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Emerging opportunities: Lymphedema management and the potential for surveillance methods in a primary care model

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Emerging opportunities: Lymphedema management and the potential for surveillance methods in a primary care model

May 2018

This evidence project, submitted by

Claire Brummet, Nicole Chang, & Kayleigh Odgear

has been approved and accepted

in partial fulfillment of the requirements for the degree of

Master of Science in Occupational Therapy from the University of Puget Sound.

_____

Project Chairperson: Jennifer Pitonyak, PhD, OTR/L, SCFES

_____

OT635/636 Instructor: George Tomlin, PhD, OTR/L, FAOTA

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Dean of Graduate Studies: Sunil Kukreja, PhD

Key words: Lymphedema, _____, _____

Abstract

Heidi Shaffer, OTR/L, MSM, CLT-LANA at MultiCare-Gig Harbor was interested in how early intervention, namely intervening at Stage 0, related to better outcomes for oncology patients at risk of lymphedema. This question was developed from a desire to follow-up prior student research relating to the usefulness of the LDEX in lymphedema management, however current literature did not indicate the LDEX as an early intervention method. Although the authors did not exclude other types of cancer, the research only reflected breast cancer outcomes. Overall, strong evidence was found that exercise is not contraindicated for clients at risk of breast cancer related lymphedema (BCRL). There was strong evidence endorsing implementation of surveillance models to increase early detection and early intervention of BCRL. There was strong evidence that compression sleeves and decongestive therapy were effective in treating BCRL. There was moderate evidence to suggest that exercise and early intervention helped prevent the progression of BCRL. There was no evidence to the authors' knowledge that surveillance methods were contraindicated for clients at risk of lymphedema. Additionally, there was some evidence that treating lymphedema at a subclinical stage reduces treatment time and inhibits the progression of lymphedema. In conclusion, surveillance methods coupled with early intervention could be recommended by the authors to help prevent the progression of lymphedema. These recommendations, if followed, may lead to reduced overall healthcare costs and maintain a high quality of life for oncology patients.

Knowledge translation was conducted to support the dissemination of our findings. Our knowledge translation included submitting an abstract to the International Lymphoedema Framework Conference in the Netherlands. The authors created and proposed a template to track outcomes of current and upcoming lymphedema clients. A PowerPoint was created and provided

to Shaffer's supervisor, Sherri Olsen OTD, MBA synthesizing our findings. The authors then had an informed conversation with Olsen about their findings and the realistic application and implementation of the findings into practice. The authors' hope was that Olsen would disseminate the information to a wider audience, specifically, providers who are responsible for referring clients at risk of lymphedema to a lymphedema specialist, and other lymphedema specialists who may benefit from this research. Future recommendations include synthesizing outcome data collected by lymphedema specialists at MultiCare and further investigation of the support systems for clients at risk of lymphedema.

Executive Summary

This one-year effort began by collaboratively creating a practice question with Heidi Shaffer, OTR/L, MSM, CLT-LANA of MultiCare in Gig Harbor, Washington. Shaffer was interested in determining the extent to which early intervention impacts outcomes for oncology patients at risk of lymphedema. The question arose from Shaffer's desire to increase her preventive care caseload. After an extensive literature search, the author's conclusions were that compression garments were supported in early intervention to stop the progression of lymphedema. Additionally, neither exercise nor stretching were contraindicated for those with or at risk of lymphedema, and there was strong evidence to support surveillance methods as an approach to preventing the progression of lymphedema. Furthermore, there was some research surrounding the negative impact the fear of developing lymphedema has on a client's quality of life. The implications of our findings varied for consumers, practitioners, and researchers. For consumers, it is important to note that exercise and movement do not increase the risk of lymphedema and know that the fear of developing lymphedema may impact function more than physical limitations as a result of progressing lymphedema. Future research should include quality of life measures for clients with lymphedema as well as retrospective information regarding how the clients felt about their intervention. Further research needs to be done on lymphedema related to other types of cancer and where it impacts the lower extremities. The implications for practitioners include referring clients at risk of lymphedema to a lymphedema specialist for preventive care and knowing that exercise is not contraindicated for those at risk of lymphedema. Additionally, practitioners should consider the emotional and psychological aspects of lymphedema during their interventions, of particular focus to occupational

therapy practitioners, but also applicable to any practitioner interacting with clients at risk of lymphedema. Knowledge translation activities included 1) an abstract submission to the International Lymphedema Framework conference, 2) creating a potential template for tracking client outcomes, and 3) a presentation to Shaffer's supervisor. The main outcome of our knowledge translation activities was a consequence of our meeting with Shaffer's supervisor. This consisted of immediate feedback following our presentation as well as an outcomes survey to be completed at a later time. The feedback from her consisted of her stated plan to speak to an oncologist she knows to refer for prevention care at a higher rate than most, discussion of plans for sharing the PowerPoint, and exploration of novel ideas for the dissemination of information to lymphedema patients within the MultiCare system.

Final CAT Paper, Revised

Focused Question:

To what extent does early intervention relate to better outcomes for oncology patients at risk of lymphedema?

Collaborating Occupational Therapy Practitioner:

Heidi Shaffer, OTR/L, MSM, CLT-LANA

Prepared By:

Claire Brummet, Nicole Chang, and Kayleigh Odgear, OTS

Chair:

Jennifer Pitonyak, PhD, OTR/L, SCFES

Course Mentor:

George Tomlin, PhD, OTR/L, FAOTA

Date Review Completed:

5/05/18

Clinical Scenario:

Heidi was interested in learning more about early intervention of lymphedema and how it impacts a client's prognosis and the progression. Early intervention was defined as having subclinical lymphedema or Stage 1 lymphedema at the start of treatment. Furthermore, she was also interested in increasing her prevention caseload to help reduce patient financial burden and monitor lymphedema progression.

Review Process

Procedures for the selection and appraisal of articles

Inclusion Criteria:

Oncology client or patient, any age, gender, and race, lymphedema measures taken (circumferential, volumetric, perometry, bioimpedance), Articles in English (journal translations allowed), any year of publication

Exclusion Criteria:

Bilateral lymphedema, vascular related lymphedema, treatment started after Stage 3 lymphedema

Search Strategy

Categories	Key Search Terms
Patient/Client Population	*Oncology clients/patients at risk of lymphedema*
Intervention (Assessment)	*Early intervention (patient education and physical modalities) initiated by early detection practices*
Comparison	*Current standards of practice*
Outcomes	*Stage of lymphedema, quality of life (via questionnaire), pain, UE function (ADL performance, A/PROM, strength), risk factors*

Databases and Sites Searched
PubMed, CINAHL, and MEDLINE (EBSCO)

Quality Control/Review Process:

Claire:
Scan abstract for applicability to research question and investigate full article if abstract does not provide enough information to determine applicability to the research question. Created and managed database in Excel for article tracking and citation follow up.

Nicole:
Scan article to verify our inclusion criteria is met and no exclusion criteria present. Find research question in article and read article once to understand it broadly. Read again to pull out main themes.

Observe how themes are changing as time progresses and as articles are found.

Kayleigh:
Input chosen articles into the CAT table as well as organized and formatted the CAT table.

Results of Search

Table 1. Search Strategy of databases.

Search Terms	Date	Database	Initial Hits	Articles Excluded	Total Selected for Review
Lymphedema and early intervention	10/10/17 4:17pm	PubMed	87	65	22
Lymphedema and early intervention	10/22/17 6:25pm	CINAHL	26	22 (2 duplicates)	4
Lymphedema and early intervention	11/03/17 6:57pm	MedLine (EBSCO)	43	41 (16 duplicates)	2
Lymphedema and early intervention	11/14/17 9:28am	Health Source: Nursing/Academic Ed (EBSCO)	6	6 (4 duplicates)	0
Lymphedema and early intervention	11/14/17 9:37am	PEDro	5	5 (4 duplicates)	0
Lymphedema AND intervention AND early AND oncology	11/4/17 9:41am	PubMed	317	315 (12 duplicates)	2
Lymphedema and early intervention	01/19/18 3:15pm	PubMed	90	89 (87 duplicates)	1
Total number of articles used in review from database searches = 31					

Table 2. Articles from citation tracking.

