measured at 1st, 3rd, 6th, 9th, and 26th week post inclusion. Edema, active ROM, pain, and ADL, number of treatment sessions. | In the modified MEM group, improvement was observed in ADL after the 3 weeks measurement ($p = 0.03$). Fewer edema treatment sessions were needed ($p = 0.03$) in the modified MEM group. | Neither modified MEM treatment nor traditional edema treatment were superior to each other. Modified MEM resulted in fewer required sessions to decrease subacute edema compared to traditional methods. |
| Pichonnaz, et al. (2016) | Measured at enrollment, 2nd day, 7th day, and 3 months postoperative TKA. Truncated Cone Volumetric measures via tape, bioimpedance, VAS, Knee Society Score, Osteoarthritis Index, Gait analysis, active and passive knee ROM. | Passive knee flexion contracture at the 3 months measurement was statistically significant for being lower and less frequent in the MLD group compared to the control group. Pain level decrease on the VAS immediately after the MLD treatment was statistically significant for 80% of the MLD sessions. | MLD applied in the short-term after TKA did not reduce swelling. MLD reduced pain after the treatment session and reduced the extent of knee flexion contracture and its frequency 3 months post operatively. |
| Ebert, et al. (2013) | Measured at enrollment, days 2, 3, 4 and 6 weeks post operatively. Active and passive knee ROM, Truncated Cone Volumetric measures via tape, VAS, and Knee Injury and Osteoarthritis Outcome Score. | Increased active knee flexion at day 4 post-surgery ($p = 0.014$, 95% CI, effect size =0.79,1.68-16.67) and at 6 weeks postoperatively ($p = 0.012$, 95% CI, effect size =0.87,2.32-16.78). | MLD applied in the short term after TKA improves active knee flexion up to 6 weeks postoperatively. |
| Ekici, et al. (2009) | Measured at baseline and at end of treatment (3 weeks). VAS, pain pressure threshold algometry, HRQoL, FIQ. | Improvements regarding pain intensity, pain pressure threshold, and HRQoL ($p < 0.05$). The MLD group improvements with the FIQ total score ($p = 0.010$). Subsets of the FIQ (morning tiredness FIQ-7 and anxiety FIQ-9) particularly demonstrated improvements ($p = 0.006$) | MLD Therapy was found to be more effective than Connective Tissue Massage according to subsets of the FIQ (morning tiredness and anxiety) and total FIQ scores. |
| Topuz, et al. (2012) | Circumferential measurements at 5 locations of the involved lower extremity, Days of hospital stay, and days to transition into permanent prosthesis. | The transition into permanent prosthesis was shorter in the CDP group ($p < 0.05$). Circumferential measurements were more obvious in the CDP group ($p < 0.05$). | CDP is effective in reducing post amputation stump edema in geriatric amputees. The reduction of edema was more obvious in the CDP group. CDP is effective in shortening the transitional period into permanent prostheses. |
| <p><i>Complete Decongestive Physiotherapy (CDP), Continuous Passive Motion (CPM), Fibromyalgia Impact Questionnaire (FIQ), Health Related Quality of Life (HRQoL), Home Exercise Program (HEP), Manual Edema Mobilization (MEM), Manual Lymph Drainage (MLD), Quality of Life (QOL), Range of Motion (ROM), Total Knee Arthroplasty (TKA), Visual Analog Scale (VAS).</i></p> | | | |

Table III.3. Summary of Qualitative Assessments.◇

| Outcomes | Subgroups | Author(s) | No. of Subjects | Risk of Bias |
|--------------------------------------|--|---|-----------------|--------------|
| Edema | Circumferential measurements, Bioimpedance, Volumeter, Truncated Cone Volume | Ebert et al. 2013; Knygsand-Roehoej and Maribo 2011; Pichonnaz et al. 2016 | 128 | (-0)◆ |
| Pain | Frequency, VAS, Numeric Scale | Ebert et al. 2013; Ekici et al. 2009; Knygsand-Roehoej and Maribo 2011; Pichonnaz et al. 2016 | 181 | (-0)◆ |
| Range of Motion | Active and/or Passive | Ebert et al. 2013; Knygsand-Roehoej and Maribo 2011; Pichonnaz et al. 2016 | 128 | (-0)◆ |
| QOL and Other Self-Reported Outcomes | Functional and QOL Scales | Ebert et al. 2013; Ekici et al. 2009; Knygsand-Roehoej and Maribo 2011; Pichonnaz et al. 2016 | 181 | (-0)◆ |
| Healthcare Utilization | Decreased supplies, treatment time, or sessions | Topuz et al. 2012; Knygsand-Roehoej and Maribo 2011 | 40 | (-1)≡ |

◇ Due to limited number of events, small sample size, and studies with non-normal distribution, effect sizes were not pooled.

◆ No serious risk of bias. PEDro internal validity scale ranged 6-8, and a “good”⁴⁰ rating.

≡ Topuz, et al. utilized different compression strategies between groups, which may have influenced a type 1 error. PEDro internal validity scale is a 4/10.

Table III.3 Continued. Summary of Qualitative Assessments.◇

| Outcomes | Inconsistency | Indirectness | Publication Bias | Imprecision |
|---|----------------------|---------------------|-------------------------|--------------------|
| Edema | (-1)◆◆ | (- 0)◆◆◆ | (- 0)◆◆◆◆ | (- 0)⊄ |
| Pain | (-1)◆◆ | (- 0)◆◆◆ | (- 0)◆◆◆◆ | (- 0) |
| Range of Motion | (-1)◆◆ | (- 0)◆◆◆ | (- 0)◆◆◆◆ | (- 0) |
| QOL and Other Self-Reported Outcomes | (-1)◆◆ | (- 0)◆◆◆ | (- 0)◆◆◆◆ | (- 0) |
| Healthcare Utilization | (-1)◆◆ | (- 0)◆◆◆ | (- 0)◆◆◆◆ | (- 0)⊄ |
| <p>◇ Due to studies with small sample sizes and studies with non-normal distribution, effect sizes were not pooled.</p> <p>◆◆ Due to heterogeneity of studies and small populations resulted in inconsistent effect sizes.</p> <p>◆◆◆ Conclusions of the studies directly applied to the PICO.</p> <p>◆◆◆◆ Not observed and unlikely. No conflicts of interest reported.</p> <p>⊄ Topuz, et al. (2012) had small number of events and moderate confidence intervals, but did not distract from the overall summary for imprecision.</p> | | | | |

Table III.3 Continued. Summary of Qualitative Assessments.◇

| Outcomes | Dose-Response Association | Residual Confounders | Large Effect | Quality of Evidence* | Quality of Evidence** |
|---|----------------------------------|-----------------------------|---------------------|-----------------------------|------------------------------|
| Edema | (+ 0) | (+ 0) | (+ 0) ≈ | ★★★○ Moderate | Moderate |
| Pain | (+ 0) | (+0) | (+ 0) | ★★★○ Moderate | Moderate |
| Range of Motion | (+ 0) | (+ 0) | (+ 0) | ★★★○ Moderate | Moderate |
| QOL and Other Self-Reported Outcomes | (+ 0) | (+ 0) | (+ 1) ⊕ | ★★★★ High | Moderate |
| Healthcare Utilization | (+ 0) | (+ 0) | (+ 0) ≈ | ★★○○ Low | Moderate |
| <p>◇ Due to studies with small sample sizes and studies with non-normal distribution, effect sizes were not pooled. ≈ Topuz, et al. (2012) had large and/or very large effect sizes for outcomes. ⊕ Ekici, et al. (2009) contributed a large effect size. *As analyzed using GRADE⁴¹⁻⁴⁴; **As analyzed using American College of Chest Physicians⁴⁴⁻⁴⁵</p> | | | | | |

Appendix III.A. Inclusionary Terms and Examples of Key Word Combinations.

| Inclusionary Terms | | | |
|--|-----------------|--|--|
| Conditions affecting the musculoskeletal system may consist of many conditions including, but not limited to, fractures, tendinitis, tendinosis, bursitis, sprains, strains, tears, degenerative conditions, post orthopedic surgical conditions, arthritis, bursitis, elbow pain and conditions, fibromyalgia, foot pain and conditions, fractures, hip pain and conditions, low back pain and conditions, hand pain and conditions, knee pain and conditions, neck pain and conditions, osteoporosis, shoulder pain and conditions, and soft tissue injuries. ²⁸⁻³¹ | | | |
| Key Search Terms and Strategy | | | |
| System | Disorder | Treatment | Localization |
| Lymph Lymphatic Orthopedic Musculoskeletal | Edema Oedema | Lymph Drainage Manual Lymph Drainage Manual Edema Mobilization | Knee Foot Ankle Hip Back Neck Shoulder Elbow Wrist Hand |
| PubMed Search Strategy Examples: <ol style="list-style-type: none"> 1. lymphatic AND drainage AND hand NOT lymphedema 2. lymphatic AND drainage AND knee NOT lymphedema 3. manual lymph drainage AND ankle NOT lymphedema 4. manual lymph drainage NOT lymphedema NOT cancer 5. lymphatic drainage AND orthopedic NOT cancer NOT lymphedema | | | |
| Google Scholar Search Strategy Examples: <ol style="list-style-type: none"> 1. "manual lymph drainage" knee edema -lymphedema 2. "manual edema mobilization" hand edema -lymphedema 3. "manual lymph drainage" -cancer -lymphedema 4. "lymph drainage" "orthopedic" -cancer -lymphedema | | | |

Appendix III.B. Operational Criteria of the PEDro Scale.

1. Eligibility criteria were specified;
2. Random allocation of subjects into groups (in a crossover study, subjects were randomly allocated an order in which treatments were received);
3. Allocation was concealed;
4. Groups were similar at baseline regarding the most important prognostic indicators;
5. There was blinding of all subjects;
6. There was blinding of all therapists who administered the therapy;
7. There was blinding of all assessors who measured at least one key outcome;
8. Measures of at least one key outcome were obtained from > 85% of the subjects initially allocated to groups;
9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or if not the case, then data for at least one key outcome was analyzed by “intention to treat”
10. The between-group statistical comparisons are reported for at least one key outcome; and
11. The study provides both point measures and measures of variability for at least one key outcome.

Appendix III.C. Operational Definitions of GRADE's Four Levels of Evidence

1. High Level of Quality (⊕⊕⊕⊕): Authors are very confident that the true effect lied close to that of the estimate of the effect.
2. Moderate Level of Quality (⊕⊕⊕○): Authors are moderately confident in the effect: The true effect is likely to be close to the estimate of the effect but there is a possibility that it is substantially different.
3. Low Level of Quality (⊕⊕○○): Authors confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect.
4. Very Low Level of Quality (⊕○○○): Authors have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of the effect.

Five categories which may downgrade the quality of evidence:

1. Risk of Bias: -1 if serious, -2 if very serious
2. Inconsistency: -1 if serious, -2 if very serious
3. Indirectness: -1 if serious, -2 if very serious
4. Imprecision: -1 if serious, -2 if very serious
5. Publication Bias: -1 if likely, -2 if very likely

Three categories which may upgrade the quality of evidence:

1. Large Effect: +1 if large, +2 if very large
2. Dose Response: +1 if evidence of a gradient
3. All plausible residual confounding: +1 would reduce a demonstrated effect, or would suggest spurious effect if no effect was observed

Appendix III.D. Operational Definitions of ACCP.

1. High Level of Quality: Reports from RCTs without significant limitations or overriding evidence from observational studies.
2. Moderate Level of Quality: Reports from RCTs with consequential limitations (inconsistent results, methodological flaws, indirect, or imprecise) or from observational studies with exceptionally strong evidence.
3. Low Level of Quality: Reports from observational studies or case series.

CHAPTER IV

Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer Survivors with Breast Cancer Related Lymphedema

David A. Doublestein, PT, PhD(c)

Amy Yorke, PT, PhD

Cathy Larson, PT, PhD

Allon Goldberg, PT, PhD

Bryan Spinelli, PT, PhD

ABSTRACT

Background: Breast cancer survivors (BCS) with breast cancer related lymphedema (BCRL) have demonstrated neuromusculoskeletal restrictions, sensorimotor impairments, postural instability, and balance deficits. To date, there have not been studies which investigate outcome measures (OMs) used by certified lymphedema therapists (CLTs) on BCS with BCRL.

Objectives: The purpose of this study was to examine 1) OMs used by CLTs on BCS with BCRL and their differences between professions; 2) unique characteristic predictors for use of OMs; and 3) facilitators and barriers which influence CLTs use of OMs and their differences between professions. **Methods:** Cross-sectional online survey research design. Electronic surveys were distributed to certified lymphedema therapists from various institutions. Data from 70 physical therapists (PTs) and 41 occupational therapists (OTs) were analyzed from 130 completed surveys. Descriptive statistics, Chi-square test of independence, and independent samples t-test were used to examine respondent demographic and practice characteristics, and group differences multiple variables, while binary logistic regression examined unique predictors to the use of OMs. **Results:** Sixteen OMs used most often assessed joint function, flexibility, strength, pain, volume, sensation, tissue consistency, body composition, health related quality of life, and upper quadrant function. There were differences between PTs and OTs in use of OMs but no trends in associations with specializations or schooling. Lymphology Association of North America certification, practice setting, and profession (PT and OT) predicted the use of some OMs. Use of OMs were valued by OTs and PTs but not equally. **Conclusions:** This study has identified individual OMs used on BCS with BCRL in clinical practice among interdisciplinary CLT practitioners. The number of OMs used to assess body functions and structures exceed those OMs for activities and participation which may be influenced by CLT profession, LANA certification, and level of highest degree. CLTs agree on the benefits of and to the use of OMs but experience barriers to their use related to knowledge and competence of OMs.

INTRODUCTION

Breast cancer related lymphedema (BCRL) that develops in breast cancer survivors (BCS) is a consequence of cancer intervention procedures, and characterized as an excessive accumulation of protein rich fluid in the interstitial environment of the ipsilateral upper-quadrant.¹ The incidence of BCRL is approximately 30-42% of those who undergo axillary lymphadenectomy, or irradiation interventions status post modified radical mastectomy.^{1,2} BCRL is a progressive chronic disease that presents with variable morbidity affecting body functions and body structures, and restrictions and limitations in activities and participation. The comorbidities include various musculoskeletal changes limiting range of motion and strength, difficulty reaching, increased fatigue and volume, sensory impairments, pain, integument changes, low self-esteem, and quality of life.^{1,3-7} In addition, BCS with BCRL have also demonstrated impairments of proprioception and sensorimotor functions realized as significant decrease in postural stability and balance.^{8,9}

Outcome Measures

Standardized outcome measures (OMs) are an essential component of evidence-based practice (EBP) and are often incorporated in the examination of a disorder and the outcome assessment of interventions for related impairments of body functions and structures, and limitations of activities and participation.^{10,11} The results of these OMs provide a foundation for clinical reasoning in the diagnosis, prognosis, and establishment of intervention and/or management of a health condition.¹² The use of OMs in the clinical setting can justify the efficacy of a plan of care for chronic conditions such as in BCRL. OMs are a key component to patient-centered care, value-based health services, and current reimbursement models, especially in complex long-term conditions.¹³

Generally, physical therapists (PT) hold positive attitudes about EBP and believe that OMs enhance patient-provider and provider-payer communication, enhance examination thoroughness, and improve directing and focusing a plan of care.^{11,14} Similarly, nurses (RN) and athletic trainers (ATC) have positive beliefs about EBP.^{15,16} While various healthcare professionals have positive beliefs about EBP and that OMs are considered useful for enhancing levels of communication and thoroughness of a plan of care, their use may be limited within these professions. Jette et al.¹⁴ reported that only 48% of PTs used OMs. Approximately

74 - 85%^{16,17} of clinically practicing ATCs do not use patient-reported OMs. In contrast, use of OMs within specialty groups may demonstrate favorable trends. A study investigating therapists who were specialized in hand therapy reported that 92% used patient-reported OMs.¹⁸

Barriers and Facilitators To Using Outcome Measures

Knowledge of and the competence to use of OMs are routinely reported as significant barriers for the use of OMs across healthcare disciplines.^{15,19,20} Other significant barriers reported across disciplines include lack of time to implement, scoring and interpreting OMs, difficulty in patient comprehension, low perceived value of the measurement, lack of suitability of the instrument, lack of appropriate psychometric properties of the instrument, diminished attitude toward EBP and OMs, and lack of advocacy from management and peers.^{14-16,19-23}

Common facilitators of OMs juxtapose the barriers. What is clearly evident in the literature is that education is needed to inform clinicians of OMs and enhance their competence and confidence in their use, which will facilitate clinical use of OMs, valuing EBP, promotion within the work setting, and cooperative initiatives in research.^{15,19,20,24}

Current Evidence for Outcome Measures on Breast Cancer Survivors and Lymphedema

In 2010, the American Physical Therapy Association (APTA) Oncology Section formed the Breast Cancer – Evaluation Database to Guide Effectiveness (EDGE) Task Force, commissioned to identifying best tests/outcome measures that were reliable, valid, and had good clinical utility for individuals treated for breast cancer.²⁵ The Breast Cancer EDGE Task Force used domains of the World Health Organization's (WHO) International Classification of Functioning, Disability, and Health (ICF) model to categorize outcomes and identify valid clinical measurement tools. Studies related to lymphedema focused on upper extremity assessment²⁶ and quality of life²⁷ OMs of secondary lymphedema in BCS. A clinical practice guideline was developed by the Oncology Section of the APTA and published in 2017.²⁸ This guideline focused on the diagnosis of upper-quadrant lymphedema secondary to breast cancer. Table IV.1 lists the OMs recommended by the Breast Cancer EDGE Task Force rated B (moderate recommendation) or A (Strong recommendation) for clinical use on BCS. In 2013, the Dutch Society of Dermatology organized a task force to create guidelines for lymphedema supporting a continuum of assessments and intervention modalities.²⁹ Due to effectiveness and favorable economic impact, this task force used the domains from the ICF model³⁰ of the WHO

and from the chronic care model.³¹ The Dutch Lymphedema Guideline recommendations of OMs (Table IV.1) were made based on an interdisciplinary approach to lymphedema and broad subdomains of measures under the ICF domains of body functions and structures, and activities and participation.

Recommended OMs on BCS, lymphedema, and BCS with BCRL have been established by the Breast Cancer EDGE Task Force and the Dutch Society of Dermatology. Beyond these documents, there are additional OMs for these populations evidenced in the research literature. There have not been studies investigating the use of OMs, whether or not recommended, by certified lymphedema therapists (CLTs) on BCS who have BCRL. Adding to that fact is that there is a multidisciplinary group of professionals that are CLTs including, PTs, occupational therapists (OTs), massage therapists (MTs), nurses (RNs), and physicians (MDs).³² The use of OMs across a number of healthcare disciplines^{14,16,33} has been limited over the last decade. Furthermore, there is limited evidence on differences in the use of OMs between PTs, OTs, RNs, and MDs.^{33,34} Past studies have reported a greater use OMs by PTs compared to OTs,³⁴ and MDs and RNs compared to PTs and OTs.³³ Facilitators and barriers to the use of OMs on BCS with BCRL have not been explored in the diverse healthcare professionals (e.g. PTs, OTs, MTs, MDs, and RNs) that are CLTs. The purpose of this study was to examine 1) OMs used by CLTs on BCS with BCRL and their differences between professions; 2) unique characteristic predictors for use of OMs; and 3) facilitators and barriers which influence CLTs use of OMs and their differences between professions.

METHODS

Design and Subjects

A cross-sectional online survey design was implemented, gathering responses from CLTs from various post-professional lymphedema continuing education programs and related professional associations in the United States. The distinct inclusion criterion of the CLT population was determined due to their use of OMs in BCRL practice, their expertise and extensive lymphedema training, and for the convenience sampling from continuing education programs and the professional associations that relate to BCS and BCRL. CLTs who did not see patients with BCRL were excluded from the study.

Instrument

An online survey (Appendix IV.A) format was constructed through Qualtrics software, Version June, 2020 of Qualtrics, copyright© 2020 Qualtrics. The survey was divided into three domains to gather; 1) demographics and practice characteristics of respondents (22 questions), 2) levels of use of standardized and clinically relevant OMs with subdomains of joint function, flexibility, strength, volume, pain, sensation, tissue consistency, body composition, patient-reported functions and health-related quality of life (HRQOL), patient-reported upper quadrant function, patient-reported fatigue, mobility and balance, and upper extremity activity and motor control (92 questions), and 3) levels of agreement on facilitators and barriers to using OMs (38 questions). Survey development used a modified version of the validated surveys from Jette et al.^{11,14} which investigated evidence-based practice and OMs used in physical therapy. In addition, survey development also followed a survey from a thesis³⁵ with various modifications. Modifications of these surveys were made to 1) improve face validity by focusing questions toward BCRL and multi-disciplinary CLTs; 2) incorporate standardized and clinically relevant OMs; and 3) incorporate facilitators and barriers to the use of BCRL OMs. Facilitators and barriers to the use of OMs were categorized from a modified format outlined by Braun et al.,³⁶ which includes; 1) beliefs of the therapist, 2) knowledge and competence, 3) healthcare practice, 4) business structures, and 5) healthcare equality.

Face validity of the survey was attested by the primary investigator and three collaborative colleagues via assessing its design based on similar studies. Consultation with two colleagues, with experience in survey research design, about survey formatting, grammar, and precision of questions prompted survey questionnaire modifications. The questionnaire was then pilot tested by six certified lymphedema therapists. An agreement between a minimum of two³⁷ CLTs with BCRL experience on the survey instrument was considered sufficient to confer the content validity of the survey instrument. Content validity was determined by calculating the item-level content validity index (I-CVI) which measures the content validity of the individual items, and the average I-CVI for the content validity of the overall tool.³⁸ Six content experts were asked to rate whether each domain and subdomain item had clarity and was relevant based upon its breadth to capture CLT's clinical practice use, barriers, and facilitators of OMs. The I-CVI scored high for the demographic domain (I-CVI = 0.83 – 1.00), OMs subdomains (I-CVI =

1.00), and facilitators and barriers domain (I-CVI = 1.00). The average I-CVI for the survey tool was 0.99. These experts were also invited to provide recommendations to the survey which resulted in minor grammar modifications to the final survey.

Procedure

The study received exempt status by the Health Sciences and Behavioral Sciences Institutional Review Board of the University of Michigan – Flint and from A.T. Still University-Arizona Institutional Review Board. Approximately 7,000 emails with survey links were e-mailed to CLT graduates from the post-professional education institutions and related professional associations. After giving consent, participants completed the online survey questionnaire administered through Qualtrics®. The survey was available for 53 days, but due to low response rate, a follow-up email was sent 16 days after the initial invitation and another institution was included 25 days after the outset for further dissemination of the survey.