Article	Date	Database	Initial Hits	Articles Excluded	Total Selected for Review
*n/a as of 11/14/17 *In progress*					
Total number of articles used in review from citation tracking = 0					

Table 3. Articles from reference tracking.

Article	Date	Articles Referenced	Articles Excluded	Total Selected for Review
Stout, N. L., Binkley, J. M., Schmitz, K. H., Andrews, K., Hayes, S.C., Campbell, K. L., ...Smith, R. A. (2012). A prospective surveillance model for rehabilitation for women with breast cancer. *Cancer*, 118, 2191-2200. doi:10.1002/cncr.27476	11/04/17	119	117	2
Fu, M. R., Deng, J., & Armer, J. M. (2014). Putting evidence into practice: Cancer-related lymphedema. *Clinical Journal of Oncology Nursing*, 18, 68-79. doi:10.1188/14.cjon.s3.68-79	01/18/19	87	86	1
Total number of articles used in review from reference tracking = 3				

Table 3. Articles from chair recommendations.

Article	Date	Total Selected for Review
Maher, C., & Mendonca, R. J. (2018). Impact of an activity-based program on health, quality of life, and occupational performance of women diagnosed with cancer. *AJOT*, *72*. doi: 10.5014/ajot.2018.023663	3/1/2018	1
Total number of articles used in review from chair recommendations = 1		

Total number of articles used in review from database searches = 31
Total number of articles used in review from citation tracking = 0
Total number of articles used in review from reference tracking = 3
Total number of articles used in review from UPS Master's Thesis = 0
Total number of articles used in review from chair recommendations = 1
Total number of articles used in CAT = 35

Summary of Study Designs of Articles Selected for the CAT Table

Pyramid Side	Study Design/Methodology of Selected Articles	Number of Articles Selected
Experimental	3 Meta-Analyses of Experimental Trials 5 Individual Randomized Controlled Trials 1 Controlled Clinical Trials 0 Single Subject Studies	9
Outcome	0 Meta-Analyses of Related Outcome Studies 0 Individual Quasi-Experimental Studies 3 Case-Control Studies 7 One Group Pre-Post Studies	10

Qualitative	___Meta-Syntheses of Related Qualitative Studies ___Small Group Qualitative Studies ___brief vs prolonged engagement with participants ___triangulation of data (multiple sources) ___interpretation (peer & member-checking) ___a posteriori (exploratory) vs a priori (confirmatory) interpretive scheme ___Qualitative Study on a Single Person	0
Descriptive	1 Systematic Reviews of Related Descriptive Studies 4 Association, Correlational Studies 1 Multiple Case Studies (Series), Normative Studies 0 Individual Case Studies	6
Comments: 10 articles were not classifiable on the pyramid because of the nature of the studies (cost analyses, literature reviews and prospective models). AOTA Levels I- 9 II- 5 III- 7 IV- 4 V- 10		*TOTAL = 25 + 10 = 35*

Table Summarizing *QUANTITATIVE* Articles

Quantitative Articles						
Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Participants**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Outcome: Limb Volume Change						
Torres Lacomba et al., 2010, *BMJ,* Spain	To determine the effectiveness of early physiotherapy in ↓ risk of 2˚ LY post BC surgery	RCT, single blinded Level I E2 Pedro: 8/10	*N*= 116 females TG= 59 CG= 57 **I=** ALND, recruited between May 2005 & June 2007 **E=** w/out ALND, w/bilateral BC, systemic disease, locoregional recurrence or those w/contraindications to physiotherapy	**Tx=** 3 weeks, 3x/week. Tx carried out by one physiotherapist TG : Education, MLD, scar massage, stretching & shoulder exercises CG : Education only **O=** Follow-up measurements @ 4 weeks, 3, 6, & 12 months post surgery Incidence of 2˚ LY (≥ 2cm ↑ in CM) measured by blinded therapist	TG had 4 cases of 2˚ LY CG had 14 cases of 2˚ LY ($p < .05$) @ 12-month follow-up, CG arm volume in affected arm was on average 5.1% > unaffected arm. TG volume of affected arm was only 1.6% > unaffected arm ($p < .05$) 2˚ LY developed 4x faster in CG compared to TG Risk factors between groups were similar, BMI was > in TG	Duration of follow-up is only one year post surgery Recruited patients from only one hospital Chose a specific dx criterion, other criterion methods may have resulted in more/fewer cases of LY No demographic info about patients
Anderson et al., 2012, *Jnl Cancer Surviv,* US	To determine the effect of an exercise program on QOL, physical function & arm volume in non-metastatic BC	RCT, single blind study Level I E2 Pedro: 7/10	*N*= 104 adult females, 32-82 years TG= 52 CG=52 **I=** Dx of stage 1-3 BC w/ALND or SLND, no previous	**Tx=** 4-12 weeks post-surgery TG: RESTORE program w/LY prevention module, delivered by LY specialist (OT or PT). Included instruction &	82 patients completed RESTORE program (TG=43, CG=39) 28% were classified as obese Mean arm volume change @ 18 months was 33.5ml for TG,	Used a combination of tx: strength training, compression, LY prevention exercises Those in TG had > contact w/health care providers

			history of BC, ≥ 18 years of age, living w/in 30 miles of study site, able to participate in moderate exercise program **E=** Homebound, exercise contraindicated, dependent upon walker or wheelchair for mobility, Dx dementia, peripheral artery disease, unstable angina, cardiac disturbances, chronic disease	care for limb, awareness of LY, 1 month follow-up. Given compression garment, 2 exercise sessions per week (5 min warmup, 30 min aerobic, 20 min U&L body, 10 min stretching) for 3 months. Months 4-6 could be home based & 1x/week, months 7-12 no exercise required CG: Given info about LY, prevention exercises, quarterly newsletter about diet & nutrition **O=** Limb volume via VD assessed @ baseline, 3, 6, 9, 12 & 18 months post-surgery. Health related QOL assessed w/Functional Assessment of Cancer Therapy-Breast Cancer at baseline 15 months	& 60.4ml in CG ($p <$ .05) QOL scores were not statistically different between groups ($p >$ .05) Provides evidence for benefit & safety of exercise programs & do not ↑risk of LY	Larger standard error in arm volume measurements, made difference between groups not statistically significant 22 patients dropped out (TG=9, CG=13)
Box et al., 2002, *Breast Cancer Res & Treat,* AUS	To examine the effects of early intervention on progression & severity in patients w/BCRL	RCT Level I E2 Pedro: 6/10	*N*= 65 females Mean age = 56.06 years **I=** ALND or modified radical mastectomy between July 1st 1996 to June 30th 1997	**Tx=** TG: Physiotherapy management care plan CG: Tx condition was not specified **O=** CM & VD. Measures were taken pre-op, 5th day post-op, 1, 3, 6, 12 and 24	TG had an incidence rate of 11% for 2˚ LY, while CG had an incidence rate of 30% Patient arm volume still ↑ despite tx Trend for ↑ risk for LY w/a > BMI	Size of TG & CG were not given Details of the physiotherapy management plan & CG tx were not provided Settings of txs & length of tx were not given