Data Analysis

Data were analyzed using IBM® SPSS® version 26 (Armonk, NY). The total sample of respondents (n = 130) included PT, OT, MT, and RN. The completion rate was 98%, with 3 surveys incomplete at 99%, 85%, and 70% completion. Due to sparsity of respondents from MT and RN professions, the sample was collapsed for analysis (n = 111) and included groups most represented, including 1) OT CLTs (n = 41) and 2) PT CLTs (n = 70). These groups were examined to understand their 1) demographic (Table IV.2) and 2) practice characteristics (Table IV.3) differences. Characteristics included continuous, ordinal, and categorical data. A Shapiro-Wilk test showed a departure from normality for PT and OT CLTs for 1) years as CLT, 2) percent of practice devoted to lymphedema interventions, 3) number of BCRL clients in eight hours work day, 4) minutes allocated for initial evaluation, 5) minutes allocated for re-evaluation, 6) hours per week providing lymphedema interventions, and 7) percent of patients seen in specific age groups. Descriptive statistics were presented as means \pm standard deviations (SD), counts (n), and frequencies (%). Frequencies for multiple response variables (i.e. respondents could choose more than one choice) are reported as count and percent of cases. Independent samples t-test were used to analyze group differences for parametric data. Nonparametric data was analyzed with the chi-square test of independence and the Mann-

Whitney U test. Fisher's exact test was used when more than 20% of cells had expected counts less than five. Alpha level was set at 0.05 for all analysis.

The primary dependent categorical variables were OMs and were separated in two categories; 1) OMs used by CLTs to measure ICF domains of body functions and body structures with levels of 1.1) joint function, 1.2) flexibility, 1.3) strength, 1.4) volume, 1.5) pain, 1.6) tissue consistency, 1.7) body composition, and 1.8) sensation (Table IV.4); and 2) OMs used by CLTs to measure ICF domains of activities and participation and restrictions with levels of 2.1) patient-reported function and HRQOL, 2.2) patient-reported upper quadrant function, 2.3) patient-reported fatigue, 2.4) mobility and balance, and 2.5) Upper extremity activity and motor control (Table IV.5). Categories 1.1-1.7 and 2.3-2.4 were chosen based on their prominence in the BCRL literature including the APTA Oncology Section Breast Cancer EDGE Task Force recommendations, APTA Oncology Section Clinical Practice Guidelines for diagnosing BCRL, and the Dutch Lymphedema Guidelines. Categories 2.1 and 2.2 was parsed from the Breast Cancer EDGE Task Force category of Measures of Patient Reported Function and Quality of Life (Table IV.1) for a more robust analysis of upper quadrant function and health-related quality of life and for the inclusion of additional measures. Categories 1.8 and 2.5 were chosen based on their inclusion in the Guide to Physical Therapist Practice Focus on Tests and Measures³⁹ and their ability to gather upper extremity sensation, function, and motor performance in an objective format. The survey included 92 OMs that respondents ticked a Likert scale for level of use, which consisted of frequently used (i.e. used for initial examinations and reassessments), occasionally used (i.e. used for initial examinations), seldom used (i.e. intermittent use as warranted), and do not use. To simplify for analysis, this scale was dichotomized into Used to some degree of frequency (frequently, occasionally, and seldom used) and Not Used with frequencies reported as count and percent of responses (Table IV.4 and IV.5). For ease of reporting, the OMs were grouped by quartile cut points (Table IV.6) which divided the range of their use into equal probabilities. Chi-square test of independence was used to show group differences in the use of OMs between OTs and PTs, and when more than 20% of cells had expected counts less than five, the Fisher's exact test was implemented (Table IV.4 and IV.5). We used binary logistic regression to examine if respondent demographic and practice characteristics (independent variables) uniquely predict the use of OMs (dependent variables)

retrieved from Tables IV.4 and IV.5. Characteristics of interest were selected based on how commonly they are reported in the literature associated with the use of OMs and evidence-based practice, which included 1) age of therapist,⁴⁰ 2) highest degree earned,^{14,21} 3) years in practice,⁴¹ 4) practice specialization (dichotomized),^{14,21} 5) years as CLT,⁴¹ 6) Lymphology Association of North America (LANA) certification,^{14,21} 7) practice setting (dichotomized),¹⁴ 8) minutes allocated for initial evaluation,^{14,21} and 9) profession.^{42,43} Profession and highest degree were correlated ($r_s = 0.22$, $p = 0.02$) as well as therapist age and years of practice ($r = .90$, $p < 0.001$), which resulted in a moderate risk of multicollinearity (variance inflation factor > 5). Age of therapist was subsequently removed from the analysis resulting in a decreased risk of multicollinearity in the logistic models (Table IV.7). While other characteristics were considered, their cell sizes were inadequate to run logistic regression with meaningful output for inference.

The secondary dependent variable was facilitators and barriers for use of OMs and were categorized into five domains; 1) beliefs of the therapist, 2) knowledge and competence, 3) healthcare practice, 4) business structures, and 5) healthcare equality (Table IV.5) based off a previous study.³⁶ Statements regarding facilitators and barriers for use of OMs were scaled ordinally with 1) strongly agree, 2) somewhat agree, 3) neither agree or disagree, 4) somewhat disagree, and 5) strongly disagree. For the analysis, the ordinal scale was collapsed into three categories; 1) somewhat to strongly agree, 2) neither agree or disagree, and 3) somewhat to strongly disagree. The frequencies for each ordinal level were reported as count and percent of responses for both groups in Table IV.8. Chi-square analysis was used to examine differences between groups for all facilitators and barriers and Fisher's exact test was used when more than 20% of cells had expected counts less than five. Those that met significance are listed in Table IV.9.

RESULTS

Participants

As presented more completely in Tables IV.2 and IV.3, of those CLT respondents ($n = 111$) who use OMs on BCS with BCRL, 98% ($n = 109$) of the respondents were female and 2% ($n = 2$) were male, with an average age of 48 ± 10.6 years which was not significantly different between PT and OT groups ($t(108) = -0.27$, $p = 0.79$). Clinical practice of the respondents were

located mainly in Midwest US (30.6%, n = 34), followed by Southeast US (22.5%, n = 25) and Northeast US (21.6%, n = 24), where they practiced mostly in an outpatient clinic (n = 104, 93.7%) in either a suburban (42.3%, n = 47) or urban (36.9%, n = 41) community. The number of years in professional practice between PTs and OTs were not significantly different ($t(102) = -0.67, p = 0.50$), and averaged 22.7 ± 11.6 years. Forty-eight (68.5%) of PTs pursued National CLT certification through LANA, while only 56% (n = 23) of OTs pursued this credentialing. Respondents similarly reported a mean of $64.2\% \pm 29.2$ of their practice devoted to lymphedema management. The allocation of intervention and management for BCRL was similar for PTs and OTs with an average of 3.5 ± 3 BCS with BCRL seen in eight hours work day. Further respondent and practice characteristics and their related group differences are evidenced in Tables IV.2 and IV.3.

Use of outcome measures

Measures to assess ICF domains of body function and structures

A number of OMs were identified as being used at some level of frequency by CLTs to measure ICF domains of body functions and structures (Table IV.4). The use of circumferential measurements and calculated volume as the singular OM used at some level of frequency by CLTs for volume measures (99.1%, n = 110). In contrast, the bioimpedance spectroscopy OM for measuring volume was used at some level of frequency by only 20.7% of respondents. OMs used most often (i.e. 75.1 – 100% of respondents) (Table IV.4 and IV.6) were 1) goniometry for AROM to measure joint function (99.1%, n = 110) with no significant difference between OT and PT groups ($p = 0.37$), 2) Stiff glenohumeral joint to measure flexibility (93.7%, n = 104) with PTs using this measure more often ($p = 0.01$), 3) MMT to measure strength (98.2%, n = 109) with no difference ($p = 1.00$) between professions, 4) Light touch brushing to measure sensation (95.5%, n = 106) with no difference between groups ($p = 0.36$), 5) numeric pain scale (94.6%, n = 105) to measure pain with no difference between PTs and OTs ($p = 1.00$), 6) Pitting edema test to measure tissue consistency (98.2%, n = 109) with no difference between groups ($p = 0.13$), and 7) body weight to measure body composition (91.0%, n = 101) with no significant difference in use between professions ($p = 0.09$). Tonometer (7.2%, n = 8), Myoton (8.1%, n = 9) and SkinFibrometer (5.4%, n = 6), which are able to quantifiably measure tissue consistency (i.e. skin firmness and elasticity), were used least often (Table IV.6).

Measures to assess ICF domains of activities and participation

There were a number of OMs identified as being used at some level of frequency by CLTs to measure ICF domains of activities and participation (Table IV.5). The LLIS for patient-reported HRQOL and the *QuickDASH* for patient-reported upper quadrant (UQ) function were the patient-reported OMs used most often (i.e. fourth quartile of responses) by CLTs (82.9%, n = 92 and 85.6%, n = 95, respectively). OTs used the LLIS more often than PTs (χ^2 (1, n = 111) = 4.40, p = 0.04). Other OMs that are used to measure activities and participation (Table IV.5) include 1) DASH (73.0%, n = 81) for patient-reported UQ function with no significant difference between groups (χ^2 (1, n = 111) = 1.86, p = 0.19), 2) Visual analog scale (55.0%, n = 61) for patient-reported fatigue with PTs using it more often than OTs (χ^2 (1, n = 111) = 4.78, p = 0.03), and 3) Timed up and Go (73%, n = 81) for mobility and balance, which PTs use more often than OTs (χ^2 (1, n = 111) = 12.30, p < 0.01). Six out of thirteen patient-reported OMs for fatigue (Table IV.6) were used least often with probability distributions of use ranging from 2.7% (n = 3) to 10.8% (n = 12). All OMs listed under the category of upper extremity and motor control were used least often (Table IV.6), which included 1) 9 Item Arm Motor Ability Test (4.5%, n = 5), 2) Ruler Drop Test/ReacStick (4.5%, n = 5), 3) Finger Tapper (5.4%, n = 6), 4) Action Research Arm Test (8.1%, n = 9), 5) Box and Block Test (12.6%, n = 14), and 6) Purdue Peg Board (23.4%, n = 26).

Characteristics influencing use of outcome measures

There were unique respondent and practice characteristics of CLTs that predicted the use of OMs. The significant findings applied to only a few OMs and they are presented in Table IV.10. The results present that CLTs who are OTs are eleven times more likely to use the pinch dynamometer OM to assess strength and three times more likely to use the monofilament OM to assess sensation. CLTs that are not LANA certified are nearly four times more likely to use the sharp-dull discrimination OM for sensation and the DASH OM for patient-reported upper quadrant function, and are three times more likely to measure fatigue with the visual analog scale OM. Those CLTs with their highest professional degree being Master's of Science or Art are nearly four times more likely to use the functional reach OM to assess mobility and balance.

Facilitators and barriers to use of outcome measures

Facilitators and barriers to the use of OMs were investigated for both PTs and OTs (Table IV.8) and those that met a 75% frequency threshold at either ends of the scale are highlighted here. Most CLTs agreed that the use of OMs helps direct the plan of care (90.1%, n= 100), improves quality of care (76.6%, n = 85), helps in the clinical reasoning for choice of interventions (77.5%, n = 86), and are necessary for the practice of BCRL interventions and management (94.6%, n = 105). They also largely agreed that use of OMs improve communication with their BCS clients with BCRL (80.2%, n = 89) and with other healthcare stakeholders (76.6%, n = 85). Eighty percent of CLT respondents (n = 88) were consistently incorporating clinical practice guidelines (CPG) and systematic reviews in their diagnosis and interventions on BCRL, and they mostly agreed (78.2%, n = 86) that they had the ability to access current research pertaining to BCRL through professional journals. CLTs largely agreed that use of OMs was part of their personal practice model (81.8%, n = 90), were important for assisting in the identification of comorbidities (87.3%, n = 96), and helped determine the efficacy of their intervention on BCRL (72%, n = 80). Respondents also mostly agreed that executing OMs at regular intervals and for patient discharge were important (86.3%, n = 95 and 80%, n = 88, respectively). CLT respondents mostly disagreed that clients with BCRL requested that they use OMs (82.7%, n = 91). Table IV.9 listed the significant differences between professions for the facilitators and barriers. Compared to OTs (2.4%, n = 1), PTs (18.6%, n = 13) disagreed that OMs improve quality of care toward clients with BCRL. A similar scenario is noted with 18.8% (n = 13) of PTs disagreeing that OMS are necessary to determine intervention efficacy for clients with BCRL, compared to 2.4% (n = 1) of OTs. PTs were relatively uncertain if OMS increase the efficiency of evaluations, with 40% (n = 28) of the profession both agreeing and disagreeing. However, a majority (68.3%, n = 38) of OTs felt that OMs increased the efficiency of evaluations. Twenty percent of PTs (n = 14) neither agreed or disagreed that OMs improved communication with other healthcare stakeholders, compared to 2.4% of OTs (n = 1). A majority of OTs (92.7%, n = 38) agreed that the use of OMs helps in the clinical reasoning for choice of interventions on clients with BCRL, whereas only 68.6% (n = 48) of PT agreed and 14% (n = 10) neither agreed or disagreed.

DISCUSSION

Participants

The participants made up an equitable sample of PT and OT CLTs presumed present in the population. The demographics and practice characteristics in this sample are comparative to a 2010 national (n = 415) and a 2018 international survey (n = 950) that investigated practice environments, patient characteristics, and educational frameworks of CLTs.^{44,45} Similarities included; 1) female sex (98% vs 95%), 2) average age (48 vs 46), 3) percentage of PTs in PT/OT sample (63% vs 59%), and 4) percent practicing in outpatient facilities (93% vs 88%). This sample deviated from the 2018 survey with 64% (n = 71) of respondents being LANA certified (compared to 33%) and a professional work history of 22.5 years (range 1 – 45) (compared to 10.7 years). A majority of CLTs practiced in the Midwestern, Northeastern, and Southeastern regions of the US, while respondents from the Western, and Southwestern regions were few, which is similar to a 2020 study on CLT's practice patterns.⁴⁶ The distributions of this BCRL focused sample is comparable to the generalized lymphedema studies since 2009 and appears to be representative of the CLT population at large. These similar distributions suggest persistent gaps in this specialized field. In both BCRL and generalized lymphedema CLT populations there remains a limited number of male practitioners and younger practitioners. In addition, most CLTs practice in outpatient settings have been relatively unchanged since 2009 which is a concern for persons with lymphedema that are home bound or in a skilled nursing facility. In this study, rural community settings were least represented, which aligns with typical access to cancer care in rural regions of the US and influences patient outcomes,⁴⁷ bringing attention to the need for lymphedema management services in the underserved rural community settings.

OMs CLTs use that measure body functions and structures

There were a number of OMs used at some level of frequency to assess body functions and structures. Current CPGs that focus on the diagnosis and interventions of BCRL^{28,48} recommend using circumferential measurements for calculated volume which aligns with what is currently being used by CLTs as noted in this study. However, this OM may not be appropriate for subclinical/stage 0 BCRL, with the recommendation to use bioimpedance analysis,²⁸ of which the bioimpedance spectroscopy was an OM used least often (20.7%). Additional OMs currently being used by CLTs include; 1) numeric pain scale, 2) goniometry for PROM and

AROM, 3) stiffness of the glenohumeral joint for flexibility, and 4) MMT which have all been analyzed via systematic review by the Breast Cancer EDGE Task Force of the Oncology Section of the American Physical Therapy Association.²⁵ Of these, MMT was not recommended for use due to insufficient information on individuals with or post cancer. Body weight and BMI were used by CLTs and their use was recommended by the Dutch Society of Dermatology.²⁹ Pitting edema test via palpation was used to measure tissue consistency and has been vetted by systematic analysis, but was not recommended for use due to absence of diagnostic accuracy.²⁸ Ultrasonography was recommended in the BCRL CPG to assess underlying tissue changes, but only for Stage III BCRL,²⁸ but was used by only 6.3% of respondents. Other tissue consistency OMs that were used least often (i.e. first quartile, 0-25%) include the SkinFibrometer which is a valid and reliable (Intrarater ICC 0.88, 95% CI 0.82 – 0.84) quantitative measure of skin stiffness,^{49,50} tonometer (e.g. Durometer), and the Myoton which is a reliable quantitative measure (Intrarater ICC 0.89 (95% CI 0.74-1.00), Interrater ICC 0.74 (95% CI 0.45-1.00)).^{50,51} This is a significant concern as it demonstrates minimal use of available OMs with appropriate psychometrics and good clinical utility to assess tissue consistency as it is a component for staging lymphedema according to the International Society of Lymphology (ISL) staging system.⁵² Other measures frequently used but not formally analyzed by systematic review for BCRL include light touch brushing and tissue texture assessment via palpation. Unfortunately, a few of the OMs (e.g. dynamic motion of scapula, stiffness of glenohumeral joint, tissue texture-palpation, pitting edema test-palpation, pectoralis major and minor length, and manual muscle test) used by CLTs for body functions and structures may present with psychometric limitations for clinical settings involved in care for BCS and BCRL. This limitation severely limits the objective findings needed to demonstrate effective progress and efficacy of interventions, especially in areas such as tissue consistency, of which the ISL lymphedema staging are based on. Without valid and reliable objective measures for basics such as sensation, strength, and tissue consistency there are limitations in transfer of care, identification of comorbidities, and guidance for clinical reasoning on interventions. For instance, a CLT will need to specifically address deficits in sensation and strength in the home management program and improvements will need to be noted with valid and reliable OMs to foster clinical reasoning to adjust a plan of care. Without objective measures of tissue consistency, accuracy of fluid volume reduction

versus reduction in fibrosis remains elusive and is detrimental for continuum of care. Subjective OMs with poor psychometrics also limit the knowledge translation from research trials into the clinical practice.

OMs that CLTs use to measure activities and participation

Few OMs for measuring activities and participation were identified as being used most often. We had hypothesized that the number of impairment-based OMs would be used most often compared to OMs that assess activity and participation and our results concur. Surprisingly, CLTs are not frequently measuring upper extremity activity and motor control with objective and quantifiable OMs, as all measures assessed were found to reside in the first quartile of probability distributions (i.e. used least often). Respondents use the LLIS and/or *QuickDASH* most often (i.e. fourth quartile of responses) to measure activities and participation. The *QuickDASH* has been recommended by the Breast Cancer EDGE Task Force and has been determined to be a valid and reliable measure for breast cancer survivors⁵³ but not specifically for BCRL. The LLIS is a validated patient-reported HRQOL OM but recent studies using COSMIN have not recommended its use on BCRL.^{54,55} The Lymphoedema Quality of Life (LYMQOL) questionnaire was reported as being used by a three (2.7%) of the respondents but was not included in the list of OMs on the survey. This measure was not recommended by the Breast Cancer EDGE Task Force and other sources due to poor psychometrics and/or poor clinical utility.⁵⁴⁻⁵⁶ The Focus On Therapeutic Outcomes (FOTO) tool was reported as being used in the categories of 1) pain, 2) HRQOL, 3) upper quadrant function, 4) fatigue, 5) mobility and balance, and 6) upper extremity activity and motor control. FOTO is a web-based tool that uses patient-reported OMs to measure the functional status of patients. FOTO has a category for lymphedema which includes upper and lower extremity OMs and also includes the Fear Avoidance Belief – Physical Activity and patient satisfaction self-report questionnaires. Other patient-reported OMs, such as the patient specific functional scale and FACIT fatigue scale can be selected for the patient to complete as part of FOTO; however, the list of additional patient-reported OMs is generated by developer, NetHealth®, and may not be extensive for the needs of the patient or clinical practice. Perhaps more concerning is that the Centers for Medicare and Medicaid Services (CMS) state, “the outcomes collected by [these types of] tools are insufficient

individually for measuring performance...⁵⁷ This study has identified OMs that are performance-based and patient-reported in the ICF domain of activities and participation.

Performance-based and patient-reported OMs

The importance of using both performance-based and patient-reported OMs cannot be overstated. In a 2011 study comparing the two types of OMs on physiologic, psychosocial, and health factors influencing rehabilitation care, Bean et al. suggested that their findings revealed both performance-based and patient-reported OMs did not provide equivalent information about a patient's functional status and that their use should be chosen based upon the unique settings and situations of care.⁵⁸ These sentiments are expressed by other authors who have investigated these two types of OMs; reporting low to moderate correlations between them ($r = 0.29 - 0.59$, $r_s = 0.45 - 0.74$).^{59,60} In the case of BCRL, it may be prudent to use performance-based OMs for UE motor control activities if the interventions being evaluated for efficacy emphasized those limitations, while using a patient-reported OM may be more appropriate if the interventions being evaluated for efficacy are geared toward independence of BCRL management, activities of daily living, skin care, psychosocial factors, and fatigue.

Group differences and unique predictors to the use of OMs

Nearly half of the OMs in the third and fourth quartiles demonstrated significant differences in usage between PTs and OTs. This may result in the inability to compare outcomes with standardized OMs and can interfere with transition and continuum of care if standardized OMs are not routinely used by CLTs, especially when inter-referral patterns exist. Specializations^{14,21} may offer plausible explanation for these differences; however, this characteristic does not lend to a consistent explanation. For instance, there were significant group differences in the use of volumeter, pinch dynamometer, monofilament, and two-point discrimination with OTs using it most often, which may be attributed to the fact that significantly ($p < 0.01$) more OTs identified as being credentialed hand therapists (19.5%, $n = 8$) compared to PTs (0.0%, $n = 0$). This trend is also seen with least often used upper extremity activity and motor control OMs (e.g. 9 Hole Peg Test, Perdue Peg Board, and Box and Block Test). However, using Chi-square and Fisher's Exact test to examine associations between specializations and the use of OMs revealed that the hand therapy specialization is only associated with the use of pinch dynamometer ($p = 0.05$) and the Purdue Peg Board test ($p <$

0.01). There may be other reasons for group differences that were not investigated in this study such as business practice and professional role identification within a practice. The mobility and balance OMs were most often used by PTs despite that the OTs identified as having specialties in geriatrics (14.6%, n = 6) and acute care (19.5%, n = 8) more than PTs (χ^2 (1, n = 111) = 10.83, p < 0.01), (χ^2 (1, n = 111) = 5.10, p = 0.03) respectively), and significant group difference were not observed for the neurology specialty (p = 0.29). In fact, those respondents who identified as being credentialed in geriatrics and/or neurology used the 9 Hole Peg Test (p = 0.01 and p < 0.01 respectively), Box and Block Test (p = 0.03 and p < 0.01 respectively), Purdue Peg Board Test (p = 0.03 and p < 0.01 respectively), and the Volumeter (p = 0.02 and p = 0.02 respectively). So, while associations exist between credentialed specializations and use of OMs, commonplace trends related to profession are not fully evident. The binary logistic regression explored this further by looking at additional factors and covariates that may actually predict the use of the OMs. Significant predictors for the use of OMs included profession (e.g. OT and PT), LANA certification, and highest degree earned (e.g. Certification, Bachelors, Masters, Clinical Doctorate, Academic Doctorate). Profession,^{42,43} specialization,^{14,21} and highest degree earned,^{14,21} have been previously reported as being associated with use of OMs and our results concur to a limited extent. Of interest was that despite the difference in use of OMs between PTs and OTs, profession did not consistently present as a predictor for the same OMs that showed differences (Tables IV.4 and IV.5) between profession. The unique contribution of profession and the other predictors to the most often used OMs may also be considered as contributors to the facilitators and barriers to the use of OMs and will need further exploration.

Facilitators and barriers to the use of OMs

Our study demonstrates a diverse distribution for most facilitators and barriers, which will require further future statistical examination and most likely would benefit from a mixed methods research study, combining components of quantitative and qualitative research strategies, especially in categories of healthcare equality, business structures, and knowledge and competence. Understanding how the predictor variables in this study are associated with the facilitators and barriers is of interest for future examination. Examining the differences of opinions on facilitators and barriers between OT and PT CLTs has revealed some shortcomings in valuing the use of OMs. Unfortunately, a greater number of PTs than OTs have suggested that

the use of OMs do not improve quality of care or determine intervention efficacy. In contrast to OTs, more PTs do not agree that the use of OMs increase the efficiency of evaluations and are uncertain if their use improves communication with other healthcare stakeholders. Compared to OTs, more PTs disagree that the use of OMs helps in the clinical reasoning for choice of interventions on clients with BCRL. While these professional differences exist, overall the respondents value the use of OMs and find them necessary for the interventions and management of BCRL which is similar to other studies on EBP and OMs.^{11,14,42} The CLTs reported that they are incorporating CPG and systematic reviews related to BCRL diagnosis and interventions into their clinical practice. However, the use of MMT and LLIS as two OMs used most often for evaluations and reevaluations seem to suggest otherwise. While many respondents reported that OMs assisted in the identification of comorbidities, some of the impairment OMs were clinician rated. Furthermore, OMs for patient-reported fatigue, mobility and balance, and UE activity and motor control were not frequently used. These factors can limit a specialist's ability to identify the comorbidities of BCRL, such as proliferative fibrosis and adiposity, and deficits in strength, motor control, and balance. Ninety-five percent of respondents used AROM, MMT, circumference, sensation, and tissue consistency OMs most often on BCRL. However, these measures alone limit a specialist's comprehensive understanding of the chronic condition and related comorbidities, bringing into consideration the lack of whole-body assessment and interventions. A concern exists about the barriers related to knowledge and competence. Lack of knowledge of OMs has been investigated as being a barrier to their use.^{15,21,40,42,43,61} While most CLT respondents in our study reported that they had sufficient skills (70%, n = 78) to use and interpret the results (64%, n = 71) of OMs for clients with BCRL, only 46% (n = 51) reported that they had sufficient knowledge about OMs for BCRL and a majority (67%, n = 74) reported that they had difficulty knowing the best OM to choose due to numerous options. A majority (68%, n = 75) of respondents agreed that they did not receive sufficient training in their professional education on OMs for clients with BCRL. Whereas, an equal proportion of respondents reported that they did (45%, n = 50) or did not (44%, n = 49) receive sufficient training in their post-professional CLT courses on OMs for clients with BCRL. This is concerning for pre and post-professional educators and researchers. Extensive choices of OMs should be narrowed to guide specialists and researchers alike to gather best outcome evidence.

Educators, both pre- and postprofessional play a significant role in exposing PTs and OTs to the knowledge and skills related to these OMs.

Education on OMs for BCS with BCRL

Previous studies suggest that therapists practicing with a specialty tend to use OMs,^{14,18,21} and perhaps the best placement for education on OMs for BCRL outside of entry-level OM skill sets should be included in the training for CLTs. LANA provides guidelines promoting “standards for the certification of healthcare professionals who help individuals with lymphedema and/or related disorders manage their lymphedema and to promote lymphedema awareness and the science of lymphology.”⁶² According to the Policy and Procedures Manual, LANA has defined curriculum content that is foundational and required of continuing education programs.⁶² This foundational content includes the theoretical instruction and practical lab work for all components of Complete Decongestive Therapy (CDT).⁶² The manual lacks specific language pertaining to curriculum on OMs for the assessments used on individuals with lymphedema. However, in the LANA Candidate Information Booklet, the examination content outline delineates topics requiring OMs such as 1) differentiating edema etiologies, and 2) conducting examination (e.g. weight, limb appearance, ROM, strength, posture, gait, sensation, volume, tissue texture, and skin integrity).³² Identifying OMs with good psychometric properties for the examination on BCS with BCRL, including the associated comorbidities, benefits the CLT regardless of their professional background (e.g. PT, OT, MT, RN, or physician).

Consensus-based core outcome set

Implementing a consensus-based set of outcomes, also known as a core outcome set (COS), on BCS with BCRL is a worthy endeavor for all allied stakeholders to capture baseline measures and BCRL comorbidities across the ICF domains. A COS can be an essential component of EBP which can be used in clinical trials, assist in the examination of a disorder and related comorbidities, and for the purpose of outcome assessment of interventions.^{10,11} The use of a COS can reduce selective reporting on conditions, inconsistency in clinical use, and variability of reporting across interdisciplinary medical fields that represent CLTs who treat BCRL.^{63,64} COSs can lead to improved systematic reviews and meta-analyses by facilitating robust effect sizes. The development of a COS is comprehensive; however, the groundwork has been laid by the Breast Cancer EDGE Task Force in identifying ICF outcome domains and OMs

with good psychometrics and clinical utility. Furthering the cause for a COS for BCS with BCRL will require various stakeholders to expand and then refine the list of outcome domains identified by the Breast Cancer EDGE Task Force studies, and then process through the Core Outcome Measures in Effectiveness Trials (COMET) guidelines.⁶³ Not only is a COS a feasible endeavor, but identifying the OMs to measure the COS is certainly within reach, as well as providing guidance as to “when” to measure are also attainable. To that end, this study has identified fifteen OMs which PT and OT CLTs tend to use most often. Most of these trending OMs have been recommended by the Breast Cancer EDGE Task Force, however, there are a few that are either not recommended or need further review for BCRL usage recommendations.

LIMITATIONS

The number of practicing CLTs in the United States is not documented and CLT graduates from the participating institutions ranged from 340 to 3200. An a priori survey sample size of 174 was expected, however, this sample size was abandoned due to the convenience sampling method, which prevented management of the emails being distributed, resulted in cross over emails from the various institutions, and returned a limited response. In addition, the sample size for the analysis (n = 111) included a sample of OTs and PTs from the total sample (n = 130). These factors limit our ability to generalize the findings to the CLT population consisting of PT, OT, MT, and RN despite that the sample appears to be unbiased to the true population that other national and international studies have reported on. There is concern that the lack of other professions, practice settings, geographical locations, and the male sex may have limited our understanding of the use of OMs and the predictive contribution that these characteristics provide. In addition, the density of CLTs that practice in outpatient clinics may have limited insights into use of OMs in other settings (e.g. home healthcare, long-term care). Further research will need to seek input from respondents that have these characteristics. Due to small cell counts some data analyses were not feasible. This may be a result of the multiple response option for some survey questions but is also reflective of the sample size. Further research may address this via mixed methodology.

CONCLUSIONS

This study adds to current knowledge by identifying OMs with good psychometrics, as previously examined by the Breast Cancer EDGE Task Force, that are being used by PT and OT

CLTs to measure body functions and body structures, and activities and participation. OMs used most often that assess body functions and structures exceed those OMs for activities and participation. Recommended OMs from the Breast Cancer EDGE Task Force, CPG from the Oncology Section of the APTA, and the Dutch Lymphedema Guideline that assess ICF domains that were identified as used most often (Table IV.6) in this study include; 1) goniometry PROM and 2) goniometry AROM for joint function, 3) stiffness of the glenohumeral joint for flexibility, 4) hand grip dynamometer for strength, 5) circumference for volume, 6) numeric pain scale for pain, 7) pitting edema test for tissue consistency, 8) body weight and 9) BMI for body composition, and 10) *QuickDash* for patient-reported upper quadrant function. This study also adds to current knowledge by identifying a multidisciplinary CLT consensus on other OMs used most often (Table IV.6) which include 1) MMT for strength, 2) light touch brushing for sensation, 3) tissue texture assessment for tissue consistency, 4) visual analog scale for pain, and 5) LLIS for patient-reported HRQOL. This study also identifies OMs being used by CLTs on BCS with BCRL that need further investigation for their use, including 1) dynamic motion of the scapula, 2) pectoralis major length, 3) MMT, 4) pinch dynamometer, 5) light touch brushing, 6) monofilament, 7) sharp-dull discrimination, 8) two-point discrimination, 9) tissue texture assessment, 10) LLIS, 11) Berg Balance Scale, 12) functional reach, and 13) five times sit to stand. The use of OMs may be influenced by CLT profession, specialization, and level of highest degree. The differences between PT and OT CLTs use of OMs are sporadic. Whereas PT CLTs seem to use mobility and balance and flexibility OMs more than OTs, OT CLTs use sensation and HRQOL OMs more than PTs. These differences cannot be solely attributed to additional credentialed specializations. However, profession, LANA certification, and highest degree earned lend to the prediction of use for some OMs. In general, CLTs agree on the benefits of and to the use of OMs, however, PT CLTs may value the use of OMs less than OTs. CLTs also experience barriers to their use related to knowledge and competence of OMs. These barriers foster the need for further guidance in selective OMs for BCS with BCRL and the education related to examination and evaluations in the field of lymphology.

REFERENCES

1. Greene A. Epidemiology and Morbidity of Lymphedema. In: *Lymphedema*. Switzerland: Springer International Publishing; 2015:33-34.
2. Norman SA, Localio AR, Potashnik SL, et al. Lymphedema in breast cancer survivors: incidence, degree, time course, treatment, and symptoms. *J Clin Oncol*. 2009;27(3):390-397. doi:10.1200/JCO.2008.17.9291
3. Bulley C, Coutts F, Blyth C, et al. Upper limb morbidity after treatment for breast cancer: A cross-sectional study of lymphedema and function. *Cancer Oncol Res*. 2013;1(2):30-39. doi:10.1016/j.ejso.2012.07.250
4. Paskett ED. Breast cancer-related lymphedema: Attention to a significant problem resulting from cancer diagnosis. *J Clin Oncol*. 2008;26(35):5666-5667. doi:10.1200/JCO.2008.19.0850
5. Kerckhove N, Collin A, Condé S, Chaletix C, Pezet D, Balayssac D. Long-term effects, pathophysiological mechanisms, and risk factors of chemotherapy-induced peripheral neuropathies: A comprehensive literature review. *Front Pharmacol*. 2017;8(86):1-17. doi:10.3389/fphar.2017.00086
6. Kneis S, Wehrle A, Freyler K, et al. Balance impairments and neuromuscular changes in breast cancer patients with chemotherapy-induced peripheral neuropathy. *Clin Neurophysiol*. 2016;127(2):1481-1490. doi:10.1016/j.clinph.2015.07.022
7. Zanville NR, Nudelman KNH, Smith DJ, et al. Evaluating the impact of chemotherapy-induced peripheral neuropathy symptoms (CIPN-sx) on perceived ability to work in breast cancer survivors during the first year post-treatment. *Support Care Cancer*. 2016;24(11):4779-4789. doi:10.1007/s00520-016-3329-5
8. Başar S, Bakar Y, Keser I, et al. Does lymphedema affect the postural stability in women after breast cancer? *Top Geriatr Rehabil*. 2012;28(4):287-294. doi:10.1097/TGR.0b013e318270c89b
9. Angin S, Karadibak D, Yavuzşen T, Demirbuken I. Unilateral upper extremity lymphedema deteriorates the postural stability in breast cancer survivors. *Wspolczesna Onkol*. 2014;18(4):279-284. doi:10.5114/wo.2014.44120
10. Duncan PW, Jorgensen HS, Wade DT. Outcome measures in acute stroke trials: A systematic review and some recommendations to improve practice. *Stroke*. 2000;31(6):1429-1438. doi:10.1161/01.STR.31.6.1429
11. Jette DU, Bacon K, Batty C, et al. Evidence-based practice: Beliefs, attitudes, knowledge, and behaviors of physical therapists. *Phys Ther*. 2003;83(9):786-805. doi:10.1093/ptj/83.9.786
12. Fulk G, Field-Fote EC. Measures of evidence in evidence-based practice. *J Neurol Phys Ther*. 2011;35(2):55-56. doi:10.1097/NPT.0b013e31821ba134
13. Elf M, Flink M, Nilsson M, Tistad M, von Koch L, Ytterberg C. The case of value-based healthcare for people living with complex long-term conditions. *BMC Health Serv Res*. 2017;17(1):24. doi:10.1186/s12913-016-1957-6
14. Jette DU, Halbert J, Iverson C, Miceli E, Shah P. Use of standardized outcome measures in physical therapist practice: Perceptions and applications. *Phys Ther*. 2009;89(2):125-135. doi:10.2522/ptj.20080234

15. Jae Y, Kim J, Jin S, Hyun L, Jung S. Clinical nurses' beliefs, knowledge, organizational readiness and level of implementation of evidence-based practice: The first step to creating an evidence-based practice culture. *PLoS One*. 2019;14(12):e0226742. doi:doi:http://dx.doi.org.libproxy.umflint.edu/10.1371/journal.pone.0226742
16. Snyder Valier AR, Jennings AL, Parsons JT, Vela LI. Benefits of and barriers to using patient-rated outcome measures in athletic training. *J Athl Train*. 2014;49(5):674-683. doi:10.4085/1062-6050-49.3.15
17. Coulombe BJ, Games KE, Eberman LE. The use of patient-reported outcome measures: secondary school athletic trainers' perceptions, practices, and barriers. *J Athl Train*. 2019;54(2):142-151. doi:10.4085/1062-6050-86-17
18. Valdes K, MacDermid J, Algar L, et al. Hand therapist use of patient report outcome (PRO) in practice: A survey study. *J Hand Ther*. 2014;27(4):299-308. doi:10.1016/J.JHT.2014.07.001
19. Stevens AJ g, Beurskens AJMH. Implementation of measurement instruments in physical therapist practice: Development of a tailored strategy background and purpose. *Phys Ther*. 2010;90(6):953-961. <https://academic.oup.com/ptj/article-abstract/90/6/953/2737882>. Accessed July 18, 2020.
20. Duncan EA, Murray J. The barriers and facilitators to routine outcome measurement by allied health professionals in practice: a systematic review. *BMC Health Serv Res*. 2012;12(1):96. doi:10.1186/1472-6963-12-96
21. Al-Muqiren TN, Al-Eisa ES, Alghadir AH, Anwer S. Implementation and use of standardized outcome measures by physical therapists in Saudi Arabia: barriers, facilitators and perceptions. *BMC Health Serv Res*. 2017;17(748):1-10. doi:10.1186/s12913-017-2693-2
22. Stapleton T, McBrearty C. Use of standardised assessments and outcome measures among a sample of Irish occupational therapists working with adults with physical disabilities. *Br J Occup Ther*. 2009;72(2):55-64. doi:10.1177/030802260907200203
23. Demers M, Blanchette AK, Mullick AA, et al. Facilitators and barriers to using neurological outcome measures in developed and developing countries. *Physiother Res Int*. 2018;24(1):1-9.
24. Meerhoff GA, van Dulmen SA, Crujlsberg Juliette K, Nijhuis-van der Sanden MWG, Van der Wees PJ. Which factors influence the use of patient-reported outcomes measures in Dutch physiotherapy practice? A cross-sectional study. *Physiother Canada*. 2020;72(1):63-70.
25. Stout N, Harrington S, Pfalzer L, Fisher M. Breast Cancer Rehabilitation: Clinical Examination and Outcomes Assessment. *Geriatr Rehabil*. 2015;31(4):258-272. <https://www.ingentaconnect.com/content/wk/tgr/2015/00000031/00000004/art00006>. Accessed October 4, 2018.
26. Perdomo M, Davies C, Levenhagen K, Ryans K. Breast cancer edge task force outcomes: assessment measures of secondary lymphedema in breast cancer survivors. *Rehabil Oncol*. 2014;32(1):22-35. <https://journals.lww.com/greenjournal/01893697-201432010-00005.fulltext>. Accessed April 29, 2020.

27. Davies C, Ryans K, Levenhagen K, Perdomo M. Breast Cancer Edge Task Force Outcomes: Quality of life and functional outcome measures for secondary lymphedema in breast cancer survivors. *Rehabil Oncol*. 2014;32(1):7-12. <https://journals.lww.com/jbjsjournal/01893697-201432010-00003.fulltext>. Accessed April 29, 2020.
28. Levenhagen K, Davies C, Perdomo M, Ryans K, Gilchrist L. Diagnosis of upper-quadrant lymphedema secondary to cancer: Clinical practice guideline from the Oncology Section of APTA. *Rehabil Oncol*. 2017;35(3):E1-E18. doi:10.1097/01.REO.0000000000000073
29. Damstra RJ, Halk A-B, Damstra RJ, et al. The Dutch Lymphedema Guidelines based on the International Classification of Functioning, Disability, and Health and the Chronic Care Model. *J Vasc Surg Venous Lymphat Disord*. 2017;5(5):756-765. doi:10.1016/J.JVSV.2017.04.012
30. WHO. Towards a common language for functioning, disability, and health; ICF. World Health Organization - Geneva. <https://www.who.int/classifications/icf/icfbeginnersguide.pdf?ua=1>. Published 2002. Accessed May 5, 2020.
31. Wagner EH. Chronic disease management: What will it take to improve care for chronic illness? *Eff Clin Pract*. 1998;1(1):2-4. <https://access.portico.org/Portico/auView?auId=ark:%2F27927%2Fphwwtrq3nv>. Accessed May 31, 2020.
32. LANA Certified Lymphedema Therapist Candidate Information Booklet (CIB). Lymphology Association of North America. <https://www.clt-lana.org>. Published 2017. Accessed September 10, 2018.
33. Burton L-J, Tyson S, McGovern A. Staff perceptions of using outcome measures in stroke rehabilitation. *Disabil Rehabil*. 2013;35(10):828-834. doi:10.3109/09638288.2012.709305
34. Chesson R, Macleod M, Massie S. Outcome measures used in therapy departments in Scotland. *Physiotherapy*. 1996;82(12):673-679. <https://www.sciencedirect.com/science/article/pii/S0031940605663754>. Accessed August 4, 2021.
35. Bohnen CL. Outcome measure use in occupational therapy for upper extremity rehabilitation: Results of a survey of therapist clinical practices. 2011. https://sophia.stkate.edu/ma_osot/1.
36. Braun T, Rieckmann A, Weber F, Grüneberg C. Current use of measurement instruments by physiotherapists working in Germany: a cross-sectional online survey. *BMC Health Serv Res*. 2018;18(810):1-16. doi:10.1186/s12913-018-3563-2
37. Thorn DW, Dietz JC. Examining content validity through the use of content experts. *Occup Ther J Res*. 1989;9(6):334-345.
38. Yusoff M. ABC of content validation and content validity index calculation. *Educ Med J*. 2019;11(2):49-54.
39. Guide to Physical Therapist Practice 3.0. American Physical Therapy Association. <http://guidetoptpractice.apta.org/>. Published 2020. Accessed September 11, 2020.
40. Cruz JP, Colet PC, Alquwez N, et al. Evidence-based practice beliefs and implementation among the nursing bridge program students of a Saudi univeristy. *Int J Heal Sci*. 2016;10(3):405-414.

41. Yoo JY, Kim JH, Kim JS, Kim HL, Ki JS. Clinical nurses' beliefs, knowledge, organizational readiness and level of implementation of evidence-based practice: The first step to creating an evidence-based practice culture. Schultz T, ed. *PLoS One*. 2019;14(12):e0226742. doi:10.1371/journal.pone.0226742
42. Weng Y-H, Kuo KN, Yang C-Y, Lo H-L, Chen C, Chiu Y-W. Implementation of evidence-based practice across medical, nursing, pharmacological and allied healthcare professionals: a questionnaire survey of nationwide hospital settings. *Implement Sci*. 2013;8(112):1-10.
43. Stokke K, Olsen NR, Espehaug B, Notvedt MW. Evidence based practice beliefs and implementation among nurses: a cross-sectional study. *BMC Nurs*. 2014;13(8):1-10.
44. Armer JM, Paskett ED, Fu MR, et al. A survey of lymphoedema practitioners across the US. *J Lymphoedema*. 2010;5(2):95-97.
45. Anderson EA, Allison AB, Armer NC, Armer JM. Lymphoedema therapists: A national and international survey. *J Lymphoedema*. 2019;14(1):22-24.
46. Hunley J, Campione E, Jackson K, Feldman J. Lymphoedema practice patterns: The current state of the industry. *J Lymphoedema*. 2020;15(1):65-70.
47. Onega T, Duell EJ, Shi X, Wang D, Demidenko E, Goodman D. Geographic access to cancer care in the U.S. *Cancer*. 2008;112(4):909-918. doi:10.1002/cncr.23229
48. Davies C, Levenhagen K, Ryans K, Perdomo M, Gilchrist L. Interventions for breast cancer-related lymphedema: Clinical practice guideline from the Academy of Oncologic Physical Therapy of APTA. *Phys Ther*. 2020;100(7):2-17. doi:10.1093/ptj/pzaa087/5862539
49. Sun D, Yu Z, Chen J, Wang L, Han L, Liu N. The value of using a SkinFibroMeter for diagnosis and assessment of secondary lymphedema and associated fibrosis of lower limb skin. *Lymphat Res Biol*. 2017;15(1):70-76. doi:10.1089/lrb.2016.0029
50. Douglass J, Graves P, Gordon S. Intrarater reliability of tonometry and bioimpedance spectroscopy to measure tissue compressibility and extracellular fluid in the legs of healthy young people in Australia and Myanmar. *Lymphat Res Biol*. 2017;15(1):57-63.
51. Dellalana LE, Chen F, Vain A, et al. Reproducibility of the durometer and myoton devices for skin stiffness measurement in healthy subjects. *Ski Res Technol*. 2019;25(3):289-293. doi:10.1111/srt.12646
52. International Society of Lymphology; Committee Executive. The Diagnosis and Treatment of Peripheral Lymphedema: 2016 Consensus Document of the International Society of Lymphology. *Lymphology*. 2016;49:170.
53. LeBlanc M, Stineman M, DeMichele A, Stricker C, Mao JJ. Validation of QuickDASH outcome measure in breast cancer survivors for upper extremity disability. *Arch Phys Med Rehabil*. 2014;95(3):493-498. doi:10.1016/j.apmr.2013.09.016
54. Beelen LM, van Dishoeck A-M, Tsangaris E, et al. Patient-reported outcome measures in lymphedema: A systematic review and COSMIN analysis. *Ann Surg Oncol*. 2021;28(3):1656-1668. doi:10.1245/s10434-020-09346-0
55. Singh V, Lee M-J, Kilbreath SL, Dylke ES, Singh Paramanandam V. Self-reported questionnaires for lymphoedema: a systematic review of measurement properties using COSMIN framework. *Acta Oncol (Madr)*. 2021;60(3):379-391. doi:10.1080/0284186X.2020.1862422