			E= Confused mental state, reconstructive surgery, lived beyond 50km from hospital, refused random allocation, unable to obtain informed consent & pre-data	months post-op by a blinded physiotherapist		
Oliveria et al., 2014, *Physiotherapy Theory & Practice,* Brazil	To compare MLD & active exercise on post-op complications in women w/BC	Non-randomized controlled clinical trial Level II E3 Pedro: 5/10	*N*= 89 females Exercise group= 46 MLD group= 43 **I=** Unilateral BC w/ALND between October 2006 & July 2011 **E=** Immediate breast reconstruction, difference in UE CM > 2cm pre-surgery, motor deficit or infection in UE & pre-op radiotherapy	**Tx=** Exercise group: Given educational strategy & 40-minute group exercise sessions 2x/week for 30 days. 19 exercises were performed under supervision of physical therapist MLD group: Given educational strategy & 40-minute individual MLD 2x/week for 30 days performed by 3 experienced physical therapists **O=** CM (↑ by 2cm or more = LY development), Shoulder ROM measurements taken pre-op & 60 days post-surgery	There was no significant difference between shoulder ROM & CM pre-op & post-op measurements between groups Exercise is not contraindicated in patients at risk for developing LY	No blinding of participants or therapists Type of ROM was not specified
Akita et al., 2017, *Jnl Amer Soc Plastic Surg,*	To investigate early changes in LY using indocyanine green lymphography & propose a new	Prospective cohort study Level III O4 Pedro: 3/6	*N*= 190 females **I=** consecutive 1˚ BC patients who underwent surgery, included SLND or	**Tx=** Injection of indocyanine green subcutaneously into affected UE. One hour post injection, circumferential	35 patients needed compression therapy, 11 of those patients improved while 24 needed persistent compression therapy	Out of 390 patients, only 190 were followed up for a full year Mean follow-up was short (20 months)

Japan	strategy for early Dx & tx of BCRL		ALND from July 2013 to July 2014 **E=** Iodine allergy, pregnancy, recurrence following previous BC, & psychiatric disorders	fluorescent images of lymphatic drainage channels obtained. Images classified into patterns: linear, splash, stardust, diffuse or no flow L-Dex value ↑ of 10% or > is a significant limb volume ↑ Those w/splash pattern followed w/no tx. Stardust, diffuse or no flow received skin care, exercise, elevation and compression sleeve. **O=** Changes in limb volume Measurements taken pre-op & follow-up measurements 1, 3, & every 3 months thereafter until 12 months post-surgery	This method of measurement can be applied to bilateral cases, low cost, less cumbersome Detected lymphatic dysfunction in 21 out of 35 patients before any limb volume change was visible Risk factors found were age, BMI, radiation therapy, ALND & docetaxel	resulting in a net incidence rate that could not be fixed
Jang et al., 2015, *PLOS One*, Korea	To evaluate the effects of arm swelling duration on shoulder pathology in patients w/BCRL	Cross-sectional study Level IV D2 Pedro: 2/3	*N*= 47 women **I=** Unilateral LY, Dx w/BCRL & free of cancer at time of study **E=** Bilateral LY, lymphangitis, skin disease, inflammatory shoulder arthritis, previous shoulder	**Tx=** Patients underwent musculoskeletal examination & ultrasound of shoulder region & shoulder ROM. All were done by a certified Korean physiatrist, then confirmed by a second physiatrist Arm measurements were also taken	41/47 (87.2%) of patients were found to have shoulder abnormalities Those w/ supraspinatus tendon tear were found to have a significantly longer duration of LY ($p < .05$)	Participants were taken from one hospital Degenerative cause of shoulder pathology could have not been related to LY Duration of LY was determined by patient's self-report of symptoms. It is unclear when LY was Dx

			trauma, or previous shoulder surgery	**O=** CM, comparison of duration of LY according to shoulder pathology	The pathology of shoulder pain is related to the duration of LY. Duration of LY influences the pathology, but is not correlated with symptoms	Type of ROM measurements were not provided
Outcome: ROM, Strength & Limb Volume Change						
Kilbreath et al., 2012, *Breast Cancer Res & Treat,* AUS	To determine whether an exercise program reduces upper limb impairments in women treated for early BC	RCT, double blinded Level I E2 Pedro: 9/10	*N*= 160 female participants, 24-82 years TG: ALND= 50 SLND= 31 CG: ALND= 46 SLND= 33 **I=** Undergone surgery for stage 1-3 BC, either SLND or ALND, could communicate in English, attend tx & follow-up visits **E=** History of LY, bilateral BC, metastatic BC, pre-existing arm impairments	**Tx=** 4-6 weeks post-op, for 8 weeks TG : Seen weekly, participated in resistance training, passive stretching & given home program. 3 stretches to perform daily, hold for 5-15 min. Resistance training = 2 sets, 8-15 reps of each exercise (# of exercises not given) CG : No exercises given, education only. Assessed fortnighlty for LY. If LY, tx was compression garment All women received post op care including : literature about prevention, seen by breast nurse or physiotherapist or OT, patients given info about post-op exercises **O=** Pre/post tx & 6 month follow-up	Changes in symptoms from self-report QOL survey were not significant between groups Shoulder ROM in affected arm increased significantly for TG compared to CG immediately post intervention (for abduction & flexion, $p < .05$) Shoulder strength increased significantly in TG compared to CG immediately post intervention (for abductors & flexors, $p < .05$) No significant changes in LY occurred in either group ($p > .05$)	1˚ outcome measure relies on self-report CG likely exposed to exercise recommendations during post-op hospital stay No follow-up before 6 months Participants were younger on average than women Dx w/BC Type of ROM measurements were not specified

				measurements taken by blinded researcher. Self-report QOL survey, shoulder ROM, shoulder muscle strength, CM		
Ammitzboll et al., 2017, *ACTA Oncologica*, Denmark	To determine if progressive strength training is feasible & safe for one year post BC to inform future RCT	Prospective pilot trial Level III O4 Pedro: 3/6	*N*= 8 female BC patients recruited August 2015 **I=** between ages 18-75, ALND for 1˚ unilateral BC, transportation to hospital, & physically/mentally able to participate in exercise **E=** previous ALND (either side), 1˚ breast reconstruction, metastatic disease, & history of LY	**Tx=** Individualized exercise programs based on 7 rep max. Took place in Physiotheraphy Dept @ Herlev hospital & supervised by physiotherapists. Regime had 5 modules, each being 4 weeks in duration. 6 exercises, 3 sets per module. Exercised 2x @ hospital, 1x @ clients choice per wk. After 20 weeks, patient exercised on their own Symptoms recorded weekly. Arm volume @ 12 & 20 weeks. Symptoms lasting 2+ weeks, extra arm measurements taken. BMI @ baseline, dynamic strength @ baseline, 12, 20 & 50 weeks, isometric strength @ baseline, 20 & 50 weeks, hand strength & shoulder PROM @ baseline & 50 weeks, questionnaire @ baseline, 20 & 50 weeks	1 patient had 5% ↑ in interlimb volume difference @ 50 week follow-up. 3 had ↑ interlimb volume difference & symptoms during program, but @ 50 week follow-up, returned to baseline Dynamic/isometric muscle strength: all showed ↑ @ 50 week follow-up Grip strength: ↓ bilaterally @ 50 week follow-up Shoulder PROM: Shoulder abd seemed most restricted post-surgery Exercise program was found to be feasible & had high satisfaction, adherence was moderate. Muscle strength gains were greatest during supervised sessions	Drop-out rate of 25% (*n*=2) Focused only on one component of rehab (strength) Small sample size