56. Fisher MI, Lee J, Davies CC, Geyer H, Colon G, Pfalzer L. Oncology Section EDGE Task Force on breast cancer outcomes: A systematic review of outcome measures for functional mobility. *Rehabil Oncol*. 2015;33(3):19-31. doi:10.1097/01893697-201533030-00004
57. Patient-reported Outcome Measures. Supplemental Material to the CMS MMS Blueprint. <https://www.cms.gov/files/document/blueprint-patient-reported-outcome-measures.pdf>. Published 2020. Accessed June 22, 2021.
58. Bean JF, Ölveczky DD, Kiely DK, LaRose SI, Jette AM. Performance-based versus patient-reported physical function: What are the underlying predictors? *Phys Ther*. 2011;91(12):1804-1811. doi:10.2522/ptj.20100417
59. Archer K, Wegener S, Vanston S, et al. Patient-reported and performance-based outcome measures following spine surgery: A longitudinal analysis. *Spine J*. 2014;14(11):S51-S52. doi:10.1016/j.spinee.2014.08.135
60. Bolink SAAN, Grimm B, Heyligers IC. Patient-reported outcome measures versus inertial performance-based outcome measures: A prospective study in patients undergoing primary total knee arthroplasty. *Knee*. 2015;22(6):618-623. doi:10.1016/j.knee.2015.04.002
61. Salbach NM, Jaglal SB, Korner-Bitensky N, et al. Practitioner and organizational barriers to evidence-based practice of physical therapists for people with stroke. *Phys Ther*. 2007;87(10):1284-1303. doi:10.2522/ptj.20070040
62. Lymphology Association of North America; Policy & Procedures Manual. www.clt-lana.org. Published 2020. Accessed May 31, 2020.
63. Williamson PR, Altman DG, Bagley H, et al. The COMET Handbook: version 1.0. *Trials*. 2017;18(S3):280. doi:10.1186/s13063-017-1978-4
64. Pohl J, Held JPO, Verheyden G, et al. Consensus-based core set of outcome measures for clinical motor rehabilitation after stroke-A Delphi study. *Front Neurol*. 2020;11:875. doi:10.3389/fneur.2020.00875

Table IV.1. Oncology Section Breast Cancer EDGE Task Force,²⁷⁻²⁹ Upper-Quadrant Lymphedema Guideline,³⁰ and Dutch Lymphedema Guideline Recommended Outcome Measures.³¹

| ICF* Domains of Body Functions and Body Structures | EDGE Rating Scale | Clinical Practice Guideline | Dutch Lymphedema Guideline | | |
|---|-------------------|-----------------------------|---------------------------------|--------------------------------|------------------------|
| | | | Secondary Prevention Assessment | Intensive Treatment Assessment | Maintenance Assessment |
| <i>Measures of Joint Function</i> | | | | | |
| Goniometry – passive range of motion | 4 | | | X | X |
| Goniometry – active range of motion | 3 | | | X | X |
| Inclinometer – passive range of motion | 3 | | | | |
| Inclinometer – active range of motion | 3 | | | | |
| <i>Measures of Flexibility</i> | | | | | |
| Muscle Length – pectoralis minor | 3 | | | | |
| Muscle Length – pectoralis minor via Borstad scapular index | 3 | | | | |
| Stiffness of glenohumeral joint | 3 | | | | |
| <i>Measures of Strength</i> | | | | | |
| Hand grip strength | 3 | | | X | AI |
| Hand-held dynamometry | 3 | | | X | AI |
| <i>Measures of Volume</i> | | | | | |
| Bioelectrical Impedance Spectroscopy | 4 | B | | | |
| Circumference | 4 | B | X | X | X |
| Perometer | | | X | X | X |
| Water Displacement (Volumeter) | 4 | B | X | X | X |
| <i>Measures of Pain</i> | | | | | |
| Brief Pain Inventory | 4 | | | | |
| Brief Pain Inventory – Short Form | 4 | | | | |
| McGill Pain Questionnaire | 4 | | | | |
| McGill Pain Questionnaire – Short Form | 4 | | | | |
| Numeric Pain Rating Scale | 4 | | | | |
| Pain Disability Index | 4 | | | | |
| Visual Analog Scale – Pain | 4 | | | X | X |
| <i>Measures of Tissue Consistency</i> | | | | | |
| Pitting Test | | | X | X | X |
| Ultrasonography | | B | | | |
| <i>Measures of Body Composition</i> | | | | | |
| Body Weight, Body Mass Index | | | X | X | X |
| *ICF = International Classification of Functioning, Disability, and Health; EDGE Rating Scale: 4 = Highly Recommended, 3 = Recommended; Clinical Practice Guideline Rating Scale: A = Strong Recommendation, B = Moderate Recommendation; AI = As Indicated | | | | | |

Table IV.1 cont. Oncology Section Breast Cancer EDGE Task Force,²⁷⁻²⁹ Upper-Quadrant Lymphedema Guideline,³⁰ and Dutch Lymphedema Guideline Recommended Outcome Measures.³¹

| ICF* Domains of Activities and Participation | EDGE Rating Scale | Dutch Lymphedema Guideline | | |
|---|-------------------|---------------------------------|--------------------------------|------------------------|
| | | Secondary Prevention Assessment | Intensive Treatment Assessment | Maintenance Assessment |
| <i>Measures of Patient Reported Function and QOL</i> | | | | |
| BREAST-Q | 4 | | | |
| EORTC Quality of Life Questionnaire-Breast | 4 | | | |
| Functional Assessment of Cancer Therapy-Breast | 4 | | | |
| Functional Assessment of Cancer Therapy-Breast + 4 | 4 | | | |
| Functional Assessment of Cancer Therapy/ Gynecologic Oncology Group-Neurotoxicity(v4) | 4 | | | |
| Lymph — ICF Arm | | X | X | |
| Upper Limb Lymphedema Measure — 27 | | X | X | |
| Disability of Arm, Shoulder, and Hand Questionnaire | 4 | | AI | AI |
| Penn Shoulder Score | 4 | | | |
| QuickDASH | 3 | | | |
| Shoulder Pain and Disability Index | 4 | | | |
| Shoulder Rating Questionnaire | 4 | | | |
| <i>Measures of Fatigue</i> | | | | |
| Bi-Dimensional Fatigue Scale /Chalder/ Fatigue Questionnaire | 3 | | | |
| Brief Fatigue Inventory | 4 | | | |
| Diagnostic Interview for Cancer-Related Fatigue | 3 | | | |
| FACT-B | 4 | | | |
| Fatigue Symptom Inventory | 3 | | | |
| Functional Assessment of Chronic Illness Therapy – Fatigue | 3 | | | |
| MOS-SF36/Rand/Vitality | 3 | | | |
| Multidimensional Fatigue Symptom Inventory | 4 | | | |
| Piper Fatigue Scale Revised | 3 | | | |
| Profile of Mood States Fatigue/Vigor and Fatigue/Inertia Subscales | 3 | | | |
| Visual Analog Scale | 3 | | AI | AI |
| Wu Cancer Fatigue Scale | 3 | | | |
| <i>Measures of Mobility and Balance</i> | | | | |
| 6-Minute Walk Test | 3 | | | |
| Fullerton Advanced Balance Scale | 3 | | | |
| Gait Analysis | | | AI | AI |
| Timed Up and Go | 3 | | | |
| *ICF = International Classification of Functioning, Disability, and Health; EDGE Rating Scale: 4 = Highly Recommended, 3 = Recommended; Clinical Practice Guideline Rating Scale: A = Strong Recommendation, B = Moderate Recommendation; AI = As Indicated | | | | |

Table IV.2. Demographic Characteristics.

| Characteristic | Occupational Therapists | Physical Therapists | Significance of Difference |
|---|-------------------------|---------------------|---------------------------------|
| Occupation n (%) | 41 (37%) | 70 (63%) | |
| Age (years) (n = 111) | 48 ± 11.2 | 48 ± 10.3 | t = -0.27, p = 0.79 |
| Sex n (%) | | | |
| Female | 40 (97.6%) | 69 (98.6%) | p = 1.00# |
| Male | 1 (2.4%) | 1 (1.4%) | |
| Ethnicity n (%) | | | |
| Asian | 4 (9.8%) | 1 (1.4%) | p = 0.06# |
| Black or African American | 1 (2.4%) | 1 (1.4%) | |
| Other | 0 (0%) | 3 (4.3%) | |
| Prefer not to answer | 1 (2.4%) | 0 (0%) | |
| White | 35 (85.4%) | 65 (92.9%) | |
| Highest Degree Earned n (%) | | | |
| Bachelor of Arts or Science | 12 (29.3%) | 17 (24.3%) | $\chi^2 = 11.24$, p < 0.01* |
| Master of Arts or Science | 21 (51.2%) | 18 (25.7%) | |
| Clinical Doctorate | 8 (19.5%) | 35 (50%) | |
| Years in Practice (n = 104) | 22 ± 12.5 | 23 ± 11.2 | t = -0.67, p = 0.50 |
| Practice Specialization[^] n (%) | | | |
| Acute care | 8 (19.5%) | 4 (5.7%) | $\chi^2 = 5.10$, p = 0.03* |
| Cardiovascular & Pulmonary | 1 (2.4%) | 1 (1.4%) | |
| Geriatric | 6 (14.6%) | 0 (0%) | $\chi^2 = 10.83$, p < 0.01* |
| Hand Therapy | 8 (19.5%) | 0 (0%) | $\chi^2 = 14.72$, p < 0.01* |
| Manual Therapy | 5 (12.2%) | 7 (10%) | p = 0.76# |
| Neurology | 5 (12.2%) | 4 (5.7%) | p = 0.29# |
| Obstetrics & Gynecology | 0 (0%) | 1 (1.4%) | p = 1.00# |
| Oncology | 11 (26.8%) | 14 (20%) | $\chi^2 = 0.69$, p = 0.48 |
| Orthopaedic | 5 (12.2%) | 9 (12.9%) | $\chi^2 = 0.01$, p = 1.00 |
| Plastic Surgery | 1 (2.4%) | 1 (1.4%) | p = 1.00# |
| Sports | 1 (2.4%) | 3 (4.3%) | p = 1.00# |
| None | 15 (36.6%) | 41 (58.6%) | $\chi^2 = 5.00$, p = 0.03* |
| Other | 4 (9.8%) | 9 (12.9%) | p = 0.76# |
| Dichotomized | | | |
| Have a Specialization | 26 (63.4%) | 29 (41.4%) | $\chi^2 = 5.00$, p = 0.03* |
| Not Specialized | 15 (36.6%) | 41 (58.6%) | |
| * = Significant, ⁺ Mann-Whitney U test, # = Fisher's Exact test, [^] = Multiple response variable; n (% of cases). CLT = Certified Lymphedema Therapist, ACOLS = Academy of Lymphatic Studies, ILWTI = International Lymphedema and Wound Training Institute, LLCC = LDT Lymphedema Complex Decongestive Therapy Certification, UWM = University of Wisconsin Milwaukee | | | |

Table IV.2. continued

| Characteristic | Occupational Therapists | Physical Therapists | Significance of Difference |
|--|-------------------------|---------------------|---------------------------------|
| CLT Institution Attended[^] n (%) | | | |
| ACOLS | 19 (46.3%) | 26 (37.1%) | p = 0.42# |
| Casley-Smith | 2 (4.9%) | 1 (1.4%) | p = 0.55# |
| Dr. Vodder School International | 0 (0%) | 2 (2.9%) | p = 0.53# |
| ILWTI | 0 (0%) | 2 (2.9%) | p = 0.53# |
| Klose Training Lymphedema Cert. | 9 (22%) | 18 (25.7%) | $\chi^2 = 0.19$, p = 0.82 |
| Norton School of Lymphatic Therapy | 6 (14.6%) | 18 (25.7%) | $\chi^2 = 1.87$, p = 0.23 |
| Pacific Therapy Education, Inc. | 1 (2.4%) | 1 (1.4%) | p = 1.00# |
| Upledger – Chikly LLCC | 0 (0%) | 2 (2.9%) | p = 0.53# |
| UWM Lymphedema Therapist Cert. | 9 (22%) | 1 (1.4%) | $\chi^2 = 13.29$, p < 0.01 |
| Other School | 1 (2.4%) | 7 (10%) | p = 0.25# |
| Years as CLT (n = 111) | 11 ± 7.6 | 11 ± 10.0 | U = 1310, p = 0.73 ⁺ |
| LANA Certified n (%) | 23 (56.1%) | 48 (68.5%) | $\chi^2 = 1.75$, p = 1.86 |
| * = Significant, ⁺ Mann-Whitney U test, [^] = Multiple response variable; n (% of cases), CLT = Certified Lymphedema Therapist, ACOLS = Academy of Lymphatic Studies, ILWTI = International Lymphedema and Wound Training Institute, LLCC = LDT Lymphedema Complex Decongestive Therapy Certification, UWM = University of Wisconsin Milwaukee | | | |

Table IV.3. Practice Characteristics.

| Characteristic | Occupational Therapists | Physical Therapists | Significance of Difference |
|--|---|---|---|
| Type of Practice Setting n (%) Acute & Subacute Care Outpatient Clinic | 4 (9.8%) 37 (90.2%) | 3 (4.3%) 67 (95.7%) | p = 0.42 [#] |
| Geographical Practice Location n (%) Midwest US Northeast US Southeast US Southwest US West US Neither US or Canada | 17 (41.4%) 5 (12.2%) 11 (26.8%) 4 (9.8%) 4 (9.8%) 0 (0%) | 17 (24.3%) 19 (27.2%) 14 (20%) 7 (10%) 12 (17.1%) 1 (1.4%) | p = 0.20 [#] |
| Community setting n (%) Rural Suburban Urban | 15 (36.6%) 12 (29.3%) 14 (34.1%) | 8 (11.4%) 35 (50%) 27 (38.6%) | $\chi^2 = 10.66, p < 0.01^*$ |
| % of practice devoted to lymphedema treatment | 66 ± 31.7 | 63.1 ± 27.8 | U = 1283, p = 0.35 ⁺ |
| Number of BCRL clients in eight hours work day | 3 ± 2.0 | 4 ± 3.4 | U = 1683, p = 0.07 ⁺ |
| Minutes allocated for initial evaluation | 61 ± 24.6 | 59 ± 13.2 | U = 1278, p = 0.29 ⁺ |
| Minutes allocated for re-evaluation | 54 ± 20.6 | 55 ± 11.2 | U = 1411, p = 0.87 ⁺ |
| Hours per week providing lymphedema treatment | 14 ± 13.2 | 15 ± 10.7 | U = 1550, p = 0.39 ⁺ |
| % of patients in age group < 21 years 21 – 40 years 41 – 60 years 61 – 75 years > 75 years | 0.25 ± 1.1 14.4 ± 13.2 39.0 ± 19.5 32.8 ± 16.0 13.9 ± 12.4 | 0.96 ± 6.0 14.6 ± 10.3 41.6 ± 15.0 30.6 ± 14.8 12.5 ± 12.0 | U = 1487, p = 0.48 ⁺ U = 1539, p = 0.52 ⁺ U = 1649, p = 0.19 ⁺ U = 1329, p = 0.51 ⁺ U = 1319, p = 0.47 ⁺ |
| * = Significant, # = Fisher's exact test, ⁺ Mann-Whitney U test, PT = Physical Therapists, OT = Occupational Therapists, BCRL = Breast Cancer Related Lymphedema, CVI = Chronic Venous Insufficiency, LE = Lymphedema | | | |

Table IV.3. continued

| Characteristic | Occupational Therapists | Physical Therapists | Significance of Difference |
|---|-------------------------|---------------------|-----------------------------|
| Treat Other Conditions with LE[^] | | | |
| Arthritis | 16 (39%) | 29 (41.4%) | $\chi^2 = 0.06$, p = 0.80 |
| CVI | 40 (97.6%) | 59 (84.3%) | p = 0.05#* |
| Filariasis | 4 (9.8%) | 4 (5.7%) | p = 0.46# |
| Head and Neck LE | 30 (73.2%) | 62 (88.6%) | $\chi^2 = 4.32$, p = 0.04* |
| Lipedema | 31 (75.6%) | 59 (84.3%) | $\chi^2 = 1.27$, p = 0.26 |
| Neurological | 21 (51.2%) | 37 (52.9%) | $\chi^2 = 0.03$, p = 0.87 |
| Reproductive Organ Cancer | 28 (68.3%) | 54 (77.1%) | $\chi^2 = 1.05$, p = 0.31 |
| Orthopedic Conditions | 36 (87.8%) | 46 (65.7%) | $\chi^2 = 6.54$, p = 0.01* |
| Post-Operative General | 25 (61%) | 34 (48.6%) | $\chi^2 = 1.60$, p = 0.21 |
| Post-Operative Orthopedic | 31 (75.6%) | 43 (61.4%) | $\chi^2 = 2.34$, p = 0.13 |
| Primary Lymphedema | 33 (80.5%) | 57 (81.4%) | $\chi^2 = 0.02$, p = 0.90 |
| Wounds | 36 (87.8%) | 3 (4.3%) | $\chi^2 = 7.25$, p = 0.01* |
| None | 0 (0%) | 2 (2.9%) | p = 0.53# |
| Other | 3 (7.3%) | 3 (4.3%) | p = 0.67# |
| * = Significant, # = Fisher's Exact test. PT = Physical Therapists, OT = Occupational Therapists, BCRL = Breast Cancer Related Lymphedema, CVI = Chronic Venous Insufficiency, LE = Lymphedema. [^] = Multiple response variable; n (% of cases) | | | |

Table IV.4. Group Differences in Use of Outcome Measures in the 3rd and 4th Quartiles that Measure ICF Domains of Body Functions and Body Structures.

| Domain | Occupational Therapists n (%) | Physical Therapists n (%) | PT & OT n (%) | Significance of Difference |
|---|--------------------------------------|----------------------------------|--------------------------|-----------------------------------|
| Joint Function | | | | |
| <u>Dynamic Motion of Scapula</u> | | | | |
| <i>Use at some frequency</i> | 23 (56.1%) | 53 (75.7%)♦ | 76 (68.5%) | $\chi^2 = 4.61, p = 0.04^*$ |
| <i>Do not use</i> | 18 (43.9%)♦ | 17 (24.3%) | 35 (31.5%) | |
| <u>Goniometer PROM</u> | | | | |
| <i>Use at some frequency</i> | 37 (90.2%) | 69 (98.6%) | 106 (95.5%) | p = 0.06# |
| <i>Do not use</i> | 4 (9.8%) | 1 (1.4%) | 5 (4.5%) | |
| <u>Goniometer AROM</u> | | | | |
| <i>Use at some frequency</i> | 40 (97.6%) | 70 (100%) | 110 (99.1%) | p = 0.37# |
| <i>Do not use</i> | 1 (2.4%) | 0 (0%) | 1 (0.9%) | |
| Flexibility | | | | |
| <u>Pectoralis Major Length</u> | | | | |
| <i>Use at some frequency</i> | 20 (48.8%) | 61 (87.1%)♦ | 81 (73%) | $\chi^2 = 19.29, p < 0.01^*$ |
| <i>Do not use</i> | 21 (51.2%)♦ | 9 (12.9%) | 30 (27%) | |
| <u>Pectoralis Minor Length</u> | | | | |
| <i>Use at some frequency</i> | 18 (43.9%) | 59 (84.3%)♦ | 77 (69.4%) | $\chi^2 = 19.84, p < 0.01^*$ |
| <i>Do not use</i> | 23 (56.1%)♦ | 11 (15.7%) | 34 (30.6%) | |
| <u>Stiff Glenohumeral Joint</u> | | | | |
| <i>Use at some frequency</i> | 35 (85.4%) | 69 (98.6%)♦ | 104 (93.7%) | p < 0.01*# |
| <i>Do not use</i> | 6 (14.6%)♦ | 1 (1.4%) | 7 (6.3%) | |
| Strength | | | | |
| <u>Hand Grip Dynamometer</u> | | | | |
| <i>Use at some frequency</i> | 38 (92.7%) | 60 (85.7%) | 98 (88.3%) | p = 0.37# |
| <i>Do not use</i> | 3 (7.3%) | 10 (14.3%) | 13 (11.7%) | |
| <u>Hand Held Dynamometry</u> | | | | |
| <i>Use at some frequency</i> | 26 (63.4%) | 46 (65.7%) | 72 (64.9%) | $\chi^2 = 0.06, p = 0.84$ |
| <i>Do not use</i> | 15 (36.6%) | 24 (34.3%) | 39 (35.1%) | |
| <u>Manual Muscle Test</u> | | | | |
| <i>Use at some frequency</i> | 40 (97.6%) | 69 (98.6%) | 109 (98.2%) | p = 1.00# |
| <i>Do not use</i> | 1 (2.4%) | 1 (1.4%) | 2 (1.8%) | |
| <u>Pinch Dynamometer</u> | | | | |
| <i>Use at some frequency</i> | 38 (92.7%)♦ | 35 (50%) | 73 (65.8%) | $\chi^2 = 20.92, p < 0.01^*$ |
| <i>Do not use</i> | 3 (7.3%) | 35 (50%)♦ | 38 (34.2%) | |
| Volume and/or TWC | | | | |
| <u>Circumferential Measurements/ Calculated Volume</u> | | | | |
| <i>Use at some frequency</i> | 40 (97.6%) | 70 (100%) | 110 (99.1%) | p = 0.37 |
| <i>Do not use</i> | 1 (2.4%) | 0 (0%) | 1 (0.9%) | |
| * = Significant, # = Fisher's Exact test, ♦standardized residuals and % were used to demonstrate strength of the group to the Chi-square value, CLT = Certified Lymphedema Therapist, IFC = International Classification of Functioning, Disability and Health, PT = Physical Therapists, OT = Occupational Therapists, TWC = Tissue Water Content. | | | | |

Table IV.4. continued.

| Domain | Occupational Therapists n (%) | Physical Therapists n (%) | PT & OT n (%) | Significance of Difference |
|--|----------------------------------|------------------------------|------------------|-----------------------------|
| Outcome measure <i>Level of use</i> | | | | |
| Pain | | | | |
| <u>Numeric Pain Scale</u> | | | | |
| <i>Use at some frequency</i> | 39 (95.1%) | 66 (94.3%) | 105 (94.6%) | p = 1.00# |
| <i>Do not use</i> | 2 (4.9%) | 4 (5.7%) | 6 (5.4%) | |
| <u>Visual Analog Scale</u> | | | | |
| <i>Use at some frequency</i> | 32 (78%) | 60 (85.7%) | 92 (82.9%) | $\chi^2 = 1.07, p = 0.43$ |
| <i>Do not use</i> | 9 (22%) | 10 (14.3%) | 19 (17.1%) | |
| Sensation | | | | |
| <u>Light Touch Brushing</u> | | | | |
| <i>Use at some frequency</i> | 38 (92.7%) | 68 (97.1%) | 106 (95.5%) | p = 0.36# |
| <i>Do not use</i> | 3 (7.3%) | 2 (2.9%) | 5 (4.5%) | |
| <u>Monofilament</u> | | | | |
| <i>Use at some frequency</i> | 31 (75.6%) [♦] | 38 (54.3%) | 69 (62.2%) | $\chi^2 = 4.99, p = 0.03^*$ |
| <i>Do not use</i> | 10 (24.4%) | 32 (45.7%) [♦] | 42 (37.8%) | |
| <u>Sharp-Dull Discrimination</u> | | | | |
| <i>Use at some frequency</i> | 34 (82.9%) | 46 (65.7%) | 80 (72.1%) | $\chi^2 = 3.81, p = 0.08$ |
| <i>Do not use</i> | 7 (17.1%) | 24 (34.3%) | 31 (27.9%) | |
| <u>Two-Point Discrimination</u> | | | | |
| <i>Use at some frequency</i> | 32 (78%) [♦] | 39 (55.7%) | 71 (64%) | $\chi^2 = 5.60, p = 0.02^*$ |
| <i>Do not use</i> | 9 (22%) | 31 (44.3%) [♦] | 40 (36%) | |
| Tissue Consistency | | | | |
| <u>Pitting Edema Test – Palpation</u> | | | | |
| <i>Use at some frequency</i> | 39 (95.1%) | 70 (100%) | 109 (98.2%) | p = 0.13# |
| <i>Do not use</i> | 2 (4.9%) | 0 (0%) | 2 (1.8%) | |
| <u>Tissue Texture – Palpation</u> | | | | |
| <i>Use at some frequency</i> | 39 (95.1%) | 69 (98.6%) | 108 (97.3%) | p = 0.55# |
| <i>Do not use</i> | 2 (4.9%) | 1 (1.4%) | 3 (2.7%) | |
| Body Composition | | | | |
| <u>Body Weight</u> | | | | |
| <i>Use at some frequency</i> | 40 (97.6%) | 61 (87.1%) | 101 (91%) | p = 0.09# |
| <i>Do not use</i> | 1 (2.4%) | 9 (12.9%) | 10 (9%) | |
| <u>Body Mass Index</u> | | | | |
| <i>Use at some frequency</i> | 37 (90.2%) | 58 (82.9%) | 95 (85.6%) | $\chi^2 = 1.14, p = 0.40$ |
| <i>Do not use</i> | 4 (9.8%) | 12 (17.1%) | 16 (14.4%) | |
| * = Significant, # = Fisher's Exact test, [♦] standardized residuals and % were used to demonstrate strength of the group to the Chi-square value, PT = Physical Therapists, OT = Occupational Therapists | | | | |

Table IV.5. Group Differences in Use of Outcome Measures in the 3rd and 4th Quartiles that Measure ICF Domains of Activities and Participation.

| Domain | Occupational Therapists n (%) | Physical Therapists n (%) | PT & OT n (%) | Significance of Difference |
|---|--|--|--|--|
| Patient-Reported HRQOL <u>Lymphedema Life Impact Scale</u> <i>Use at some frequency</i> <i>Do not use</i> | 38 (92.7%) [♦] 3 (7.3%) | 54 (77.1%) 16 (22.9%) [♦] | 92 (82.9%) 19 (17.1%) | $\chi^2 = 4.40, p = 0.04^*$ |
| Patient-Reported Upper Quadrant Function <u>DASH</u> <i>Use at some frequency</i> <i>Do not use</i> <u>QuickDASH</u> <i>Use at some frequency</i> <i>Do not use</i> | 33 (80.5%) 8 (19.5%) 38 (92.7%) 3 (7.3%) | 48 (68.6%) 22 (31.4%) 57 (81.4%) 13 (18.6%) | 81 (73%) 30 (27%) 95 (85.6%) 16 (14.4%) | $\chi^2 = 1.86, p = 0.19$ $\chi^2 = 2.66, p = 0.16$ |
| Patient-Reported Fatigue <u>Visual Analog Scale</u> <i>Use at some frequency</i> <i>Do not use</i> | 17 (41.5%) 24 (58.5%) [♦] | 44 (62.9%) [♦] 26 (37.1%) | 61 (55%) 50 (45%) | $\chi^2 = 4.78, p = 0.03^*$ |
| Mobility and Balance <u>Berg Balance Scale</u> <i>Use at some frequency</i> <i>Do not use</i> <u>Functional Reach</u> <i>Use at some frequency</i> <i>Do not use</i> <u>Timed Up and Go</u> <i>Use at some frequency</i> <i>Do not use</i> <u>5x Sit to Stand</u> <i>Use at some frequency</i> <i>Do not use</i> <u>6 Minute Walk Test</u> <i>Use at some frequency</i> <i>Do not use</i> | 21 (51.2%) 20 (48.8%) [♦] 20 (48.8%) 21 (51.2%) 22 (53.7%) 19 (46.3%) [♦] 11 (26.8%) 30 (73.2%) [♦] 12 (29.3%) 29 (70.7%) [♦] | 54 (77.1%) [♦] 16 (22.9%) 39 (55.7%) 31 (44.3%) 59 (84.3%) [♦] 11 (15.7%) 50 (71.4%) [♦] 20 (28.6%) 44 (62.9%) [♦] 26 (37.1%) | 75 (67.6%) 36 (32.4%) 59 (53.2%) 52 (46.8%) 81 (73%) 30 (27%) 61 (55%) 50 (45%) 56 (50.5%) 55 (49.5%) | $\chi^2 = 7.93, p < 0.01^*$ $\chi^2 = 0.50, p = 0.56$ $\chi^2 = 12.30, p < 0.01^*$ $\chi^2 = 20.78, p < 0.01^*$ $\chi^2 = 11.67, p < 0.01^*$ |
| UE Activity & Motor Control | NA | NA | NA | NA |

* = Significant, # = Fisher's Exact test, ♦ standardized residuals and % were used to demonstrate strength of the group to the Chi-square value, NA = OMs did not meet 50% threshold, CLT = Certified Lymphedema Therapist, ICF = International Classification of Functioning, Disability and Health, PT = Physical Therapists, OT = Occupational Therapists, HRQOL = Health Related Quality of Life, UQ = Upper Quadrant, DASH = Disability of Arm, Shoulder, and Hand

Table IV.6. Outcome Measures Divided in Quartile Probability Distributions.*

| Outcome Measure | Frequently Used n (%) | Occasionally Used n (%) | Seldom Used n (%) | Do Not Use N (%) |
|---------------------------------------|------------------------------|--------------------------------|--------------------------|-------------------------|
| 75.1% – 100% | | | | |
| Circumferential Measurements | 106 (95.5%) | 2 (1.8%) | 2 (1.8%) | 1 (0.9%) |
| Tissue Texture – Palpation | 105 (94.6%) | 2 (1.8%) | 1 (0.9%) | 3 (2.7%) |
| Pitting Edema Test – Palpation | 104 (93.7%) | 4 (3.6%) | 1 (0.9%) | 2 (1.8%) |
| Numeric Pain Scale | 104 (93.7%) | 0 (0.0%) | 1 (0.9%) | 6 (5.4%) |
| Goniometer AROM | 100 (90.1%) | 7 (6.3%) | 3 (2.7%) | 1 (0.9%) |
| Manual Muscle Test | 88 (79.3%) | 19 (17.1%) | 2 (1.8%) | 2 (1.8%) |
| Stiff Glenohumeral Joint | 73 (65.8%) | 23 (20.7%) | 8 (7.2%) | 7 (6.3%) |
| Goniometer PROM | 69 (62.2%) | 22 (19.8%) | 15 (13.5%) | 5 (4.5%) |
| Light Touch Brushing | 67 (60.4%) | 25 (22.5%) | 14 (12.6%) | 5 (4.5%) |
| QuickDASH | 67 (60.4%) | 13 (11.7%) | 15 (13.5%) | 16 (14.4%) |
| Body Weight | 65 (58.6%) | 24 (21.6%) | 12 (10.8%) | 10 (9.0%) |
| Lymphedema Life Impact Scale | 65 (58.6%) | 17 (15.3%) | 10 (9.0%) | 19 (17.1%) |
| Visual Analog Scale - Pain | 65 (58.6%) | 13 (11.7%) | 14 (12.6%) | 19 (17.1%) |
| Body Mass Index | 61 (55.0%) | 20 (18.0%) | 14 (12.6%) | 16 (14.4%) |
| Hand Grip Dynamometer | 38 (34.2%) | 31 (28.0%) | 29 (26.1%) | 13 (11.7%) |
| 50.1% - 75% | | | | |
| Pectoralis Major Length | 52 (46.9%) | 16 (14.4%) | 13 (11.7%) | 30 (27.0%) |
| DASH | 47 (42.4%) | 19 (17.1%) | 15 (13.5%) | 30 (27.0%) |
| Pectoralis Minor Length | 44 (39.7%) | 20 (18.0%) | 13 (11.7%) | 34 (30.6%) |
| Visual Analog Scale - Fatigue | 35 (31.5%) | 12 (12.6%) | 12 (10.9%) | 50 (45.0%) |
| Dynamic Motion of Scapula | 34 (30.7%) | 20 (18.0%) | 22 (19.8%) | 35 (31.5%) |
| Timed Up and Go | 31 (28.0%) | 35 (31.5%) | 15 (13.5%) | 30 (27.0%) |
| Five Times Sit to Stand | 28 (25.3%) | 15 (13.5%) | 18 (16.2%) | 50 (45.0%) |
| Hand Held Dynamometry | 23 (20.7%) | 24 (21.6%) | 25 (22.5%) | 39 (35.2%) |
| Berg Balance Scale | 22 (19.8%) | 34 (30.6%) | 19 (17.1%) | 36 (32.5%) |
| Pinch Dynamometer | 19 (17.1%) | 19 (17.1%) | 35 (31.5%) | 38 (34.3%) |
| Six Minute Walk Test | 18 (16.2%) | 22 (19.8%) | 16 (14.4%) | 55 (50.0%) |
| Sharp-Dull Discrimination | 17 (15.3%) | 33 (29.8%) | 30 (27.0%) | 31 (27.9%) |
| Functional Reach | 13 (11.7%) | 22 (19.8%) | 24 (21.6%) | 52 (46.9%) |
| Two-Point Discrimination | 9 (8.2%) | 26 (23.4%) | 36 (32.4%) | 40 (36.0%) |
| Monofilament | 9 (8.2%) | 26 (23.4%) | 34 (30.6%) | 42 (37.8%) |
| 25.1% - 50% | | | | |
| Upper Extremity Functional Index | 19 (17.1%) | 11 (9.9%) | 13 (11.7%) | 68 (61.3%) |
| Pain Disability Index | 17 (15.3%) | 10 (9.0%) | 19 (17.1%) | 64 (58.6%) |
| Brief Fatigue Inventory | 14 (12.6%) | 13 (11.7%) | 9 (8.1%) | 75 (67.6%) |
| Brief Pain Inventory | 14 (12.6%) | 6 (5.4%) | 19 (17.1%) | 72 (64.9%) |
| Shoulder Pain and Disability Index | 12 (10.8%) | 13 (11.7%) | 20 (18.0%) | 66 (59.5%) |
| Nine Hole Peg Test | 12 (10.8%) | 7 (6.3%) | 15 (13.5%) | 77 (69.4%) |
| Two Minute Walk Test | 11 (9.9%) | 21 (18.9%) | 18 (16.2%) | 16 (55.0%) |
| Breast Cancer Questionnaire | 11 (9.9%) | 9 (8.1%) | 9 (8.1%) | 82 (73.9%) |

*Listed in quantiles of 0-25%, 25.1-50%, 50.1%-75%, 75.1%-100%. Each quartile is listed in descending order based on Frequently Used. AROM = Active Range of Motion, PROM = Passive Range of Motion, DASH = Disabilities of the Arm, Shoulder, and Hand. **Bolded text denotes OMs systematically assessed by Breast Cancer Edge Task Force and/or Dutch Lymphedema Guidelines.**

Table IV.6. continued.*

| Outcome Measure | Frequently Used n (%) | Occasionally Used n (%) | Seldom Used n (%) | Do Not Use N (%) |
|---|------------------------------|--------------------------------|--------------------------|-------------------------|
| 25.1% - 50% | | | | |
| One-Repetition Maximum | 10 (9.0%) | 11 (9.9%) | 31 (27.9%) | 59 (53.2%) |
| Brief Pain Inventory – Short Form | 10 (9.0%) | 10 (9.0%) | 18 (16.2%) | 73 (65.8%) |
| Functional Independence Measure | 10 (9.0%) | 10 (9.0%) | 14 (12.6%) | 77 (69.4%) |
| FACT-B | 7 (6.3%) | 7 (6.3%) | 13 (12.6%) | 75 (74.8%) |
| McGill Pain Questionnaire – Short Form | 5 (4.5%) | 4 (3.6%) | 19 (17.1%) | 83 (74.8%) |
| Activities-Specific Balance Confidence Scale | 4 (3.6%) | 14 (12.6%) | 13 (11.7%) | 80 (72.1%) |
| Inclinometer AROM | 4 (3.6%) | 9 (8.1%) | 19 (17.1%) | 79 (71.2%) |
| Vibration/Tuning Fork | 3 (2.7%) | 11 (9.9%) | 32 (28.8%) | 65 (58.6%) |
| Inclinometer PROM | 3 (2.7%) | 5 (4.5%) | 22 (19.8%) | 81 (73.0%) |
| 0% - 25% | | | | |
| Bioelectrical Impedance Spectroscopy – Volume | 14 (12.6%) | 2 (1.8%) | 7 (6.3%) | 88 (79.3%) |
| Bioelectrical Impedance Analysis – Body Composition | 12 (10.8%) | 3 (2.7%) | 3 (2.7%) | 93 (83.8%) |
| Lymphoedema Functioning Disability and Health Questionnaire | 10 (9.0%) | 9 (8.1%) | 5 (4.5%) | 87 (78.4%) |
| Barthel Index | 8 (7.2%) | 7 (6.3%) | 12 (10.8%) | 84 (75.7%) |
| Upper Limb Lymphedema Measure | 6 (5.4%) | 7 (6.3%) | 5 (4.5%) | 93 (83.8%) |
| Functional Assessment of Cancer Therapy – Breast +4 | 6 (5.4%) | 4 (3.6%) | 11 (9.9%) | 90 (81.1%) |
| Penn Shoulder Score | 6 (5.4%) | 1 (0.9%) | 5 (4.5%) | 99 (89.2%) |
| Pectoralis Minor Length – Borstad | 5 (4.5%) | 6 (5.4%) | 13 (11.7%) | 87 (78.4%) |
| Perometry | 4 (3.6%) | 1 (0.9%) | 5 (4.5%) | 101 (91.0%) |
| Purdue Pegboard | 3 (2.7%) | 12 (10.8%) | 11 (9.9%) | 85 (76.6%) |
| Shoulder Disability Questionnaire | 3 (2.7%) | 8 (7.2%) | 12 (10.8%) | 88 (79.3%) |
| Functional Assessment of Cancer Therapy Breast | 3 (2.7%) | 8 (7.2%) | 10 (9.0%) | 90 (81.1%) |
| Balance Evaluation Systems Test | 3 (2.7%) | 5 (4.5%) | 8 (7.2%) | 95 (85.6%) |
| McGill Pain Questionnaire | 3 (2.7%) | 4 (3.6%) | 18 (16.2%) | 86 (77.5%) |
| Breast – Q | 3 (2.7%) | 3 (2.7%) | 9 (8.1%) | 96 (86.5%) |
| Diagnostic Interview for Cancer Related Fatigue | 3 (2.7%) | 2 (1.8%) | 3 (2.7%) | 103 (92.8%) |
| Fullerton Advanced Balance Scale | 2 (1.8%) | 5 (4.5%) | 8 (7.2%) | 96 (86.5%) |
| Box and Block Test | 2 (1.8%) | 3 (2.7%) | 9 (8.1%) | 97 (87.4%) |
| FACT/Gynecologic Oncology Group Neurotoxicity (v4) | 2 (1.8%) | 3 (2.7%) | 8 (7.2%) | 98 (88.3%) |
| Short Performance Physical Battery | 1 (0.9%) | 5 (4.5%) | 6 (5.4%) | 99 (89.2%) |
| Ultrasonography | 1 (0.9%) | 2 (1.8%) | 4 (3.6%) | 104 (93.7%) |

*Listed in quantiles of 0-25%, 25.1-50%, 50.1%-75%, 75.1%-100%. Each quartile is listed in descending order based on Frequently Used. FACT = Functional Assessment of Cancer Therapy, AROM = Active Range of Motion, PROM = Passive Range of Motion.

Table IV.6. continued.*

| Outcome Measure | Frequently Used n (%) | Occasionally Used n (%) | Seldom Used n (%) | Do Not Use N (%) |
|--|------------------------------|--------------------------------|--------------------------|-------------------------|
| 0% - 25% | | | | |
| EORTC Quality of Life Questionnaire – Breast | 1 (0.9%) | 2 (1.8%) | 7 (6.3%) | 101 (91.0%) |
| Myoton – Tissue Consistency | 1 (0.9%) | 2 (1.8%) | 6 (5.4%) | 102 (91.9%) |
| Shoulder Rating Questionnaire | 1 (0.9%) | 2 (1.8%) | 6 (5.4%) | 102 (91.9%) |
| Functional Assessment of Chronic Illness Therapy – Fatigue | 1 (0.9%) | 2 (1.8%) | 5 (4.5%) | 103 (92.8%) |
| Tissue Dielectric Constant | 1 (0.9%) | 1 (0.9%) | 4 (3.6%) | 105 (94.6%) |
| Ruler Drop Test/ReacStick | 1 (0.9%) | 0 (0.0%) | 7 (6.3%) | 103 (92.8%) |
| Wu Cancer Fatigue | 1 (0.9%) | 0 (0.0%) | 4 (3.6%) | 106 (95.5%) |
| Multidimensional Fatigue Symptom Inventory | 1 (0.9%) | 0 (0.0%) | 3 (2.7%) | 107 (96.4%) |
| Water Displacement/Volumeter | 0 (0.0%) | 10 (9.0%) | 13 (11.7%) | 88 (79.3%) |
| Fatigue Symptom Inventory | 0 (0.0%) | 7 (6.3%) | 5 (4.5%) | 99 (89.2%) |
| Functional Living Index – Cancer | 0 (0.0%) | 5 (4.5%) | 8 (7.2%) | 98 (88.3%) |
| Skin Fibrometer | 0 (0.0%) | 2 (1.8%) | 4 (3.6%) | 105 (94.6%) |
| Finger Tapper Test | 0 (0.0%) | 2 (1.8%) | 4 (3.6%) | 105 (94.6%) |
| MOS-SF36/Rand/Vitality | 0 (0.0%) | 2 (1.8%) | 3 (2.7%) | 106 (95.5%) |
| Action Research Arm Test | 0 (0.0%) | 1 (0.9%) | 8 (7.2%) | 102 (91.9%) |
| Tonometry | 0 (0.0%) | 1 (0.9%) | 7 (6.3%) | 103 (92.8%) |
| Profile of Mood States Fatigue/Vigor and Fatigue/Inertia Subscales | 0 (0.0%) | 1 (0.9%) | 4 (3.6%) | 106 (95.5%) |
| Piper Fatigue Scale Revised | 0 (0.0%) | 0 (0.0%) | 5 (4.5%) | 106 (95.5%) |
| Short Form Wolf Motor Function Test | 0 (0.0%) | 0 (0.0%) | 5 (4.5%) | 106 (95.5%) |
| Nine Item Arm Motor Ability Test | 0 (0.0%) | 0 (0.0%) | 5 (4.5%) | 106 (95.5%) |
| 3D Imaging | 0 (0.0%) | 0 (0.0%) | 4 (3.6%) | 107 (96.4%) |
| Myoton – Body Composition | 0 (0.0%) | 0 (0.0%) | 4 (3.6%) | 107 (96.4%) |
| Bi-Dimensional Fatigue Scale | 0 (0.0%) | 0 (0.0%) | 4 (3.6%) | 107 (96.4%) |
| Chalder Fatigue Questionnaire | 0 (0.0%) | 0 (0.0%) | 3 (2.7%) | 108 (97.3%) |

*Listed in quantiles of 0-25%, 25.1-50%, 50.1%-75%, 75.1%-100%. Each quartile is listed in descending order based on Frequently Used. EORTC = European Organization for Research and Treatment of Cancer

Table IV.7. Multicollinearity of Independent Variables.

| Variable | Tolerance* | VIF [#] |
|----------------------------|------------|------------------|
| Profession | 0.85 | 1.17 |
| Highest Degree | 0.74 | 1.36 |
| Years in Practice | 0.55 | 1.81 |
| Practice Specialization | 0.88 | 1.14 |
| LANA Certified | 0.82 | 1.21 |
| Years as CLT | 0.58 | 1.73 |
| Practice Setting | 0.95 | 1.06 |
| Initial Evaluation Minutes | 0.88 | 1.13 |

*= values less than 0.1 should be investigated. # = Variance Inflation Factor: values above 10 are an indication of multicollinearity. For weaker models, values > 2.5 is of concern.

Table IV.8. Facilitators and Barriers to Use of Outcome Measures.

| Category | Agree | Neither Agree or Disagree | Disagree |
|---|-------------|---------------------------|------------|
| | n (%) | n (%) | n (%) |
| Beliefs of the Therapist | | | |
| The use of OMs is necessary for the practice of BCRL treatment and management. (n = 111) | 105 (94.6%) | 2 (1.8%) | 4 (3.6%) |
| The use of OMs for clients with BCRL places unreasonable demand on the practitioner. (n = 110) | 32 (29.1%) | 23 (20.9%) | 55 (50.0%) |
| The use of OMs improves quality of care toward clients with BCRL. (n = 111) | 85 (76.6%) | 12 (10.8%) | 14 (12.6%) |
| The use of OMs helps direct the plan of care for clients with BCRL. (n = 111) | 100 (90.1%) | 7 (6.3%) | 4 (3.6%) |
| The use of outcome measures helps in the clinical reasoning for choice of interventions on clients with BCRL. (n = 111) | 86 (77.5%) | 10 (9.0%) | 15 (13.5%) |
| The use of OMs improves communication with clients who have BCRL. (n = 111) | 89 (80.2%) | 18 (16.2%) | 4 (3.6%) |
| The use of OMs improves communication with other healthcare stakeholders. (n = 111) | 85 (76.6%) | 15 (13.5%) | 11 (9.9%) |
| The use of OMs increases the efficiency of evaluations with clients who have BCRL. (n = 111) | 56 (50.5%) | 20 (18.0%) | 35 (31.5%) |
| OMs help to motivate and encourage clients with BCRL in the treatment and management of their condition. (n = 111) | 66 (59.5%) | 28 (25.2%) | 17 (15.3%) |
| Knowledge and Competence | | | |
| I have sufficient knowledge about OMs for clients with BCRL. (n = 111) | 51 (46.0%) | 17 (15.3%) | 43 (38.7%) |
| I have sufficient skills to use OMs for clients with BCRL. (n = 111) | 78 (70.3%) | 13 (11.7%) | 20 (18.0%) |
| The interpretation of the results obtained by OMs are easily interpreted for clinical reasoning pertaining to BCRL. (n = 110) | 71 (64.5%) | 19 (17.3%) | 20 (18.2%) |
| I have the ability to access current research pertaining to BCRL through professional journals. (n = 110) | 86 (78.2%) | 4 (3.6%) | 20 (18.2%) |
| With so many OMs, I do not know the best option to choose to use on my clients with BCRL. (n = 110) | 74 (67.3%) | 17 (15.4%) | 19 (17.3%) |
| I consistently incorporate CPG and systematic reviews related to BCRL diagnosis and interventions (n = 110) | 88 (80.0%) | 17 (15.5%) | 5 (4.5%) |
| I received sufficient training in using various OMs on clients with BCRL (n = 110) | 40 (36.4%) | 23 (20.9%) | 47 (42.7%) |
| I received sufficient training about OM for clients with BCRL in my professional training (n = 110) | 25 (22.7%) | 10 (9.1%) | 75 (68.2%) |
| I received sufficient training about OM for clients with BCRL in my post-professional CLT course(s) (n = 110) | 50 (45.5%) | 11 (10.0%) | 49 (44.5%) |
| Healthcare Practice | | | |
| OMs are important for assisting in the identification of comorbidities in clients with BCRL. (n = 110) | 96 (87.3%) | 10 (9.1%) | 4 (3.6%) |
| The use of OMs is necessary to determine treatment efficacy for clients with BCRL. (n = 110) | 80 (72.7%) | 16 (14.5%) | 14 (12.8%) |
| The use of OMs is part of my personal practice model. (n = 110) | 90 (81.8%) | 12 (10.9%) | 8 (7.3%) |
| Clients with BCRL request that I use OMs. (n = 110) | 7 (6.4%) | 12 (10.9%) | 91 (82.7%) |