				O= feasibility outcomes, VD, BMI, Dynamic muscle strength, isometric muscle strength, hand grip strength & shoulder PROM, questionnaire data		
Springer et al., 2010, *Breast Cancer Res & Treat,* US	To examine the extent & time course of UE impairment & dysfunction in women being treated for BC	Prospective observational study Level III O4 Pedro: 3/6	*N*= 94 participants **I=** Women dx w/unilateral stage 1-3 BC between 2001 and 2006 **E=** Male, < 18 years of age, history of BC, bilateral BC, injury/surgery affected UE	**Tx=** Evaluated by physical therapist at baseline & follow-up appointment Instructed on post-op AROM exercise program & education on LY. If patient Dx w/LY, tx was initiated. No movement restrictions were given **O=** Measurements taken pre-op, 1, 3-6 months post-op & 12 months+ post-op Shoulder AROM (flexion, abduction, internal rotation, external rotation), manual muscle testing, UE volume	Shoulder AROM & strength ↑ after 1 month post-op @ 12 months, 92% reported no or slight limitations performing hard UE functional tasks Limb volume ↑ over course of follow-up, however differences between the affected & unaffected limbs was insignificant, thought to be due to weight gain Significant difference found between those w/subclinical LY & those w/out ($p < .05$)	All subjects from a military background/association Mean age was younger than most studies Many sought out after care closer to home, resulting in less patients @ follow-up & varying tx from other clinics
Stout Gergich et al., 2008, *Cancer,* US	To investigate the efficacy of a surveillance method for early Dx & tx of subclinical LY	Case control, observational study Level II O3 Pedro: 4/6	*N*= 196 patients TG= 43 w/subclinical LY (volume ↑ > 3%), aged 34-82 years CG= 43 w/out LY, aged 33-81 years	**Tx=** Upon Dx of LY, patient given compression garment to wear daily for 4 weeks. No activity limitations were given	Mean ↑ of volume change in TG was 83 mL and 2.7 mL in CG TG had > UE volume than CG @ beginning of intervention	Perometer used to Dx LY may not be financially available Unable to control BC related side effects

			I= Newly Dx w/unilateral early stage BC **E=** History of BC, bilateral BC, prior trauma/surgery on UE	**O=** Bilateral AROM, strength & UE volume were assessed pre-op, 1, 3, 6, 9, 12 & 18 months post-op	Follow-up after intervention, limb volume ↓ was 46 mL w/activity related garment wear, compared to 2.3 mL ↓ in CG	Setting of tx not indicated Tx for CG was not specified
Outcome: QOL						
Thakur et al., 2016, *Indian Jrnl of Physiotherapy & OT,* India	To determine effectiveness of early physiotherapy to reduce risk of developing 2˚ LY	RCT Level I E2 Pedro: 5/10	*N*= 20 females TG= 10 CG= 10 **I=** Above age 18, unilateral BC surgery w/ALND **E=** Recurrence/relapse of BC, bilateral BC, untreated infection, heart disease, renal disease, deep vein thrombosis, & any other physiotherapeutic contraindications	**Tx=** TG: Given educational strategy & early physiotherapy intervention (MLD, UE stretching exercises, active/active assisted shoulder exercises, proprioceptive neuromuscular facilitation exercises) CG: Given only educational strategy Both programs lasted 3 weeks w/3 visits per week **O=** QOL & VD	Mean QOL scores were significantly better for the TG than the CG ($p < .05$) Mean VD measurements were significantly > for CG post-tx ($p < .05$) Intervention w/early physiotherapy & education was significantly more effective @ reducing risk for developing 2˚ LY compared to just education	Small sample size Details regarding educational materials were not provided Information about what QOL survey used was not given Very brief results section, only given tables w/no explanation No blinding of subjects or assessors
Gordon et al., 2005, *Breast Canc Res & Treat,* AUS	To assess changes in health related QOL & upper body disability over time	Longitudinal Quasi-experimental design Level II O3 Pedro: 4/6	*N*= 275 women TG: DAART program = 36 STRETCH program = 31 CG = 208 **I=** 1˚ unilateral BC, spoke English, & were between 25-74	**Tx**= TG: DAART (home-based physiotherapy) or STRETCH (group-based & psychosocial tx) program. The goal of the programs was to ↑ UE strength & provide support	DAART participants showed clinically significant improvements in UE function & health related QOL There was minimal change in QOL & UE	CG was only available for measures taken at 6 & 12 months Selection bias of TG because they were generally healthier than others w/BC, maybe impacting generalizability

			w/no cognitive impairments **E=** Too ill, did not understand English, or previously attended one of the intervention programs Between May 2002 & July 2003	CG: Did not receive support group tx **O=** Health related QOL & UE strength. Measures were taken at pre/post tx, 6 & 12 months from Dx	function in STRETCH group Early intervention may expedite recovery & enhance QOL	Only relevant to those w/unilateral BC Very little information was given about what the TG & CG were given as tx Groups were not similar at baseline
Maher & Mendonca, 2018, *AJOT*, USA	To determine impact of a 1-week activity program on health, QOL & occupational performance in women Dx w/cancer.	One-group Pre-Post test Level III O4 Pedro: 3/6	*N*= 71 females Dx w/cancer **I=** Women w/cancer, aged 21 or older, & clearance from physician **E=** Not specified	**Tx=** 5 day long activity camp from 9 am to 1pm addressing QOL, health, well-being and occupational performance. 4 classes were done each day and included activities such as Tai Chi, dance, poetry, scrapbooking, meditation, yoga, gardening, cooking, and nutrition. Classes were taught by occupational therapists and occupational therapy students **O=** 3 assessments were administered: 36 item Short Form Health Survey, World Health Organization QOL Brief Survey, and the COPM. COPM was administered on day 1, 5 and @ 6 week follow up. QOL and health	A significant difference was found on the QOL Social Relationships subscale ($p = .002$, w/moderate effect size, $d_z = 0.37$). No other subscales had significant differences @ posttest Mental Health subscale on the health survey did have a moderate effect size, but was not significantly different ($d_z = 0.28$) Results of COPM were statistically significant between pre-posttest, pre & follow up, & post to follow up ($p < .05$) implying improved occupational functioning	Women who had completed and were actively completing cancer tx were used in the study. 6 recruits were lost due to medical complications from tx All 3 assessments were time consuming surveys Exclusion criteria were not specified

				survey were administered on day 1 and @ 6 week follow up.		
O'Toole et al., 2015, *Breast Cancer Res & Treat,* US	To assess the association between BCRL & ability to perform ADLs	Prospective surveillance Level IV D2 Pedro: 2/3	*N*= 324 females between 2005 & 2014. Median age@ Dx = 56 years **I=** Unilateral BC **E=** Bilateral breast surgery & metastatic cancer	**Tx=** Pre-op limb volume measurement w/perometry. Perometry measurements post-op, after chemo/radiation, & every 3-7 months @ each visit, questionnaire for QOL **O=** RVC (BCRL defined as RVC↑ ≥ 10%) QOL survey scores	32% had one or more RVC ↑ between 5-10% 8% had RVC ↑ ≥ 10% post-op. No significant association between BCRL & ability to perform ADLs Significant association between physical function, pain & fear w/ability to perform ADLs. ↓ functional scores were associated w/ ↑ fear, > pain, mastectomy & ALND ($p < .05$)	↓ rate of LY in this cohort Their program utilizes early intervention strategies, which can slow LY progression. More severe LY may result in > impact on function
Outcome: Risk Factors & Limb Volume Change						
Kaufman et al., 2017, *Breast Cancer Res & Treat,* US	To assess impact of early intervention using BIS as surveillance tool to detect BCRL	Prospective BCRL surveillance program Level III O4 Pedro: 4/6	*N*= 206 BC patients, mean age of 61. Between August 2010 & December 2016 High risk patients = ALND & regional node irradiation patients **I=** patients w/BC, undergoing BC surgery	**Tx=** pre-op baseline L-Dex measures, post-op measures @ 6 weeks, & 3-6 month intervals. Subclinical BCRL defined as : L-Dex score ↑ > 10 from baseline. If > 10, patient given over the counter compression garment for 4 weeks. Patients underwent repeated L-Dex measures, if no resolution, patients	Overall, 9.8% of patients (*n*=21) were Dx w/subclinical BCRL. 7 of these were ALND patients & 12 were SLND patients Findings supported use of structured surveillance programs to ↓ morbidity of BCRL	Follow-up time was short (25 months), limiting long-term outcomes No control group for comparison if LY would have resolved w/out tx