Table IV.8. continued.

| Category | Agree | Neither Agree or Disagree | Disagree |
|--|--------------|----------------------------------|-----------------|
| Healthcare Practice | n (%) | n (%) | n (%) |
| It is important to execute OMs for patient discharge. (n = 110) | 88 (80.0%) | 6 (5.5%) | 16 (14.5%) |
| It is important to execute OMs at regular intervals for patient progress summaries. (n = 110) | 95 (86.3%) | 8 (7.3%) | 7 (6.4%) |
| Clients with BCRL that I see ARE NOT suitable for OMs. (n = 110) | 9 (8.2%) | 16 (14.5%) | 85 (77.3%) |
| Business Structures | | | |
| Management at my work place supports the use of OMs on clients with BCRL. (n = 110) | 77 (70.0%) | 19 (17.3%) | 14 (12.7%) |
| I have sufficient time to conduct a battery of OMs on clients with BCRL. (n = 110) | 29 (26.4%) | 12 (10.9%) | 69 (62.7%) |
| I have sufficient time to analyze results of OMs for clients with BCRL. (n = 110) | 30 (27.3%) | 12 (10.9%) | 68 (61.8%) |
| I have sufficient time to complete documentation of OMs for clients with BCRL. (n = 110) | 26 (23.6%) | 13 (11.9%) | 71 (64.5%) |
| Using OMs on clients with BCRL is encouraged at my workplace. (n = 110) | 73 (66.3%) | 20 (18.2%) | 17 (15.5%) |
| I have colleague support in using outcome OMs on clients with BCRL. (n=110) | 55 (50.0%) | 32 (29.1%) | 23 (20.9%) |
| At my workplace, I have access to the tools I need to conduct OMs to address the comorbidities in clients with BCRL. (n = 110) | 57 (51.8%) | 14 (12.7%) | 39 (35.5%) |
| EMRs for documentation facilitates the use of OMs on clients with BCRL. (n = 110) | 61 (55.5%) | 17 (15.5%) | 32 (29.0%) |
| Paper records for documentation facilitates the use of OMs on clients with BCRL. (n = 110) | 48 (43.6%) | 36 (32.8%) | 26 (23.6%) |
| Healthcare Equality | | | |
| Clients with BCRL have difficulty understanding the written instructions of the patient reported OMs. (n = 110) | 45 (41%) | 27 (24.5%) | 38 (34.5%) |
| Clients with BCRL have difficulty understanding the verbal instructions of OMs. (n = 110) | 32 (29.1%) | 23 (20.9%) | 55 (50.0%) |
| The patient-reported OMs for clients with BCRL are NOT gender inclusive. (n = 110) | 35 (31.8%) | 50 (45.5%) | 25 (22.7%) |
| The patient-reported OMs for clients with BCRL are NOT culturally/ethnically inclusive. (n =110) | 33 (30.0%) | 50 (45.5%) | 27 (24.5%) |
| OMs = Outcome Measures, BCRL = Breast Cancer Related Lymphedema, EMRs = Electronic Medical Records | | | |

Table IV.9. Group Differences for Facilitators and Barriers to Use of Outcome Measures.

| Beliefs of the Therapist | | OT (n = 41) n (%) | PT (n = 70) n (%) | Significance of Difference |
|---|--|--------------------------------------|--|---------------------------------------|
| <i>Statement</i> | Likert Scale | | | |
| <i>The use of OMs improves quality of care toward clients with BCRL.</i> | Agree Neither Agree or Disagree Disagree | 36 (87.8%) 4 (9.8%) 1 (2.4%) | 49 (70%) 8 (11.4%) 13 (18.6%) | $\chi^2 = 6.47, p = 0.04^*$ |
| <i>The use of OMs helps in the clinical reasoning for choice of interventions on clients with BCRL.</i> | Agree Neither Agree or Disagree Disagree | 38 (92.7%) 0 (0.0%) 3 (7.3%) | 48 (68.6%) 10 (14.3%) 12 (17.1%) | $\chi^2 = 9.65, p = 0.01^*$ |
| <i>The use of OMs improves communication with other healthcare stakeholders.</i> | Agree Neither Agree or Disagree Disagree | 36 (87.8%) 1 (2.4%) 4 (9.8%) | 49 (70%) 14 (20%) 7 (10%) | $\chi^2 = 6.97, p = 0.03^*$ |
| <i>The use of OMs increases the efficiency of evaluations with clients who have BCRL.</i> | Agree Neither Agree or Disagree Disagree | 28 (68.3%) 6 (14.6%) 7 (17.1%) | 28 (40%) 14 (20%) 28 (40%) | $\chi^2 = 8.83, p = 0.01^*$ |
| Healthcare Practice | | OT (n = 41) n (%) | PT (n = 70) n (%) | |
| <i>Statement</i> | Likert Scale | | | |
| <i>The use of OMs is necessary to determine intervention efficacy for clients with BCRL.</i> | Agree Neither Agree or Disagree Disagree | 36 (87.8%) 4 (9.8%) 1 (2.4%) | 44 (63.8%) 12 (17.4%) 13 (18.8%) | $\chi^2 = 8.51, p = 0.01^*$ |

* = Significant. OT = Occupational Therapist, PT = Physical Therapist, OMs = Outcome Measures.

Table IV.10. Unique Predictors of Use of Outcome Measures.

| Outcome measure | <i>Predictor variable</i> | Wald χ^2 | Significance | OR, Exp (B) | 95% CI |
|----------------------------------|----------------------------------|---------------------------------|---------------------|--------------------|---------------|
| Pinch dynamometer | | | | | |
| | <i>OT profession</i> | 10.49 | p < 0.01 | 11.36 | 2.61 – 49.45 |
| Monofilament | | | | | |
| | <i>OT profession</i> | 4.45 | p = 0.04 | 3.01 | 1.08 – 8.39 |
| Sharp-dull discrimination | | | | | |
| | <i>Not LANA certified</i> | 4.74 | p = 0.03 | 3.65 | 1.14 – 11.69 |
| DASH | | | | | |
| | <i>Not LANA certified</i> | 5.77 | p = 0.02 | 4.37 | 1.31 – 14.59 |
| VAS - Fatigue | | | | | |
| | <i>Not LANA certified</i> | 4.80 | p = 0.03 | 3.23 | 1.13 – 9.24 |
| Functional reach | | | | | |
| | <i>Highest degree – Master's</i> | 5.71 | p = 0.02 | 3.65 | 1.26 – 10.53 |

OR = odds ratio, CI = confidence interval, OT = occupational therapist, DASH = Disability of the Arm, Shoulder, and Hand, VAS = visual analog scale, LANA = Lymphology Association of North America.

Appendix IV.A. Survey on Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer Survivors with Breast Cancer-Related Lymphedema.

Q1 Consent to Participate in a Research Study - Online Survey (HUM00188013)

Ph.D. in PT student, David Doublestein, PT, OCS, CLT-LANA, LLCC, Cert. MDT of the University of Michigan-Flint, Department of Physical Therapy, invites you to be a part of a research study to investigate the use of outcome measures by certified lymphedema therapists (CLT) on breast cancer survivors (BCS) with breast cancer related lymphedema (BCRL). As a CLT, you are invited to participate in this study by completing the web-based survey. The study's aim is to examine: 1) the use of outcome measures used by CLT on BCS with BCRL and their associated factors; and 2) facilitators and barriers with influence CLT use of outcome measures and their associated factors. The survey will take approximately 25 minutes to complete. The researchers were careful in using language in the questions when developing the survey to facilitate the ease of understanding and responding. While you may not receive any direct benefit for your participation in this survey, we hope that this study will contribute to the improvement of the field of lymphology via the assessment, planning, and providing lymphedema therapeutics. Researchers will not be able to link your survey responses to you. The survey software has been set so that no identifying information is captured alongside your survey responses. Participation in this study is completely voluntary. When completing the survey, you will need to be located in the United States. Those who complete the survey may choose to be entered into a randomized prize drawing for a \$25 dollars gift card, of which there are 60. To be entered into the drawing, you will need to provide your name, postal address, and email address. This data will not be linked to the survey and will be destroyed within 30 days from the closure of the survey. There will be four \$25.00 gift cards given for a total of 15 drawings occurring on 15 separate days. Participants who choose to participate will be pooled into 15 equally distributed groups. Individuals cannot be entered into a pool for a prize more than once. Odds of winning a gift card is based on the total number of individuals who complete the survey and choose to participate in the drawing. Survey respondents are eligible to win a maximum of one prize. Prize drawings are conducted within 30 days of the conclusion of the survey on 05/07/21. Prize winners will be notified by email. Should you decide to participate now, you may change your mind and stop at any time by simply exiting the survey. We expect to publish the results of this study, but will not include any information that would identify you.

If you have questions about this survey, you can contact

Principal Investigator: David Doublestein, PT

Email: ddouble@umich.edu

Phone: 231-629-7109

Faculty Advisor: Cathy Larson, PT, PhD

Email: clarson@umich.edu

Phone: 810-762-3373

Faculty Advisor: Amy Yorke, PT, PhD

Email: amyorke@umich.edu

Phone: 810-762-3373 **As part of their review, the University of Michigan Institutional Review Board Health Sciences and Behavioral Sciences has determined that this study is no more than minimal risk and exempt from on-going IRB oversight.**

Informed Consent:

By clicking on "Yes, I agree to participate," you are consenting to participate in this research survey.

If you do not wish to participate, select "No, I do not wish to participate" to exit the survey.

- Yes, I agree to participate (1)
- No, I do not wish to participate (2)

Skip To: End of Survey If Consent to Participate in a Research Study - Online Survey Use of Outcome Measures by Certified L... = No, I do not wish to participate

Q2 Do you see clients with breast cancer related lymphedema?

Yes (1)

No (2)

Skip To: End of Block If Do you see clients with breast cancer related lymphedema? = No

Q3 The survey is divided into four sections. This first section of the survey focuses on demographic and professional information.

Q4 What is your age (years)? Please enter nearest whole number.

Q5 What is your gender?

Female (9)

Male (10)

Transgender (11)

Prefer not to answer (12)

Q6 Please identify your ethnicity.

- American Indian or Alaska Native (13)
 - Asian (14)
 - Black or African American (12)
 - Native Hawaiian or Pacific Islander (15)
 - White (11)
 - Other (16)
 - Prefer not to answer (17)
-

Q7 What is your profession?

- Certified Athletic Trainer (1)
 - Chiropractor (2)
 - Massage Therapist (3)
 - Nurse (4)
 - Occupational Therapist (5)
 - Occupational Therapist Assistant (6)
 - Physical Therapist (7)
 - Physical Therapist Assistant (8)
 - Physician (9)
 - Physician Assistant (10)
 - Other (please describe): (11) _____
-

Q8 What is your highest earned degree? Select all that apply.

- Academic Doctorate (e.g. PhD, D.Sc.) (6)
 - Clinical Doctorate (e.g. MD, DPT, DC, ATD, OTD, DNP) (5)
 - Master of Arts or Science (e.g. MSPT, MAT, MOT, MSN) (4)
 - Bachelor of Arts or Science (e.g. BScPT, BScOT, BScAT, BScMT, BScN) (3)
 - Associate of Arts (e.g. PTA, COTA) (2)
 - Certification/Credentialing (CMT, CBT, CMBT, LMT, RMT) (1)
-

Q9 Which of the following best describes the geographical region of your clinical practice?

- Midwest United States (OH, IN, MI, IL, MO, IA, WI, MN, ND, SD, NE, KS) (1)
 - Northeast United States (MD, PA, NY, VT, ME, NH, MA, RI, CT, NJ, DE) (2)
 - Southwest United States (AZ, NM, TX, OK) (3)
 - Southeast United States (AR, LA, MS, AL, FL, GA, SC, NC, VA, WV, KY, TN, DE) (5)
 - West United States (CO, UT, WY, MT, ID, WA, OR, NV, CA, AK, HI) (4)
 - Canada (6)
 - Neither United States or Canada (7)
-

Q10 Which of the following best describes the community setting of your clinical practice?

- Urban (1)
 - Suburban (2)
 - Rural (3)
-

Q11 How many years have you been practicing your profession?

Q12 How many years have you been certified as a lymphedema therapist?

Q13 From which school did you receive your training and credentials as a certified lymphedema therapist (CLT)? Select all that apply.

- Academy of Lymphatic Studies (1)
 - Brennan School of Innovative Lymphatic Studies (2)
 - Casley Smith International (3)
 - Chikly Health Institute - LLCC (4)
 - Dr. Vodder School International (5)
 - International Lymphedema & Wound Training Institute (7)
 - Klose Training Lymphedema Certification (8)
 - Norton School of Lymphatic Therapy (6)
 - Pacific Therapy Education, Inc. (10)
 - UWM Lymphedema Therapist Certification (12)
 - Other school that offers minimum of 135 hours of CLT training and certification (please name and identify if not within U.S.): (11) _____
-

Q14 Are you a nationally certified lymphedema therapist through the Lymphology Association of North America (CLT-LANA)?

- Yes (1)
 - No (2)
-

Q15 What other broad scope of practice specializations are you credentialed in? (select all that apply)

- Acute Care (13)
 - Clinical Electrophysiology (1)
 - Cardiovascular and Pulmonary (2)
 - Family Medicine (15)
 - Geriatric (3)
 - Hand Therapy (4)
 - Internal Medicine (14)
 - Manual Therapy (5)
 - Neurology (6)
 - Obstetrics & Gynecology (18)
 - Oncology (7)
 - Orthopaedic (8)
 - Pediatric (9)
 - Plastic Surgery (16)
 - Sports (10)
 - Vascular Medicine (17)
 - Other (please describe): (11) _____
 - None (12)
-

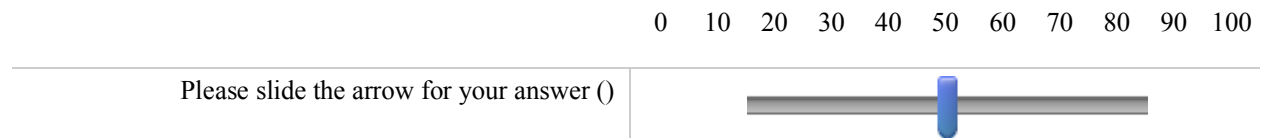
Q16 Which of the following BEST describes the facility at which you conduct MOST of your Breast Cancer Related Lymphedema patient/client care? (please select only one)

- Acute Care Hospital (1)
- Acute Rehabilitation (2)
- Extended Care Facility (3)
- Facility-Based Outpatient Clinic (4)
- Home Health Care (5)
- Privately Owned Outpatient Clinic (6)
- Subacute Rehabilitation (7)
- University (8)
- Other (please describe): (9) _____

Q17 How would you characterize the age of the patient population with breast cancer related lymphedema you manage? **Please put a number in ALL of the boxes (could be 0%).**

- Percentage < 21 years of age (12) _____
- Percentage 21 - 40 years of age (13) _____
- Percentage 41 - 60 years of age (14) _____
- Percentage 61 - 75 years of age (15) _____
- Percentage > 75 years of age (16) _____

Q18 Approximately what percentage of your practice is devoted to the treatment of lymphedema?
Not Applicable



Q19 On average, how many Breast Cancer Related Lymphedema clients do you see in an eight hours work day? If working less than 8 hours, please sum to 8 hours work day.

Not Applicable

0 3 6 9 12 15 18 21 24 27 30

Please slide the arrow for your answer ()



Q20 On average, how many hours per week do you provide interventions on clients with breast cancer related lymphedema?

Not Applicable

0 8 16 24 32 40 48 56 64 72 80

Please slide the arrow for your answer ()



Q21 On average, how many minutes are allocated for an initial evaluation on clients with breast cancer related lymphedema?

Not Applicable

0 9 18 27 36 45 54 63 72 81 90

Click to write Choice 1 ()



Q22 On average, how many minutes are allocated for a follow-up appointment on clients with breast cancer related lymphedema?

Not Applicable

0 9 18 27 36 45 54 63 72 81 90

Click to write Choice 1 ()



Q23 Do you treat lymphedema that has manifested with any of the following conditions? (please select all that apply)

- Arthritis (1)
- Chronic Venous Insufficiency (2)
- Filariasis Infection (3)
- Head and Neck Cancer (4)
- Lipedema (5)
- Neurological Conditions (6)
- Reproductive Organ Cancers (7)
- Orthopedic Conditions (8)
- Post-Operative General (9)
- Post-Operative Orthopedic (10)
- Primary Lymphedema (11)
- Wounds (12)
- Other (please describe): (13) _____
- None (14)

Q24 Do you conduct assessments on clients with breast cancer related lymphedema in which you use outcome measures (e.g. ROM, strength, volume, fatigue, quality of life)?

- Yes (1)
 - No (2)
-

Q25 Please proceed with the second section of the survey which focuses on outcome measures used to identify **Body Structure and Function Impairments**. Please answer to your best ability.

Q26 Which of the following outcome measures do you use to measure **JOINT FUNCTION** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| Dynamic Motion Assessment of Scapula (dichotomous) (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Goniometry - passive range of motion (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Goniometry - active range of motion (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Inclinometer - passive range of motion (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Inclinometer - active range of motion (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (7) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure JOINT FUNCTION on your clients with... = Do Not Use

Q27 You have selected that you do not use outcome measure(s) for JOINT FUNCTION from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (6)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (9)
 - My workplace does not support the use of the measure (10)
 - Too confusing for the patient to understand (11)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q28 Which of the following outcome measures do you use to measure **FLEXIBILITY** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Pectoralis major length (7) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Pectoralis minor muscle length (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Pectoralis minor muscle length - Borstad scapular index (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Stiffness of glenohumeral joint (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure FLEXIBILITY on your clients with br... = Do Not Use

Q29 You have selected that you do not use outcome measure(s) for FLEXIBILITY from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (8)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (9)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q30 Which of the following outcome measures do you use to measure **STRENGTH** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Hand Grip Dynamometry (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Hand Held Dynamometry (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Manual Muscle Testing (MMT) (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| One Repetition Maximum (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Pinch Dynamometry (Tip, Lateral, 3 Jaw Chuck) (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure STRENGTH on your clients with breas... = Do Not Use

Q31 You have selected that you do not use outcome measure(s) for STRENGTH from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (9)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (10)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q32 Which of the following outcome measures do you use to measure **VOLUME and/or TISSUE WATER CONTENT** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|--|------------------------|--------------------------|-----------------------|-----------------------|
| Bioelectrical Impedance Spectroscopy (BIS) (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Circumferential Measurements - Calculated Volume (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Perometry (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Tissue Dielectric Constant (TDC) (9) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Water displacement/Volumeter (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3D Imaging (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure VOLUME and/or TISSUE WATER CONTENT ... = Do Not Use

Q33 You have selected that you do not use outcome measure(s) for VOLUME and/or TISSUE WATER CONTENT from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (9)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (10)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q34 Which of the following outcome measures do you use to measure **PAIN** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| Brief Pain Inventory (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Brief Pain Inventory - Short Form (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| McGill Pain Questionnaire (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| McGill Pain Questionnaire - Short Form (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Numeric Pain Rating Scale (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Pain Disability Index (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Visual Analog Scale (7) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (8) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure PAIN on your clients with breast ca... = Do Not Use

Q35 You have selected that you do not use outcome measure(s) for PAIN from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (9)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (10)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q36 Which of the following outcome measures do you use to measure **SENSATION** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Light Touch (e.g. cotton ball, finger, brush) (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Monofilament (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sharp-Dull Discrimination (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Two-Point Discrimination (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Vibration/Tuning Fork (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure SENSATION on your clients with brea... = Do Not Use

Q37 You have selected that you do not use outcome measure(s) for SENSATION from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (9)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (10)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q38 Which of the following outcome measures do you use to measure **TISSUE CONSISTENCY** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Myoton (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Pitting Edema Test - Palpation (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| SkinFibrometer (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Tissue Texture - Palpation (normal, soft, spongy, firm) (8) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Tonometry (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Ultrasonography (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure TISSUE CONSISTENCY on your clients... = Do Not Use

Q39 You have selected that you do not use outcome measure(s) for TISSUE CONSISTENCY from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (9)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (10)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q40 Which of the following outcome measures do you use to measure **BODY COMPOSITION** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|--------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Myoton (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Bioelectrical Impedance Analysis (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Body Weight (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Body Mass Index (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

*If Which of the following outcome measures do you use to measure BODY COMPOSITION on your clients wi...
= Do Not Use*

Q41 You have selected that you do not use outcome measure(s) for BODY COMPENSATION from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
- My lack of knowledge of this outcome measure (2)
- My lack of skill in using this outcome measure (3)
- My lack of time to implement this outcome measure (4)
- Too difficult for the patient to perform (5)
- My examination preference (e.g. review of systems, predetermined tests and measures) (9)
- The outcome measure is not available at my workplace (e.g. cost, resources) (10)
- My workplace does not support the use of the measure (11)
- Too confusing for the patient to understand (6)
- The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
- Other (please describe): (12) _____

Page Break

Q42 This third section of the survey focuses on outcome measures used to identify ***Activities and Participation Limitations***. Please answer to your best ability.