			E= no implantable devices (pacemakers), pregnancy, renal failure, & heart failure	were defined as chronic BCRL & sent to CDT **O=** L-Dex measurements Client characteristics : BMI, age. Tx characteristics : surgery, axillary management, chemo, radiation, & regional node irradiation	Found ALND & regional node irradiation were risk factors for developing subclinical BCRL w/elevated BMI.	
Jammallo et al., 2013, *Breast Cancer Res Treat,* US	To assess the impact of pre-op BMI & post-op weight change on risk for LY	Pre-Post study Level III O4 Pedro: 3/6	*N*= 787 females Between 2005 & 2011 **I=** Undergoing tx for 1˚ BC at their institution **E=** Bilateral breast surgery & metastatic disease	**Tx=** Pre-op BMI & arm volume w/perometry was taken. LY was defined as RVC ↑ ≥ 10%, occurring > 3 months post-op Post-op BMI & arm volume w/perometry taken **O=** BMI & arm volume, evaluated every 3-8 months post-op (depended on clients next visit)	Participants w/BMI ≥ 30 had 4.5x ↑ risk for developing LY compared to BMI < 25 ($p < .05$) ALND & regional lymph node radiation were found to be risk factors for LY ($p < .05$)	Authors claim LY was measured by perometry, but no data was given to show those measurements, only reported BMI BMI & perometry measurements were not taken during same visit Non-standardized measurement schedule was used (every 3-8 months depending on clients visit)
Soyder et al., 2014, *Jnl Breast Health,* Turkey	To determine post-op LY frequency & identify risk factors	Retrospective study Level IV D2 Pedro: 2/3	*N*= 101 females Dx w/unilateral BC **I=** surgery to breast & axilla between January 2010 - March 2011 **E=** Were not specified	**Tx :** CM 12th months follow-up post surgery. If LY present, patient referred to LY tx center. Patient characteristics were taken **O=** CM Risk factors : Age, BMI, smoking status, arm dominance	LY was found in 7 patients @ 12 months assessment No risk factors were found to be significantly correlated w/LY development ($p > .05$), but 6 cases had a BMI > 25	No pre-op measurements Exclusion criteria were not specified Details of tx were not provided

				Applied tx factors : surgery type, dissected # lymph node, lymph node positivity, post-op seroma & infection, chemo or radiation, grade of tumor, size of tumor	Applied tx factors that were significantly correlated w/LY were: axillary dissection or SLND, lymph node positivity, > 15 lymph node dissections, radiation therapy & tumor size ($p < .05$) Radiation therapy & axillary dissection appear to be major factors that ↑ risk for LY	
Outcome: Prospective Surveillance Model & Cost						
Whitworth & Cooper, 2017, *Breast Jrnl*, US	To evaluate patient outcomes of a large group using prospective surveillance & BIS	Prospective Surveillance Level III Pyramid: O4 Pedro: 3/6	***N*=** 596 women at risk for developing BCRL. **I=** Nashville Breast Center, between April 2010 & November 2016. **E=** were not specified.	**Tx=** Patients followed prospectively using a standard protocol including BCRL education & pre/post BIS measurements. If L-Dex measurements ↑ > 10 points from baseline (subclinical LY), patient given over the counter compression garment for 4 weeks, then L-Dex score was rechecked. Median follow-up time was 17 months, w/an average of 4 visits. Patients were considered high risk if	Overall, 73 patients had abnormal L-Dex levels. 18 of these patients scores did not return to normal and required CDT. Patients undergoing ALND were more likely to develop an abnormal L-Dex score & unresolved BCRL ($p < .05$). This evidence supports the use of prospective surveillance for at risk patients using BIS to detect subclinical LY.	No exclusion criteria were provided. Did not provide information on when follow-up visits occurred after surgery. Little information was given about the standard protocol used, education provided & how/where measurements were taken.

				BMI > 25 (n= 379), ALND (n= 93), regional nodal irradiation (n= 17) or taxane chemotherapy (n= 163).		
Shih et al., 2009, *Jrnl of Clinical Oncol,* US	To examine the economic burden, incidence & risk factors of BCRL	Regression Analysis Level II Pyramid: D2 Pedro: 2/3	***N*=** 1,877 women W/BCRL: n= 180 W/out BCRL: n= 1,697. **I=** Women, been observed by physician for 2 years, & ICD-9 codes 457.0 & 457.1 between 1997 & 2003. **E=** Men, enrollees w/missing identifiers, & <27 months of continuous care.	**Tx=** Matched CG was created to compare costs & complications of BCRL. Multivariate logistic regression was performed to ascertain factors associated w/BCRL & to compare the rates of complications between groups.	10% (n= 180) women had Dx of LY w/in 2 years of BC tx. Significantly higher proportion of women w/BCRL underwent mastectomy, ALND, chemotherapy or lived in the West ($p <$ .05). Incidence of BCRL ↑ from 9.6% in 2 year follow up to 12% in 4 year follow up. 15.9% of women w/BCRL developed lymphangitis & 14.1% developed cellulitis, compared to 8.4% & 7.8% in CG. Total cost for tx in BCRL group was $86,707 & &64,554 for the CG.	Cost of BCRL was likely underestimated because costs were estimated at first 2 years of BC tx, not 2 years after LY Dx. ICD-9 codes in claims data were used to identify women. Some women in CG may of had LY, but Dx was not added to insurance claims. Participants were working-age women w/BCRL and therefor may not be generalizable to elderly women w/BCRL.
Stout et al., 2012,	To compare a prospective model w/a traditional	Perspective article on cost analysis	**I=** were not specified	**Tx=** Prospective model or traditional model	The cost of treating & managing BCRL in one patient	Does not consider indirect costs

Physical Therapy, US	model & examine direct tx costs for each program	Level V Pyramid N/A Pedro: N/A	**E=** were not specified	**Methods for determining costs:** Average retail costs considered for durable medical equipment, incidence data used to approximately newly Dx cases, only direct tx costs associated w/intervention were included. Defined direct tx costs, early-stage LY, & advanced-stage LY **O=** costs of prospective model & costs of traditional model	w/prospective model per year for early-stage LY is $636.19 Cost of treating & managing advanced-stage LY w/traditional model would be $3,124.92 For 100 patients, prospective model costs range from $29,315.50 to $43,799.20 per year. Traditional model costs range from $32,811.66 to $149,996.16 per year per 100 patients Prospective surveillance is effective for early detection & tx. May ↓ overall health care costs compared to traditional model Upfront cost for prospective model may be a barrier to implementation	Need to consider additional cost sensitive variables like time lost from work, ADLs, QOL & disability Estimated costs based on estimated incidence rates Assumed LY in patients in prospective model did not progress Only considered costs of tx for single BC related impairments, not bilateral
Carlson, R., 2012, *Oncol Times*, US	To examine the evidence for implementing the prospective surveillance model into standard care	Opinion Level V Pyramid N/A Pedro: N/A	N/A	**Tx=** Stout et al. (2012, next table entry) prospective surveillance model **O=** Should prospective surveillance model be implemented	No consensus has been reached. The prospective model has positives & negatives to it, however there does need to be a more standardized form of	No resources or references cited to back up authors opinions