Q43 Which of the following **PATIENT-REPORTED** outcome measures do you use to measure **HEALTH-RELATED QUALITY OF LIFE** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|
| Breast Cancer Questionnaire (14) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Breast-Q (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| EORTC Quality of Life Questionnaire - Breast (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional Assessment of Cancer Therapy - Breast (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional Assessment of Cancer Therapy - Breast +4 (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional Assessment of Cancer Therapy/Gynecologic Oncology Group-Neurotoxicity (v4) (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional Living Index - Cancer (13) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Lymphedema Life Impact Scale (7) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Lymphoedema Functioning Disability, and Health Questionnaire (8) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (15) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following PATIENT-REPORTED outcome measures do you use to measure HEALTH-RELATED QUA... = Do Not Use

Q44 You have selected that you do not use PATIENT-REPORTED outcome measure(s) for HEALTH-RELATED QUALITY OF LIFE from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (8)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (9)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q45 Which of the following **PATIENT-REPORTED** outcome measures do you use to measure **UPPER QUADRANT FUNCTION** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| Disability of Arm, Shoulder, and Hand Questionnaire (DASH) (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Penn Shoulder Score (PSS) (9) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| QuickDASH (10) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Shoulder Disability Questionnaire (SDQ) (8) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Shoulder Pain and Disability Index (SPADI) (11) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Shoulder Rating Questionnaire (SRQ) (12) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Upper Extremity Functional Index (UEFI) (13) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Upper Limb Lymphedema Measure (ULDQ) (14) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (15) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following PATIENT-REPORTED outcome measures do you use to measure UPPER QUADRANT FUN... = Do Not Use

Q46 You have selected that you do not use PATIENT-REPORTED outcome measure(s) for UPPER QUADRANT FUNCTION from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
- My lack of knowledge of this outcome measure (2)
- My lack of skill in using this outcome measure (3)
- My lack of time to implement this outcome measure (4)
- Too difficult for the patient to perform (5)
- My examination preference (e.g. review of systems, predetermined tests and measures) (8)
- The outcome measure is not available at my workplace (e.g. cost, resources) (9)
- My workplace does not support the use of the measure (11)
- Too confusing for the patient to understand (6)
- The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
- Other (please describe): (12) _____

Q47 Which of the following **PATIENT-REPORTED** outcome measures do you use to measure **FATIGUE** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|--|------------------------|--------------------------|-----------------------|-----------------------|
| Bi-Dimensional Fatigue Scale (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Brief Fatigue Inventory (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Chalder Fatigue Questionnaire (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Diagnostic Interview for Cancer Related Fatigue (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| FACT-B (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Fatigue Symptom Inventory (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional Assessment of Chronic Illness Therapy - Fatigue (7) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| MOS-SF36/Rand/Vitality (8) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Multidimensional Fatigue Symptom Inventory (9) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Piper Fatigue Scale Revised (10) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Profile of Mood States Fatigue/Vigor and Fatigue/Inertia Subscales (11) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Visual Analog Scale (12) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Wu Cancer Fatigue Scale (13) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (14) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following PATIENT-REPORTED outcome measures do you use to measure FATIGUE on your cl... = Do Not Use

Q48 You have selected that you do not use PATIENT-REPORTED outcome measure(s) for FATIGUE from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
- My lack of knowledge of this outcome measure (2)
- My lack of skill in using this outcome measure (3)
- My lack of time to implement this outcome measure (4)
- Too difficult for the patient to perform (5)
- My examination preference (e.g. review of systems, predetermined tests and measures) (9)
- The outcome measure is not available at my workplace (e.g. cost, resources) (10)
- My workplace does not support the use of the measure (11)
- Too confusing for the patient to understand (6)
- The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
- Other (please describe): (12) _____

Q49 Which of the following outcome measures do you use to measure **MOBILITY AND BALANCE** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|--|------------------------|--------------------------|-----------------------|-----------------------|
| Activities-Specific Balance Confidence Scale (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Balance Evaluation Systems Test (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Berg Balance Scale (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Barthel Index (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Fullerton Advanced Balance Scale (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional Independence Measure (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Functional Reach (7) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Short Form Wolf Motor Function Test (8) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Short Performance Physical Battery (9) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Timed Up and Go (10) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2 - Minute Walk Test (11) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5 - Times Sit to Stand (12) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6 - Minute Walk Test (13) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (14) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure MOBILITY AND BALANCE on your client... = Do Not Use

Q50 You have selected that you do not use outcome measure(s) for MOBILITY AND BALANCE from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
- My lack of knowledge of this outcome measure (2)
- My lack of skill in using this outcome measure (3)
- My lack of time to implement this outcome measure (4)
- Too difficult for the patient to perform (5)
- My examination preference(e.g. review of systems, predetermined tests and measures) (9)
- The outcome measure is not available at my workplace (e.g. cost, resources) (10)
- My workplace does not support the use of the measure (11)
- Too confusing for the patient to understand (6)
- The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
- Other (please describe): (12) _____

Q51 Which of the following outcome measures do you use to measure **UPPER EXTREMITY ACTIVITY & MOTOR CONTROL** on your clients with breast cancer related lymphedema? Please indicate the frequency of use of each assessment.

Frequency Definitions:

Frequently Used: Used for initial examination and reassessments.

Occasionally Used: Used for initial examination.

Seldom Used: Intermittent use as warranted.

| | Frequently Used (1) | Occasionally Used (2) | Seldom Used (3) | Do Not Use (4) |
|-------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Action Research Arm Test (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Box and Block Test (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Finger Tapper Test (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Purdue Pegboard (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Ruler Drop Test/ReacStick (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9 - Hole Peg Test (6) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9 - Item Arm Motor Ability Test (7) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Others (please describe): (8) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Display This Question:

If Which of the following outcome measures do you use to measure UPPER EXTREMITY ACTIVITY & MOTOR CO... = Do Not Use

Q52 You have selected that you do not use outcome measure(s) for UPPER EXTREMITY & ACTIVITY AND MOTOR CONTROL from the previous question. From the choices below, please identify barriers in utilizing those outcome measure(s). Select all that apply.

- My attitude and/or personal beliefs toward this outcome measure usefulness (1)
 - My lack of knowledge of this outcome measure (2)
 - My lack of skill in using this outcome measure (3)
 - My lack of time to implement this outcome measure (4)
 - Too difficult for the patient to perform (5)
 - My examination preference (e.g. review of systems, predetermined tests and measures) (9)
 - The outcome measure is not available at my workplace (e.g. cost, resources) (10)
 - My workplace does not support the use of the measure (11)
 - Too confusing for the patient to understand (6)
 - The outcome measure is not inclusive (e.g. culturally, ethnically, gender) (7)
 - Other (please describe): (12) _____
-

Q53 You are almost done! We appreciate your time. Lymphedema stakeholders appreciate your input! This fourth section of the survey focuses on perceived beliefs, facilitators, and barriers toward the use of outcome measures. For the following items, please select the appropriate choice for your response. Please answer to your best ability.

Q54 The use of **outcome measures is necessary for the practice** of breast cancer related lymphedema treatment and management.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q55 The use of **outcome measures** for clients with breast cancer related lymphedema **places unreasonable demand on a practitioner**.

- Strongly agree (11)
 - Somewhat agree (12)
 - Neither agree nor disagree (13)
 - Somewhat disagree (14)
 - Strongly disagree (15)
-

Q56 The use of **outcome measures improves quality of care** toward clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q57 The use of **outcome measures helps direct the plan of care** for clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q58 The use of **outcome measures helps** in the clinical reasoning for **choice of interventions** on clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q59 The use of **outcome measures improves communication with clients** who have breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q60 The use of **outcome measures improves communication with other healthcare stakeholders** (physician, colleagues, case managers, and insurance).

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q61 The use of **outcome measures increases the efficiency of evaluations** with clients who have breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q62 **Outcome measures help to motivate and encourage clients** with breast cancer related lymphedema in the treatment and management of their condition.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q63 I have **sufficient knowledge about outcome measures** for clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q64 I have **sufficient skills to use outcome measures** for clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q65 The interpretation of the results obtained by **outcome measures** are **easily interpreted** for clinical reasoning pertaining to breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q66 I have the ability to **access current research** pertaining to breast cancer related lymphedema **through professional journals**.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q67 With so many outcome measures, **I do not know the best option to choose to use** on my clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q68 I consistently incorporate **clinical practice guidelines and systematic reviews** related to breast cancer related lymphedema diagnosis and interventions.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q69 I received **sufficient training in using various outcome measures** on clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q70 I received **sufficient training** about outcome measures for clients with breast cancer related lymphedema in my **professional training** (e.g. PT, OT, PA).

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q71 I received sufficient training about outcome measures for clients with breast cancer related lymphedema in my **post-professional CLT course(s)**.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q72 **Outcome measures** are important for **assisting** in the **identification of problems (comorbidities)** in clients with breast cancer related lymphedema (e.g. fall risk, balance deficits, increased fibrosis, restricted motion, decreased reaction time, etc.).

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q73 The use of **outcome measures is necessary to determine treatment efficacy** for clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q74 The use of **outcome measures is part of my personal practice model.**

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q75 **Clients with breast cancer related lymphedema request that I use outcome measures.**

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q76 It is important to **execute outcome measures for patient discharge.**

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q77 It is important to **execute outcome measures at regular intervals** for patient progress summaries.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q78 **Clients** with breast cancer related lymphedema that I see **ARE NOT suitable for outcome measures.**

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q79 **Management** at my work place **supports the use of outcome measures** on clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q80 I have **sufficient time to conduct a battery of outcome measures** on clients with breast cancer related lymphedema (this includes time for self-report questionnaires).

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q81 I have **sufficient time to analyze results of outcome measures** for clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q82 I have **sufficient time to complete documentation** of outcome measures for clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q83 **Using outcome measures** on clients with breast cancer related lymphedema **is encouraged** at my workplace.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q84 I have **colleague support in utilizing outcome measures** on clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q85 At my workplace, I have **access to the tools I need to conduct outcome measures** to address the comorbidities in clients with to breast cancer related lymphedema (e.g. fall risk, balance deficits, increased fibrosis, restricted motion, decreased reaction time, etc.).

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q86 **Electronic medical records** for documentation facilitates the use of outcome measures (this includes patient self-report questionnaires) on clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q87 **Paper records** for documentation **facilitates the use of outcome measures** (this includes patient self-report questionnaires) on clients with breast cancer related lymphedema.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q88 **Clients** with breast cancer related lymphedema **have difficulty understanding the written instructions** of the patient-reported outcome measures.

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q89 **Clients** with breast cancer related lymphedema **have difficulty understanding the verbal instructions of outcome measures.**

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q90 The **patient-reported outcome measures** for clients with breast cancer related lymphedema **are NOT gender inclusive.**

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q91 The **patient-reported outcome measures for clients with** breast cancer related lymphedema **are NOT culturally/ethnically inclusive.**

- Strongly agree (1)
 - Somewhat agree (2)
 - Neither agree nor disagree (3)
 - Somewhat disagree (4)
 - Strongly disagree (5)
-

Q92 Thank you for participating in this survey! You may choose to participate in a randomized drawing for a \$25.00 Amazon gift card. Please choose one of the following options below. Again, we appreciate the time you spent completing this survey.

- Please enter me in the randomized drawing for a \$25 Amazon gift card. (1)
- I choose not to be entered in the drawing and conclude my participation. (2)

Skip To: End of Survey If Thank you for participating in this survey! You may choose to participate in a randomized drawing... = I choose not to be entered in the drawing and conclude my participation.

End of Block: Default Question Block

CHAPTER V

Discussion of the Dissertation

OVERVIEW

Three manuscripts with separate aims and objectives have been united to accomplish the purpose of this dissertation, which was to advance a greater understanding of the status of lymphology education and practice in physical therapy through a multimodal investigation of entry-level knowledge, post-professional knowledge, and MLdT on lymphedema in the physical therapy specialty areas of oncology and orthopaedics.

To accomplish the multimodal investigation, three separate studies with two separate research designs were implemented. With the premise that lymphology education is important to the future of the physical therapy profession, the first study investigated by means of survey research design, the status of lymphology education in professional DPT programs. The overall consensus was that lymphology education is entry-level material for DPT students albeit a high variability in the hours devoted to disseminating this curricular topic. Adding to this foundation, there has been an increase depth of knowledge from recent discoveries about fluid homeostasis and the limitations of previous interventions to reduce edema. This promoted a second study using a systematic review to investigate the effects of manual lymphatic drainage techniques (MLdT) on conditions affecting the musculoskeletal system. There was moderate support for using MLdT for conditions affecting the musculoskeletal system as effective interventions to reduce pain, improve function and/or QOL, and were associated with lower HU. This knowledge gave rise to investigating use of OMs that are foundational for the examination of individuals with chronic edema, including BCRL, in both physical and occupational therapy practice and in research. Using survey research methodology, the third study examined the use of OMs by post-professional CLTs attending to the impairments and limitations identified in BCS with BCRL, including an exploration of predictive factors to their use and the barriers and facilitators to the use of OMs. This final chapter presents a synopsis of the cardinal findings from the proceeding chapters, including their strengths and weaknesses, and establishes a pathway toward future research of the discipline of lymphology in the field of professional physical therapy.

SUMMARY OF STUDY RESEARCH DESIGNS AND RESULTS

STUDY ONE

The aims of this study were to 1) describe current, typical lymphology content within professional DPT programs; and 2) identify whether lymphology content is perceived as entry-level material amongst professional DPT faculty who were responsible for teaching lymphology content (TL) and professional DPT faculty who did not teach lymphology content (NTL). A cross-sectional web-based survey research design was implemented to gather data on lymphology content, hours, and curriculum standings. The survey was disseminated to professional DPT faculty in the US who taught or did not teach lymphology curriculum. The analysis included descriptive data with means and frequencies, Chi-square test assessing relationships between faculty status and entry-level lymphology curriculum status, and Spearman rank correlation coefficient assessing relationships between teaching hours and entry-level status. The cardinal conclusions were that individual lymphology curriculum contents were predominantly considered entry-level material (e.g. anatomy, physiology, pathophysiology, classifications, comorbidities, functional limitation reporting, compression pumps, bandaging, MLdT, and compression garments), however, variability existed across curricula in range of hours devoted to didactic (0.4-14.1 hours) and laboratory (0-10 hours) instruction pertaining to lymphology. This study had limitations in methodology due to recruitment of faculty who were involved in the lymphology curriculum allowed for more than one per university to respond to the survey. In addition, the a priori survey sample size of 80 representatives, using a 35% response rate¹⁻³ from a larger pool of accredited professional DPT programs in the United States, was not accomplished (response rate = 24%) which limited geographical representation and generalizability. Regardless of the inclusivity efforts imbedded in the survey instructions and email reminders to participate in the study, a significant disproportion of TL to NTL respondents occurred. Future research indicated to improve the methodology of this survey with the aim to have a better generalizable understanding of lymphology curricula in professional DPT programs and also to explore best educational practices of teaching didactic and laboratory lymphology content in both eLearning and traditional methods.

STUDY TWO

The aim of the second study was to determine whether MLdT in addition to conventional rehabilitation on conditions affecting the musculoskeletal system, can decrease edema, and improve ROM, patient-reported outcomes, and healthcare use. The objective was to complete a systematic review of literature to achieve this aim. Using PRISMA guidelines, eligible studies published between 2007 and 2018, with similar outcome measurements, were grouped for analysis and then analyzed for methodological quality via PEDro scale. Strength of the body of evidence was determined by using the Cochrane GRADE guidelines and the American College of Chest Physicians guidelines. The cardinal conclusions were that MLdT was associated with lower HU and that there was moderate evidence for the use of MLdT on conditions affecting the musculoskeletal system to reduce pain and improve patient-reported outcomes for functional activities and QOL. Other results of the study suggest that MLdT in combination with conventional rehabilitation were effective in edema reduction and improving ROM. Due to limited studies (n = 5), moderate PEDro scores, and significant heterogeneity of the studies, a meta-analysis was not conducted. Future randomized control trial research is needed to provide stronger evidence to support the use of MLdT for patient with conditions affecting the musculoskeletal system and provide evidence as to which auxiliary interventions (e.g. compression bandage, compression garment, elastic taping, or exercise) concurrent with MLdT produce best outcomes.

STUDY THREE

This study's aim was to examine 1) OMs used by CLTs on BCS with BCRL and their differences between professions; 2) unique characteristic predictors for use of OMs; and 3) facilitators and barriers which influence CLTs use of OMs and their differences between professions. A cross-sectional web-based survey research design was implemented to gather demographic information of CLTs and information about levels of use and the facilitators and barriers to the use of outcome measures that CLTs use on BCS with BCRL. The survey was distributed to CLT graduates from the post-professional education institutions and related professional associations. The analysis included descriptive data with means and frequencies, chi-square test of independence, student t-test, and Mann-Whitney U test for group differences, and binary logistic regression for odds ratios as a predictive value of participant characteristics to the use of outcome measures. The cardinal conclusions were that the OMs used most often by CLTs to measure ICF domains of body functions and structures include 1) goniometry for PROM and AROM; 2) stiffness of the glenohumeral joint for flexibility; 4) hand grip dynamometer and MMT for strength; 5) circumferential measurements for volume; 6) numeric pain scale and visual analog scale for pain; 7) body weight and BMI for body composition; 8) light touch brushing for sensation; and 9) pitting edema and tissue texture via palpation for tissue consistency. OMs used most often to measure ICF domains of activities and participation include 1) LLIS for patient-reported HRQOL, and 2) *QuickDASH* for patient-reported upper quadrant function. A CLT's profession, highest degree earned, and specialization may affect their use of OMs. CLTs value the use of OMs and find them necessary for the treatment and management of BCRL. Most CLTs reported that they had sufficient skills to use and interpret the results of OMs for clients with BCRL, however, less than half of the CLTs reported that they had sufficient knowledge about OMs for BCRL, while over half of CLTs reported that they had difficulty knowing the best OM to choose due to numerous options. More than half of CLTs reported that they did not receive sufficient training on BCRL OMs in their professional education and an equal proportion of respondents reporting that they did or did not receive sufficient training in their post-professional CLT courses. Limitations of the study include sample size which limited generalizability.

SUMMARY OF RESULTS

This dissertation added to the existing body of knowledge by advancing a greater understanding of the status of lymphology education and practice in physical therapy. It also established a list of OMs used by CLTs which can provide a foundation for lymphology educational standards in BCRL examination and evaluation.

Study One was fundamental to the dissertation by reporting what lymphology content was currently being taught in professional DPT curriculums. The most recent survey research on lymphedema management content in physical therapy programs was conducted over 20 years ago.⁴ The field of lymphology has expanded into various disciplines (e.g. oncology, orthopedics, and wound care) of physical therapy, which necessitated an updated investigation. Study One identified current lymphology content within professional DPT programs, and indicated that programs taught mostly on lymphology intervention, followed by anatomy, physiology, pathophysiology, and to a lesser extent examination content. Peripheral circulation examination and reexamination (including lymphedema) are considered a minimum required skill set by the APTA – BOD.⁵ CAPTE⁶ emphasizes the knowledge base of examination, evaluation, and diagnosis of the lymphatics. Respondents in this survey labeled most of the didactic curriculum as being entry-level including anatomy (suprafascial and subfascial), physiology, and lymphedema pathophysiology (including its comorbidities). Pathophysiology content focused on teaching about mechanical insufficiency of the lymphatic system, whereas dynamic insufficiency and combined insufficiency were taught to a lesser extent. This study also reported that the frequency of teaching about compression devices (garments and bandage alternatives) took precedence to other interventions (e.g. MLdT).

Study Two was conceptualized by considering results from Study One including; 1) the frequency that MLdT is entry-level education (58.1%, n = 25); and 2) the frequency that mechanical insufficiency (86.8%, n = 33) and dynamic insufficiency (73.7%, n = 28) edemas are typically taught in professional DPT lymphology curriculums. Study Two, a systematic review, explored MLdT and their effects on conditions affecting the musculoskeletal system, whose resulting edema would by definition be considered either a dynamic or mechanical insufficiency edema depending on the time continuum of healing. There is moderate evidence to advocate the

use of MLdT for decreasing edema in acute, subacute, and chronic healing phases of conditions affecting the musculoskeletal system. While studies pertaining to acute edema evidenced a lack of volume reduction with MLdT, one study⁷ reported less increase in edema compared to the control group. Reduction in girth⁸ suggested that acute edema may benefit from MLdT, when the addition of auxiliary multilayer short-stretch compression bandaging and exercises is incorporated. Compression was one key treatment which appeared to influence the outcomes of one study;⁹ This summary aligned with another systematic review published in the same year, using some of the same RCT, investigating lymphatic treatments after orthopedic surgery and injury.¹⁰ Study Two contributed further to the available body of evidence by evidencing moderate evidence for the use of MLdT for improving ROM after TKA. One author⁷ suggested that their improved ROM observations may be attributed to the slight decrease in edema, mechanical effects of MLdT during popliteal maneuvers, prevention of fibrosis through protein reabsorption, or simply through relaxation. In addition, the use of MLdT was recommended for hastened and stable pain relief and improving outcomes pertaining to functional activities and QOL. One contribution to the body of knowledge which Study Two offered was the moderate evidence to support the use of MLdT for improving HU. Patient-centered care and value-based reimbursement models advocate for rehabilitation therapists to be responsible with the delivery of evidence-based practice to lower HU. This systematic review in combination with similar reviews, suggest that MLdT with and without auxiliary treatment modalities may be used as an evidence-based intervention for the purpose of lowering HU, decreasing edema and pain, and increasing functional activities, ROM, and QOL.^{10,11}

Various OMs were employed in the individual RCT investigated in Study Two. Edema measurement methods that were employed in the studies, included volumeter, bioimpedance, and circumferential measurements. Also, studies used different OMs for Patient-reported OMs on functional activities and HRQOL. In Study One, the respondents (TL and NTL) somewhat agreed to strongly agreed that the subject matter of examination of the lymphatic system (81.4%, n = 35) was entry-level material. Ninety percent (n = 34) of TL respondents reported that their professional DPT programs taught on examination pertaining to lymphatics. Examination including circumferential measurements, special tests, volumetric measurement, and integument were taught in the integumentary course (44.7%, n = 17), followed by the cardiopulmonary

(28.9%, n = 11), and musculoskeletal (21.1%, n = 8) course. For the purposes of clinical reasoning and differential diagnosis, having the skillsets of lymphatic examination, evaluation, and diagnosis would align with their importance as indicated by CAPTE⁶ and the APTA – BOD.⁵ These underpinnings led to Study Three and the investigation of the use of OMs by post-professional CLTs on BCS with BCRL and the facilitators and barriers to the use of OMs. There were a number of OMs identified as being used at some level of frequency by CLTs to measure body functions and structures and activities and participation. Those OMs used most often (i.e. fourth quartile of responses) included; 1) goniometry for AROM and PROM (99.1%, n = 110 and 95.5%, n = 106, respectively), 2) stiff glenohumeral joint (93.7%, n = 104), 3) hand grip dynamometry and MMT (88.3%, n = 98 and 98.2%, n = 109, respectively), 4) circumferential measurements (99.1%, n = 110), 5) numeric pain scale and visual analog scale (94.6%, n = 105 and 82.9%, n = 92, respectively), 6) light touch brushing (95.5%, n = 106), 7) pitting edema test and tissue texture via palpation (98.2%, n = 109 and 97.3%, n = 108, respectively), 9) body weight and BMI (91.0%, n = 101 and 85.6%, n = 95), 10) LLIS (82.9%, n = 92), and 11) *QuickDASH* (85.6%, n = 95). The number of OMs used to assess body functions and structures exceeded those OMs that assess activities and participation. In fact, there were no OMs used by the fourth quartile of CLT respondents to measure patient-reported fatigue, mobility and balance, and upper extremity (UE) activity and motor control. At the third quartile of responses, the category of activities and participation did not populate a single OM for upper extremity activity and motor control. Profession, specialization, and highest degree earned were unique characteristics of CLTs that predicted the use of some OMs.

Facilitators and barriers to the use of OMs were investigated for both PT and OT CLTs. Most CLTs agreed that the use of OMs helps direct the plan of care (90.1%, n= 100), improves quality of care (76.6%, n = 85), helps in the clinical reasoning for choice of interventions (77.5%, n = 86), and are necessary for the practice of BCRL interventions and management (94.6%, n = 105). They also largely agreed that OMs improves communication with their BCS clients with BCRL (80.2%, n = 89) and with other healthcare stakeholders (76.6%, n = 85). CLTs largely agreed that use of OMs were part of their personal practice model (81.8%, n = 90), and that OMs were important for assisting in the identification of comorbidities (87.3%, n = 96) and determining the efficacy of their intervention on BCRL (72%, n = 80).