					care for patients w/BCRL	
Stout et al., 2012, *Cancer*, US	To introduce a prospective surveillance model of care for BC physical rehabilitation	Prospective surveillance model Level V Pyramid N/A Pedro: N/A	**I & E=** Would be based on a risk & impairment screening to determine if eligible for tx	**Tx=** Pre-op eval & education Early post-op rehab: re-eval & exercise program Ongoing surveillance **O=** feasibility of such a program	There is a need for ongoing surveillance for those @ risk for LY Prospective surveillance model provides framework for values survivors indicate as important	Little info provided on cost of prospective surveillance model No inclusion & exclusion criteria for prospective patients
Outcome: UE Function						
Singh et al., 2013, *Physiotherapy*, Canada	To compare the effects of arm morbidity w/early physiotherapy intervention to an intervention w/pre-op education only	Prospective quasi-experimental prettest-posttest Level II O3 Pedro: 4/6	*N*= 72 females TG= 41 CG= 31 **I=** Women receiving surgery for BC including modified radical mastectomy, simple mastectomy or breast conserving surgery. All stages of cancer were included **E=** Transverse rectus abdominis myocutaneous flap surgery at time of breast surgery, could not provide informed consent in English, or unable to physically engage in physiotherapy	**Tx=** TG: Received standardized pre-op education & seen twice post-op (1 & 6 months). Further tx were provided if needed (↓ AROM, ↓ in strength, ↑ in limb girth, or poor posture). Focus was on self-management techniques (compression), scar tissue massage, & progressive shoulder exercises CG: Received standardized pre-op education only All education & follow-up visits were done by one of two trained physiotherapists	For the TG, shoulder AROM had returned close to baseline, while the CG post-op measurements were lower than their baseline At post-op, differences in QOL were not statistically significant in TG vs CG ($p > .05$) There was a lower incidence of LY in TG than CG, but it was not statistically significant ($p = 0.19$) Arm morbidity was lower in the TG than the CG but was also not statistically significant	Duration of tx sessions were not given Longer follow-up may be needed to identify the true incidence of arm morbidity Physiotherapists performing follow-up measures were not blinded

				O= Composite measure of arm morbidity (↓ in shoulder AROM ≥ 10˚) Presence of LY (2cm ↑ in UE circumference compared to pre-op). self-report questionnaires (UE function & QOL) Measurements collected pre-op (baseline) & 7 months post-op for all participants. TG was assessed at 1 & 6 months post-op (additional sessions were recorded)	There needs to be more effective management to treat & identify UE impairments in those w/BC	
Schmitz et al., 2012, *Cancer*, AUS	To provide data for the prevalence of adverse effects in BC survivors in a 6-year follow-up	Longitudinal observational cohort study Level IV D3 Pedro: 1/3	*N*= 287 women **I=** Unilateral BC, 75 or younger, 100km radius of Brisbane, between January & December 2002 **E=** Were not specified	**Tx=** Personal, tumor & treatment characteristics were collected by questionnaires. Functional Assessment of Cancer Therapy Breast +4 & the Disability of the Arm, Shoulder & Hand were given to the clients **O=** UE function & symptoms. Surveys & characteristics were measured at baseline, 6, 12, 18 months & 6 years follow-up.	At 6-year follow-up, 60% of women were experiencing more than 1 adverse tx effect Prevalence of most physical impairments decreased throughout the 6 years follow-up, except for LY & weight gain These findings lend merit to the proposal of a prospective surveillance for adverse tx effects	Did not specify exclusion criteria Relied on patient recall & report of physical limitations It is hard to determine if some of the adverse effects were caused by BC tx Comorbid conditions & natural aging process need to be considered Adverse effects were limited to those that were established & clinically defined

						High attrition, only 80 patients completed all measures at all time points

Abbreviation Key for Quantitative Table

ALND = axillary lymph node biopsy, A/PROM = active/passive range of motion, BC = breast cancer, BCRL = breast cancer related lymphedema, BIS = bioimpedance spectroscopy, BMI = body mass index, CDT = complete decongestive therapy, CG = control group, CM = circumferential measure, Dx = diagnosis/diagnostic, E = exclusion, I = inclusion, L-Dex = lymphedema index, LY = lymphedema, O = outcomes, QOL = quality of life, RVC = relative volume change, SLND = sentinel lymph node biopsy, TG = treatment group, Tx = treatment, UE = upper extremity, VD = volume displacement

Table Summarizing *Meta-Analyses/Meta-Syntheses/Systematic Review* Articles

Systematic Reviews/Meta-Analyses/Meta-Syntheses						
Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Number of Papers Included, Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Non-Systematic Reviews						
Outcome : QOL, Dx & Tx Trends						
Sayegh et al., 2017, *Curr Breast Cancer Rep*, US	To discuss recent studies regarding risk factors, Dx, prevention through early screening & intervention of BCRL to improve QOL for survivors	Non-systematic Review Level V N/A	N/A	**O=** Ways to improve QOL for BCRL patient Recent information regarding Dx, tx, risk factors	Dx measures: VD, CM, perometry & BIS Risk factors: regional lymph node radiation, method of surgery, high BMI, weight fluctuations, subclinical edema & cellulitis Txs: regular screening using various methods (VD, CM, perometry, BIS),	Suggested the need to improve QOL for survivors, however did not recommend any ways to do that Out of 94 references, only provided basic background information on 7 of them

					CDT, MLD, intermittent pneumatic compression, compression garments, exercise, skincare, education & self-management Screening may have financial benefits, cost per year to tx early stage BCRL = $636.19, late stage BCRL = $3124.92	
Passik & McDonald, 1998, *Cancer*, US	To identify & discuss the psychosocial impacts of LY	Non-systematic Review Level V N/A	N/A	**O=** Psychological & functional morbidity, predictors of psychological & functional morbidity, as well as intervention & prevention of LY	Women w/LY tend to have higher levels of psychological, functional, sexual & social morbidity Greater disability is reported in women who have > pain, passive/avoidant coping styles, poor support systems, & LY in dominant hand Tx of LY should consider psychological well-being (counseling, support groups, role playing, behavioral	Limited number of references Minimal intext citations, majority of them are the authors own previous article

					techniques & pharmacology)	
Shah et al., 2012, *Breast Jnl,* US	To summarize recent data on BCRL to provide recommendations to patients & health care providers	Non-systematic Review Level V N/A	N/A	**Current trends:** Dx: CM, VD, self-assessment, BIS perometry Tx: compression, pharmacology, CDT, multi-modality Risk factors: ALND, chemotherapy, regional node irradiation, radiation therapy **O=** Rates of BCRL, Dx of LY, tx of LY, risk reduction	BCRL is more prevalent than generally thought, even after less morbid axillary surgery is performed BCRL can be identified earlier w/newer dx tools, may be used to prevent chronic LY Assessment aids should be used before & after therapy for all @ risk patients Data for optimal tx strategies are limited, but CDT had significant support	Brief analyses of the literature Very little mention of exercise interventions for LY, which there were some studies looking at it during this time
Outcome : Risk Factors and Models of Care						
O'Toole et al., 2013, *Crit Rev Oncol Hematol,* US	To emphasize the need for more Level I evidence & suggest a surveillance program	Non-systematic Review Level V N/A	Extensive searching of websites & brochures was mentioned	**Tx=** Prospective surveillance approach for early detection & intervention of LY **O=** Risk factors: ALND, radiation, chemotherapy, high BMI QOL: fear & body image	LY is a major concern for BC patients, they fear its development Inconsistencies regarding appropriate timing & intervention for LY, no standard approach to measurement	The accuracy of websites & brochures may impact the reliability & validity of their analysis Mentioned an extensive literature search but gave no specifics about it

				Controversies: definition of LY, measurement methods, timing, management of LY	Want to implement a prospective surveillance approach w/ a randomized phase III trial to provide level I evidence for early intervention of LY	
Keeley, V., 2017, *Curr Opinon,* UK	To focus on current & new developments that are relevant to clinical practice	Non-systematic Review Level V N/A	N/A	**O=** Risk factors Early detection & intervention techniques Causes of severe LY	Common risk factors associated w/LY were: BMI, ALND, > lymph node dissection, sedentary life styles & history of other cancers New possible tx for LY include: docetaxel, lymphaticovenular anastomosis, liposuction, & subcutaneous needle drainage Germ line & somatic mutations have become proposed causes for severe LY There needs to be more research on new & emerging detection & tx of LY	Mainly focused on new treatments & causes of LY, very little discussion on trends on detection or risk factors

Ostby et al., 2014, *Jrnl Personalized Med*, USA	To review the current research & to support the need for a BCRL surveillance program	Non-systematic Review Level V Pyramid N/A	N/A	**O=** Risk factors Forms of tx for LY Preventative interventions Cost of traditional & prospective models	Common risk factors seen in the literature are BMI, radiation therapy, sedentary lifestyle, ALND, BC surgery & comorbidities Txs included compression bandaging, surgery, exercise, as well as adjuct therapies (CDT, low-level laser therapy, alternative medicine) A multidisciplinary surveillance approach should be implemented for the tx of BCRL A prospective surveillance model may cost more initially; however, it can save money in the future & could improve patient QOL	Some of the references were 16 + years old. May need to redefine current w/ research
Gerber et al., 2012, *Cancer*, US	To review healthcare models for cancer, provide an overview of current care plans, & how to incorporate a	Non-systematic Review Level V Pyramid N/A	N/a	**O=** Models for chronic issues: Chronic care model & Shared care model Models for BC: Survivorship care plans	Prospective surveillance model provides many elements that are mentioned in the Institute of Medicine's goals	Very little recommendations on how to implement the prospective surveillance model Integration of the prospective

	prospective surveillance program into cancer tx models				The health models are missing elements that the prospective surveillance model can provide This model needs to be integrated into current models to identify impairments sooner	surveillance model was proposed for only one type of model of care (survivorship care) Very strong survivor language, which may appear as bias towards the survivorship model
Systematic Reviews						
Outcome : Treatments for LY						
Shah et al., 2016, *Cancer Med*, US	To perform a literature review regarding early detection & intervention of BCRL	Literature Review Level I E1/D1/O1	N = 13 studies. 3 RCTs, 4 prospective studies & 6 retrospective studies **I=** Studies in English evaluating patients treated for breast cancer w/some form of early LY intervention &/or diagnostic assessment between 1990 & 2015 **E=** Were not specified	Searched Medline & Pubmed for articles. Search terms & how articles were evaluated was provided **O=** Tx: MLD, exercise, education, physiotherapy, surveillance, compression sleeves Volume changes in UE Dx: Optoelectronic perometry, Dual energy x-ray absorptiometry, BIS, CM were used in the various studies	Some support for early LY tx (two RCTS) There is a need to form a surveillance program for LY management New diagnostic techniques have made early intervention for LY possible	The RCTs had a small sample size Sensitivity of diagnostic tests varied No comparison between the models (surveillance & intervention) Exclusion criteria were not specified
Stuiver et al., 2015,	To assess the effectiveness of conservative interventions for preventing LY	Systematic Review Level I E1	*N*= 10 RCTs **I=** RCTs that reported 2˚ LY as outcome, compared usual tx/placebo to conservative tx.	**Tx=** Gave data bases used for searches, Psychinfo, PEDro, CENTRAL, CINAHL, WHO, MEDLINE,	Conflicting results for MLD, no conclusions can be drawn for its effectiveness	# of studies reviewed was small None looked @ effectiveness of

Cochrane Database Sys Rev, Netherlands			Studies w/both sexes & all ages, non-pharmacological/surgical tx (exercise, patient education, MLD, compression), looked @ LY occurrence, QOL, pain, function **E=** Trials w/patients w/recurrence, surgical/pharmacological interventions, lower extremity LY	EMBASE, CBCG. The process for selecting and reviewing articles was described **O=** Effectiveness of conventional tx, occurrence of LY in UE	Resistance training does not ↑ risk of LY Immediate post-op start of shoulder exercises leads to better function in the short term (6 months)	compression therapy or education None of the studies included psychosocial morbidity (depression/anxiety) Overall quality of evidence was low, due to lack of blinding in studies Definition of LY differed amongst the studies
McNeely et al., 2010, *Cochrane Database of Sys Rev*, Canada	To review RCTs that examined the effectiveness of exercise on improving, preventing & minimizing UE dysfunction from BC	Systematic Review Level I E1	*N*= 24 RCTs **I=** RCTs that examine the effectiveness & safety of exercise for UE dysfunction **E=** Exercise studies that included cancers other than BC, non RCTs	**Tx=** Gave key terms used in search. Searched PubMed, PEDro, Medline, Embase, LILACS, grey literature, SIGLE, reference lists of articles chosen & Cochrane BC group specialized register 2 authors screened the articles to determine if they were retained. 3 authors rated quality of studies on a 6-point scale. Performed meta-analyses when possible	Early exercise programs in the early weeks post-op were effective @ improving shoulder flex & abd More structured post-op exercise programs were more beneficial than usual care No evidence for ↑ risk from exercise program w/adjuvant tx 3 studies supported the use of exercise programs post cancer tx for QOL	Authors were not able to perform meta-analyses on every study Data pooling because of outcome measures, measurement methods, & timing of measurements in chosen articles Performed meta-analyses despite inter-study heterogeneity

				O= Early vs delayed exercise, exercise vs comparison, exercise vs comparison during adjuvant cancer tx, exercise vs comparison post-tx		
Fu et al., 2014, *Oncol Nursing Soc*, US	To provide healthcare providers w/evidence based-clinical guidelines for current tx of LY	Systematic Review Level I D1	*N*= 75 articles, between Jan 2009 & Feb 2014 **I=** Full research report, systematic review, guideline or meta-analysis, must report results of LY measurement, must look at an intervention (risk reduction/prevention/management), study sample must include patient's w/cancer **E=** Duplicates, studies that don't meet inclusion criteria, qualitative studies, case reports, studies on vascular changes, no grey literature, non-systematic reviews, nonreferenced articles, abstracts, review guidelines, dissertations & secondary data analysis	**Tx=** Gave table of key search terms used. Searched PubMed, CINAHL, Medline, Cochrane Database, CancerLit & National Library of Medicines Each article was assessed independently by 2 researchers. Articles were categorized using ONS PEP level of evidence **O=** Evidence for CDT, compression garments/bandages, full-body exercise	The use of complete decongestive therapy & compression garments had support from the highest levels of evidence Exercise, early intervention & tx are likely to be effective	Found limited articles in other areas besides complete decongestive therapy & full body exercise (possible selection bias) Little explanation for conclusions on MLD, pneumatic compression, & low-level laser therapy

Abbreviation Key for Systematic Review Table

ALND = axillary lymph node biopsy, BC = breast cancer, BCRL= breast cancer related lymphedema, BIS = bioimpedance spectroscopy, BMI = body mass index, CDT = complete decongestive therapy, CM = circumferential measures, Dx = diagnosis/diagnostic, E = exclusion, I = inclusion, LY = lymphedema, MLD = manual lymph drainage, O = outcomes, QOL = quality of life, Tx = treatment, UE = upper extremity, VD = volume displacement

Summary of Key Findings:

Summary of Experimental Studies

There is strong evidence that exercise is not contraindicated for clients at risk of lymphedema (Anderson et al., 2012; Box et al., 2002; Kilbreath et al., 2012; McNeely et al., 2010; Olivera et al., 2014; Stuiver et al., 2015, Thakur et al., 2016; Torres Lacomba et al., 2010). Physiotherapy included physical modalities such as massage, stretching, and compression sleeves. Exercise included various strength training protocols. There is strong evidence that exercise directly following post-op is correlated with increased function of the upper extremity for clients at risk of lymphedema (Kilbreath et al., 2012; McNeely et al., 2010; Stuiver et al., 2015). There is limited evidence that control groups without exercise interventions and treatment groups with exercise interventions had similar quality of life outcomes on a short-term basis (Anderson et al., 2012, Thakur et al., 2016).