LIMITATIONS OF THE DISSERTATION

This dissertation focused on the status of lymphology education and practice in professional physical therapy. Although the lymphatic system is a major body system, its presence is commonly morphed into either the circulatory system and/or immune system in curriculums and even in physiology textbooks. The average medical school graduate receives less than 30 minutes of lymphology education,¹² while our results indicate that physical therapists receive a variable range of hours devoted to didactic (0.4-14.1 hours) and laboratory (0-10 hours) instruction pertaining to lymphology. These conditions elude to the realization that the general population of faculty, specialists, and researchers in lymphology, let alone lymphology in the field of physical therapy, is marginal. This limited population resulted in the primary limitation of recruitment of a sample population across all three studies, those being faculty that taught lymphology curriculum, articles about MLdT applied to orthopedic conditions, and CLTs that use OM on BCS with BCRL. The examination of lymphology content and use of OM and their facilitators and barriers were conducted via web-based survey research design. Web-based surveys yield less response than other modes of survey delivery, and on average, yield an expected 35% response rate, or approximately a third of the surveys administered.¹⁻³ Unfortunately, the low response rates across both survey research designs limited a population representation and would not allow generalization of the outcomes. In addition, a sizable disproportion of respondents occurred in both studies. Both surveys studies may have incurred survey burden and recall bias, especially considering the length of Study Three and the recall of instructional time in Study One and frequency of OM use in Study Three. Study Three examined PTs and OTs from the original sample, thereby limiting the generalizability of the results to the CLT population as a whole. The limited articles that were retrieved and included in Study Two limited the analysis due to significant heterogeneity (across population, intervention, and outcome measures), low number of total participants, and moderate internal validity of the studies. This prevented a meta-analysis to accurately determine the effect size of each study and overall effect size from the systematic review.

FUTURE RESEARCH

The scholarship of teaching and learning lymphology content is the baseline for future research endeavors stemming from this dissertation. Study One begins to foster further research with regards to lymphology education in professional DPT programs. Future studies may consider investigating DPT programs that offer specialist certifications and those that offer lymphology education without certification. This study may use a mixed method approach, examining not only what lymphology content was being taught in these programs, but also assessing the lymphology knowledge of third year DPT students from different approaches. In addition, interviews with individual faculty members may clarify the reasons for the variability of hours devoted to lecture and lab, and toward anatomy, physiology, pathophysiology, examination and intervention content that was discovered in Study One. Currently, I am participating as co-investigator of a survey research design from LANA that has examined content being taught in post-professional lymphedema therapist certification courses. The survey was disseminated to instructors from continuing education institutions of various tenets. Descriptive statistics will examine; 1) what is the current, typical lymphology post-professional content being taught, and 2) how the content is being taught (e.g. online or traditional). This study will add knowledge to what has been presented in Study Three by investigating what is being taught post-professionally with regard to anatomy, physiology, examination, evaluation, clinical reasoning, and interventions of lymphatic and vascular disorders.

Understanding what core outcomes should be of greatest concern for CLTs to understand, identify, and measure on BCS with BCRL requires further investigation. Creating a COS for BCS with BCRL is a worthy endeavor for all allied stakeholders to capture baseline measures and BCRL comorbidities across the ICF levels. This is a feasible endeavor and my relationship with LANA and the APTA Oncology section will enhance my efforts to unite various stakeholders to expand and then refine a list of outcome domains identified by the Breast Cancer EDGE Task Force studies, and then process through the COMET guidelines, including the possibility of a Delphi study. The development of a COS is comprehensive; however, Study Three has cultivated insights of what OMs are used to measure a select set of outcomes. Not

only is a COS a feasible endeavor, but identifying the OMs to measure the COS is certainly within reach, as well as providing guidance as to “when” to measure are also attainable.

Study Two introduces the need to understand the use of MLdT and auxiliary modalities as interventions across disciplines of physical therapy (e.g. orthopedic, neurology, sports medicine, oncology, wound management, and pediatrics). There have been some recent randomized-controlled and quasi-experimental research exploring applications of MLdT for post-operative TKA subjects. Unfortunately, most of the studies are examining acute and subacute episodes and also examine either MLdT or compression rather than exploring the combination in CDT. This presents bias to the study and is evidence of the disregard to lymphology related to acute, subacute, and chronic edema. There is a need for well-developed RCT to explore the efficacy of MLdT and compression in orthopedic physical therapy practice. Future research is needed to provide stronger evidence to support the use of MLdT for patients with conditions affecting the musculoskeletal system, and provide evidence as to which auxiliary interventions concurrent with MLdT produce best outcomes.

Study Three revealed that OMs related to upper extremity and motor control were not used most often. Linking lymphology, orthopedics, and neurology, I have proposed an original cross-sectional comparison study to investigate reaction time and movement time in females with breast cancer-related lymphedema. Upper extremity simple reaction time and movement time are vital for the safety and health of an individual to restore balance and protect the body from an oncoming object or fall. Individuals with breast cancer-related lymphedema (BCRL) have demonstrated sensorimotor impairments. To date, there have not been studies that investigate upper extremity simple reaction time and movement time in females with BCRL. Female BCS with and without lymphedema will participate in the study, along with healthy female participants without history of breast cancer or upper extremity lymphedema. I have hypothesized that female BCS with unilateral BCRL will have slower simple reaction time, movement time, and execution time when performing a quick reaching task, compared to healthy females, and female BCS without lymphedema. In addition, increased simple reaction, movement, and execution times in unilateral BCRL will be associated with upper extremity volumetric measures. Additional factors will be investigated to screen biological plausibilities that would be associated with altered motor control skills in BCRL. This proposal has been

approved by A.T. Still University's Institutional Review Board and recruitment will commence in the fall. Understanding how a chronic edema such as BCRL can affect the neuromusculoskeletal system can extend into future research examining similar edemas in orthopedics and neurology. Assuming the significant finding from this study, my pursuits will lead to further investigations examining lower extremity lymphedema, chronic edema in lower extremities, and then chronic edema in upper extremities. Broad research topics can be explored such as; 1) gait analysis in chronic edema/lymphedema, 2) balance analysis pre-post edema/lymphedema, 3) fear of falling among individuals with lower extremity lymphedema, 4) ice application and edema reduction measured by bioimpedance analysis.

DISSERTATION CONCLUSIONS

The results of the studies provided in this dissertation give evidence to the status of lymphology education and practice in physical therapy.

Consistent content and format (didactic and laboratory hours) is currently lacking with regards to lymphatic system examination skills, and intervention techniques within the professional DPT programs. The variability of hours was significant, with one program's cumulative hourly investment in lymphology content to be two hours, while another school's cumulative hours were forty. The rehabilitation knowledge and skill sets of physical therapists, that are associated with lymphatics, prepares the field of physical therapy to forge new rehabilitation dimensions in lymphology. Therefore, lymphology deserves a more prominent place in professional DPT curriculums, and should be disseminated throughout the various curricula modules. Modifications in physical therapy curriculums occur as the global health care environment changes, knowledge within the profession evolves, and the higher education system advances in purpose, principles, and policies. There is evidence for opportunities in developing optimal and congruous professional entry-level lymphology education in order to provide patient centered evidence-based lymphatic examinations and interventions.

Lymphedema is not the only condition in which knowledgeable physical therapists can apply the skilled aptitudes recommended by CAPTE, and the APTA to address edema, effusion, inflammation, joint swelling, pain, and neural compression. Neurological disorders,¹³ pain,^{14,15} headaches,^{16,17} complex regional pain syndrome,^{18,19} rheumatoid arthritis,²⁰ fibromyalgia,²¹ chronic fatigue syndrome,²² and sports medicine^{11,23} are all trending areas for MLdT interventions. There was moderate support for using MLdT as effective interventions to reduce pain and edema, improve ROM, and promote function and/or QOL. In addition, MLdT are effective treatment methods associated with lower HU. However, use of MLdT should only proceed with clinical expertise and the patient values in perspective. Future research is needed to provide stronger evidence to support the use of MLdT for patients with conditions affecting the musculoskeletal system, and provide evidence as to which auxiliary interventions concurrent with MLdT produce best outcomes.

Quantifiable OMs are an essential component of EBP and are often incorporated in the examination of a disorder and the outcome assessment of interventions for related impairments of body functions and structures, and limitations of activities and participation.^{24,25} The results of these measures provide a foundation for clinical reasoning in the diagnosis, prognosis, and establishment of intervention and/or management of a health condition.²⁶ The number of OMs used most often that assess body functions and structures exceed those OMs for activities and participation. Recommended OMs from the Breast Cancer EDGE Task Force and the Dutch Lymphedema Guideline that assess ICF domains that were identified as used most often in this study include; 1) goniometry PROM and AROM for joint function, 2) stiffness of the glenohumeral joint for flexibility, 3) hand grip dynamometer for strength, 4) circumference for volume, 5) numeric pain scale for pain, 6) pitting edema test for tissue consistency, 7) body weight and BMI for body composition, and 8) *QuickDash* for patient-reported upper quadrant function. Other OMs used most often were 1) MMT for strength, 2) light touch brushing for sensation, 3) tissue texture assessment for tissue consistency, 4) visual analog scale for pain, and 5) LLIS for patient-reported HRQOL. Overall, CLTs largely agree on the benefits of and to the use of OMs. However, they experience barriers to their use related to knowledge and competence of OMs. These barriers foster the need for further guidance in a selective core outcome set and OMs with proper psychometrics for BCS with BCRL. Lymphology education related to examination and evaluations for clinical reasoning, diagnosis, and assessment of interventions may be lacking in the field of physical therapy both pre and post-professionally, which leads to the need for further studies to curtail the gap in lymphology education and practice.

REFERENCES

1. Manfreda KL, Bosnjak M, Berzelak J, Haas I, Vehovar V. Web Surveys versus other Survey Modes: A Meta-Analysis Comparing Response Rates. *Int J Mark Res*. 2008;50(1):79-104. doi:10.1177/147078530805000107
2. Shih T-H, Xitao Fan. Comparing response rates from web and mail surveys: A meta-analysis. *Field methods*. 2008;20(3):249-271. doi:10.1177/1525822X08317085
3. Cook C, Heath F, Thompson RL. A meta-analysis of response rates in web- or internet-based surveys. *Educ Psychol Meas*. 2000;60(6):821-836. doi:10.1177/00131640021970934
4. Augustine E, Corn M, Danoff J. Lymphedema management training for physical therapy students in the United States. *Cancer*. 1998;83(12):2869-2873.
5. *Minimum Required Skills of Physical Therapist Graduates at Entry-Level; BOD G11-05-10-49*. Alexandria, VA: American Physical Therapy Association; Board of Directors; 2005:18.
6. *Commission on Accreditation in Physical Therapy Education. Accreditation Handbook. Evaluative Criteria PT Programs (Adopted October 26, 2004; Effective January 1, 2006; Revised December 7, 2017)*. Alexandria: American Physical Therapy Association; 2015. www.captionline.org.
7. Pichonnaz C, Bassin J-P, Lécureux E, et al. Effect of manual lymphatic drainage after total knee arthroplasty: A randomized controlled trial. *Arch Phys Med Rehabil*. 2016;97(5):674-682. doi:10.1016/j.apmr.2016.01.006
8. Topuz S, Ülger Ö, Bakar Y, Şener G. Comparison of the effects of complex decongestive physiotherapy and conventional bandaging on edema of geriatric amputees: a pilot study. *Top Geriatr Rehabil*. 2012;28(4):275-280.
9. Knygsand-Roehoej K, Maribo T. A randomized clinical controlled study comparing the effect of modified manual edema mobilization treatment with traditional edema technique in patients with a fracture of the distal radius. *J Hand Ther*. 2011;24(3):184-194. doi:10.1016/j.jht.2010.10.009
10. Klein I, Tidhar D, Kalichman L. Lymphatic treatments after orthopedic surgery or injury: A systematic review. *J Bodyw Mov Ther*. 2020;24(4):109-117. doi:10.1016/J.JBMT.2020.06.034
11. Vairo GL, Miller SJ, McBrier NM, Buckley WE. Systematic review of efficacy for manual lymphatic drainage techniques in sports medicine and rehabilitation: An evidence-based practice approach. *J Man Manip Ther*. 2009;17(3):80E-90E.
12. Rockson SG, Granger DN, Skeff KM, Chaite W. Lymphatic biology and disease: Is it being taught? Who is listening? *Lymphat Res Biol*. 2004;2(2):86-95. doi:10.1089/lrb.2004.2.86
13. Trettin H. Neurologic principles of edema in inactivity. *J Lymphology*. 1992;16(1):14-16.
14. Hutzschenreuter P, Ehlers R. Effect of manual lymph drainage on the autonomic nervous system. *Z Lymphol*. 1986;10(2):58-60.
15. Kim SS-J, Kwon OO-Y, Yi C-H. Effects of manual lymph drainage on cardiac autonomic tone in healthy subjects. *Int J Neurosci*. 2009;119(8):1105-1117. <https://www.tandfonline.com/doi/abs/10.1080/00207450902834884>. Accessed September 27, 2018.

16. Happe S, Peikert A, Siegert R, Evers S. The efficacy of lymphatic drainage and traditional massage in the prophylaxis of migraine: a randomized, controlled parallel group study. *Neurol Sci.* 2016;37(10):1627-1632. doi:10.1007/s10072-016-2645-3
17. Longo C, Rizzo R, Inzitari MT, Scumaci G, Caroleo S, Iocco M. [Chronic Tension-Type Headache Non Conventional Therapy with Manual Lymphatic Drainage]. *Recenti Prog Med.* 2006;97(9):462-465.
18. Uher EM, Vacariu G, Schneider B, Fialka V. Comparison of manual lymph drainage with physical therapy in complex regional pain syndrome, Type I. A comparative randomized controlled therapy study. *Wien Klin Wochenschr.* 2000;112(3):133-137.
19. Dunman I, Dincer K, Ozdemir A, Tan AK. The efficacy of manual lymphatic drainage therapy in the mangement of limb edema secondary to reflex sympathetic dystrophy. *Rheumatol Int.* 2009;29(7):759-763.
20. Joos E, Bourgeois P, Famaey JP. Lymphatic disorders in rheumatoid arthritis. *Semin Arthritis Rheum.* 1993;22(6):392-398.
21. Ekici G, Bakar Y, Akbayrak T, Yuksel I. Comparison of manual lymph drainage therapy and connective tissue massage in women with fibromyalgia: A randomized controlled trial. *J Manipulative Physiol Ther.* 2009;32(2):127-133.
22. Perrin RN. Lymphatic drainage of the neuraxis in chronic fatigue syndrome: A hypothetical model for the cranial rhythmic impulse. *JAOA J Am Osteopath Assoc.* 2007;107(6):218-224.
23. Majewski-Schrage T, Snyder K. The effectiveness of manual lymphatic drainage in patients with orthopedic injuries. *J Sport Rehabil.* 2016;25(1):91-97. doi:10.1123/jsr.2014-0222
24. Duncan PW, Jorgensen HS, Wade DT. Outcome measures in acute stroke trials: A systematic review and some recommendations to improve practice. *Stroke.* 2000;31(6):1429-1438. doi:10.1161/01.STR.31.6.1429
25. Jette DU, Bacon K, Batty C, et al. Evidence-based practice: Beliefs, attitudes, knowledge, and behaviors of physical therapists. *Phys Ther.* 2003;83(9):786-805. doi:10.1093/ptj/83.9.786
26. Fulk G, Field-Fote EC. Measures of evidence in evidence-based practice. *J Neurol Phys Ther.* 2011;35(2):55-56. doi:10.1097/NPT.0b013e31821ba134

APPENDICES

Appendix V.A. Institutional Review Board Letters of Determination



Flint Institutional Review Board • 530 French Hall, 303 E. Kearsley St, Flint, MI 48502 • phone (810) 762-3383 • fax (313) 593-0526 • research@umflint.edu

To: David Doublestein

From:

Kazuko Hiramatsu

Cc:

Amy Yorke
Cathy Larson
David Doublestein

Subject: Notice of Exemption for [HUM00132411]

SUBMISSION INFORMATION:

Title: A Faculty Survey on the Status of Lymphology Education

Full Study Title (if applicable): A Faculty Survey on the Status of Lymphology Education in Entry-Level Doctorate Physical Therapy Programs in the United States

Study eResearch ID: [HUM00132411](#)

Date of this Notification from IRB: 8/23/2017

Date of IRB Exempt Determination: 8/23/2017

UM Federalwide Assurance: FWA00004969 (For the current FWA expiration date, please visit the [UM HRPP Webpage](#))

OHRP IRB Registration Number(s): IRB00000248

IRB EXEMPTION STATUS:

The IRB Flint has reviewed the study referenced above and determined that, as currently described, it is exempt from ongoing IRB review, per the following federal exemption category:

EXEMPTION #2 of the 45 CFR 46.101.(b):

Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Note that the study is considered exempt as long as any changes to the use of human subjects (including their data)

To: David Doublestein

From:

Thad

Polk

Cc:

Amy Yorke
Cathy Larson
David Doublestein
Allon Goldberg

Subject: Notice of Exemption for [HUM00188013]

SUBMISSION INFORMATION:

Title: Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer Survivors with Breast Cancer Related Lymphedema
Full Study Title (if applicable): Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer Survivors with Breast Cancer Related Lymphedema
Study eResearch ID: [HUM00188013](#)
Date of this Notification from IRB: 2/19/2021
Date of IRB Exempt Determination: 2/19/2021
UM Federalwide Assurance: FWA00004969 (For the current FWA expiration date, please visit the [UM HRPP Webpage](#))
OHRP IRB Registration Number(s): IRB00000246

IRB EXEMPTION STATUS:

The IRB HSBS has reviewed the study referenced above and determined that, as currently described, it is exempt from ongoing IRB review, per the following federal exemption category:

EXEMPTION 2(i) and/or 2(ii) at 45 CFR 46.104(d):

Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) **if at least one of the following criteria is met:**

(i) The information obtained is recorded by the investigator in such a manner that **the identity of the human subjects cannot readily be ascertained**, directly or through identifiers linked to the subjects;

(ii) Any disclosure of the **human subjects' responses** outside the research **would not reasonably place the subjects at risk** of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation

Note that the study is considered exempt as long as any changes to the use of human subjects (including their data) remain within the scope of the exemption category above. Any proposed changes that may exceed the scope of this category, or the approval conditions of any other non-IRB reviewing committees, must be submitted as an amendment through eResearch.

Although an exemption determination eliminates the need for ongoing IRB review and approval, you still have an obligation to understand and abide by generally accepted principles of responsible and ethical conduct of research. Examples of these principles can be found in the Belmont Report as well as in guidance from professional societies and scientific organizations.

SUBMITTING AMENDMENTS VIA eRESEARCH:

You can access the online forms for amendments in the eResearch workspace for this exempt study, referenced above.

ACCESSING EXEMPT STUDIES IN eRESEARCH:

Click the "Exempt and Not Regulated" tab in your eResearch home workspace to access this exempt study.



Thad Polk
Chair, IRB HSBS

INSTITUTIONAL REVIEW BOARD
MESA, ARIZONA CAMPUS

NOTICE OF APPROVAL – EXEMPT HUMAN RESEARCH PROTOCOL

25 February 2021

DETERMINATION: Exempt Protocol #2021-071 (no greater than minimal risk)
PRINCIPAL INVESTIGATOR: David Doublestein PhD (c)
PROTOCOL TITLE: “Use of Outcome Measures by Certified Lymphedema Therapists on Breast Cancer Survivors with Breast Cancer Related Lymphedema”

Dear ATSU Investigator:

The ATSU-AZ IRB has reviewed your application cited above. The purpose of this study is to examine 1) the use of outcome measures used by CLT on BCS with BCRL and their associated factors; and 2) facilitators and barriers with influence CLT use of outcome measures and their associated factors.

Therefore, per Code of Federal Regulations, 45 CFR §46.104(d)(2i), this project is approved as an Exempt human research study, which precludes the federal mandate for IRB continued oversight beyond this determination.

45 CFR §46.104(d)(2)

(2) Surveys, Interviews, Observation: Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:

(i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;

You may now proceed with your research. If your project deviates from materials submitted to the ATSU-AZ IRB, you must seek amendment approval from the ATSU-AZ IRB prior to any work involving human subjects. Otherwise, no further reporting to the ATSU-AZ IRB is required. Keep this letter with your study files to verify IRB review.

Sincerely,



Brigit M. Ciccarello, M.A.
IRB Coordinator, Designee of the Chair
ATSU Arizona Institutional Review Board
MesaIRB@atsu.edu

Appendix V.B. PEERS Certifications



PEERRS Certification Record for Doublestein, David (ddouble)

Doublestein, David
Username or Friend Account: ddouble
UMID: 35891391
Date: Sep 01, 2021

The person named above has completed the indicated online courses in the University of Michigan's Program for Education and Evaluation in Responsible Research and Scholarship (PEERRS).

PEERRS is a web-based foundational instruction and certification program for the members of the University of Michigan community engaged in or associated with research. Courses are offered in in Responsible Conduct of Research and Scholarship Training (RCRS); Research Administration; Human Subjects Research Protections; and Export Controls. Each course consists of 30+ pages containing the core material, short case studies with questions, and pop-ups with additional information to provide greater depth and elaboration.

Certifications are obtained by passing a test associated with each course. The certifications are valid for three years from the completion date.

Active Certifications:

| Module | Certified Through |
|------------------------------------|-------------------|
| PEERRS: Human Subjects Protections | 11-23-2022 |
| Research Administration | 11-23-2022 |

Expired Certifications:

| Module | Certified Through |
|------------------------------------|-------------------|
| PEERRS: Human Subjects Protections | 12-23-2019 |

Appendix V.C. Use of Copyrighted Material

Rightslink® by Copyright Clearance Center - Google Chrome
https://s100.copyright.com/AppDispatchServlet#formTop

CCC | RightsLink®

Home Help Live Chat Sign in Create Account

Faculty Survey on the Status of Lymphology Education in Professional Doctor of Physical Therapy Programs

Wolters Kluwer

Author: David A. Doublestein, Amy M. Yorke, and Cathy A. Larson
Publication: Rehabilitation Oncology
Publisher: Wolters Kluwer Health, Inc.
Date: Jul 1, 2021

Copyright © 2021, © 2021 Academy of Oncologic Physical Therapy, APTA.

License Not Required

Wolters Kluwer policy permits only the final peer-reviewed manuscript of the article to be reused in a thesis. You are free to use the final peer-reviewed manuscript in your print thesis at this time, and in your electronic thesis 12 months after the article's publication date. The manuscript may only appear in your electronic thesis if it will be password protected. Please see our Author Guidelines here: https://cdn-tp2.mozu.com/16833-m1/cms/files/Author-Document.pdf?_mzts=636410951730000000.

BACK CLOSE WINDOW

© 2021 Copyright - All Rights Reserved | Copyright Clearance Center, Inc. | Privacy statement | Terms and Conditions
Comments? We would like to hear from you. E-mail us at customer-care@copyright.com

Sharon Klinski
to me ▾

Tue, Sep 7, 8:13 AM (1 day ago) ☆ ↶ ⋮

Hi David,

Thank you for your query; I apologize for my delay in responding. I have been out of the office for the last week.

You have the AOPT permission to reprint your article for your dissertation purposes. Please indicate that the material is reprinted from:

Doublestein D, Sublett S, Huang M. Effects of Manual Lymphatic Drainage Techniques on Conditions Affecting the Musculoskeletal System: A Systematic Review. *Orthop Phys Ther Pract.* 2020;32(2):92-101, with permission from the Academy of Orthopaedic Physical Therapy, Inc.

Make it a great day!

Sharon Klinski
ISC & OPTP Managing Editor
2920 East Ave. South, Suite 200
La Crosse, WI 54601
Ph: 608/351-2790



...

Appendix V.D. Conflict of Interest Declaration

The author declares that there is no conflict of interest.