Summary of Outcome Studies

There is strong evidence that compression sleeves are a safe early intervention for treating lymphedema in Stage 0 and Stage 1 (Akita et al., 2017; Kaufman, 2017; Sing et al., 2013, Stout et al., 2008). There is some evidence that risk factors for lymphedema development/progression included axillary lymph node removal, regional nodal irradiation, and increased BMI. There is limited evidence to suggest that when clients with lymphedema perform occupation based activities, their social relationships, mental health, performance and satisfaction with occupational performance improves (Maher & Mendonca, 2017).

Summary of Non-Classifiable Studies

There is strong evidence to implement a surveillance model to increase early detection and early intervention of lymphedema. Three articles do conclude that a prospective surveillance model may be more expensive initially, however the long-term health care costs would be less than current traditional models (Otsby et al., 2014; Sayegh et al., 2017, Stout et al., 2012). One article suggests that the surveillance method can be integrated into the current models of practice (Gerber et al., 2012). There is moderate evidence to conclude that BMI, radiation therapy and method of surgery were risk factors for developing lymphedema (Keeley et al., 2017, Otsby et al., 2014). There is limited evidence to suggest that the psychological and psychosocial aspects of lymphedema need to be considered during treatment (Passik & McDonald, 1998) as well as that the incidence of lymphedema is much greater than previously thought (Shah et al., 2012).

Summary of Descriptive Studies

There is strong evidence that compression sleeves and decongestive therapy will be effective in treating lymphedema (Fu et al., 2014). There is moderate evidence that exercise and early intervention help prevent the progression of lymphedema (Fu et al., 2014). Limited evidence exists that BMI, radiation, and axillary lymph node dissection were risk factors for developing lymphedema (Schmitz et al., 2012, Soyder et al., 2014).

Implications for Consumers:

There is strong evidence that exercise does not increase risk of lymphedema post-op. Also, surveillance methods to detect lymphedema at a subclinical stage are supported and should be discussed with your oncology provider. It is also important to note that fear of developing lymphedema may impact function more than physical limitations caused by the lymphedema.

Implications for Practitioners:

Pre-operative measurements and surveillance methods are strongly supported in order to implement early intervention practices. There should be awareness around potential risk factors and education about signs/symptoms of subclinical lymphedema. Exercise may be prescribed with a surveillance approach to verify lymphedema is not developing or progressing. This is important because in most cases education alone was not sufficient in preventing lymphedema, when compared to treatment groups that received a physical modality intervention. Additionally, there is strong evidence that compression garments may prevent lymphedema from progressing to an irreversible stage. Furthermore, practitioners should consider interventions that may impact psychosocial aspects during lymphedema treatment.

Implications for Researchers:

Quality of life measures should be included in research investigating lymphedema management and intervention. Retrospective research of client perspective, e.g, how did they feel about interventions they received or the lack of, did they receive education on lymphedema management, how accessible was the education., etc. Additionally, more research needs to be conducted on lymphedema that is related to other types of cancer and impacts the lower extremities.

Bottom Line for Occupational Therapy Practice/ Recommendations for Better Practice:

There is no evidence that surveillance methods would be contraindicated for lymphedema patients. Additionally, there is some evidence that treating lymphedema at a subclinical stage reduces treatment time and inhibits the progression of lymphedema. In conclusion, there is potential that surveillance methods, coupled with early intervention, may reduce overall healthcare costs and maintain a high quality of life for oncology clients.

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Involvement Plan

Introduction

In our meeting with Heidi Shaffer, OTR/L, MSM, CLT-LANA last semester, we presented the results from our CAT table. The table provided the strongest evidence for surveillance methods as preventing lymphedema from progressing past Stages 1 and 2. Additionally, there was strong evidence for the use of compression garments as an early intervention. Furthermore, strong evidence was found to suggest that exercise was not contraindicated for early treatment of lymphedema.

We then discussed how our results applied to Shaffer's setting. We asked Shaffer if MultiCare was moving towards a surveillance method. She reported that they were moving towards the implementation of surveillance methods, as supported by the purchase of the L-Dex. However, she concluded that a surveillance method has not yet been fully implemented. One barrier to the implementation was the time commitment required to create and implement a system-wide method. Later, we discussed potential options for knowledge translation. These included assisting lymphedema lobbyists to further support advocacy for compression garment coverage by Medicare or creating a system that Shaffer could use to track patient outcomes. This system could help determine the relationship within MultiCare between time of treatment (Stage 0, 1, 2), length of treatment, modalities, and progression of lymphedema. Additionally, we wanted to track the financial outcomes of early intervention vs. standard practice within the MultiCare system. These ideas were discussed with our mentor and our chair and were assessed based on the semester time constraint limiting what could realistically be completed.

In our follow up meeting with Shaffer during spring semester, she suggested knowledge translation options that would be most helpful to her. These included submitting our research to

the International Lymphoedema Framework Conference, a presentation to her supervisor, and a potential presentation to the team of lymphedema specialists at one of their quarterly meetings. With the course mentor's guidance, the authors discussed creating a template for tracking outcomes to share with Shaffer, her supervisor, and her team. In conclusion, our knowledge translation included submission of an abstract to the International Lymphoedema Framework Conference, a verbal presentation to Shaffer and her supervisor and a PowerPoint that was made available to the rest of Shaffer's team and other providers who may be interested in the research. We conducted a survey to help evaluate the outcomes of our presentation and the proposed tracking outcomes data sheet.

Context

Our collaborator is employed by MultiCare which is a nonprofit organization in Washington State that is a comprehensive healthcare system. There are currently seven MultiCare hospitals centered in the South Sound. Shaffer is employed at the MultiCare Women's Health and Wellness Center, Gig Harbor Medical Park. Oncology services are also available at the Gig Harbor location. Having multiple specialties within the same physical location ensures greater potential for fluid knowledge translation.

Shaffer is an OTR/CLT/LANA who supports the philosophy of early intervention in lymphedema treatment. She is a part of a lymphedema specialist team. This team is composed of OTs and PTs and is supervised by Sherri Olsen, OTD, MBA. Shaffer expressed that Olsen actively seeks out information that would impact their client outcomes. Olsen's desire to support best practice of lymphedema treatment supported our knowledge translation outcomes. Shaffer's manager has a greater impact on the MultiCare system and therefore, there was a greater potential for dissemination of our research findings.

Tasks/Products and Target Dates:

NOTE: Date change for presentation of findings to supervisor Sherri Olsen, moved the dates for other tasks into late March.

Task Product (1a-f)	**Deadline**	**Steps w/ dates to achieve the final outcome**	**How items were achieved w/dates**
Abstract to International Lymphoedema Framework	2/14/18	● Determine the requirements for submitting abstract (2/11-2/12) ● Meet to write up the abstract for submission (2/12-2/13) ● Submit the abstract (2/14)	● Abstract was submitted to the International Lymphoedema Framework on 2/14/18 ● Abstract was sent to George and Jenny on 3/26/18

Tracking Outcomes Data Sheet	3/19/18*	● Create a potential template and meet with George/Jenny to discuss (3/5/18*) ● Send Shaffer potential template and discuss how to best implement it (3/6/18*) ● Work it into the presentation/introduce it to the lymphedema team (3/19/18*)	● Draft template for tracking outcomes completed on 2/21/18 ● Meeting w/George to discuss data sheet on 3/26/18 ● Finalized outcomes sheet presented to Shaffer's supervisor on 4/6/18

Presentation to supervision and lymphedema team		● Talk to Shaffer about the logistics of the presentation (2/12/18) ● Compile the main points of our evidence and main topic for in-service (3/1/18) ● Begin creating a presentation (3/2/18) ● Provide Shaffer with a draft presentation for approval (3/20/18*) ● Meet with Shaffer's supervisor to present findings (3/28/18*) ● Present findings to lymphedema team (4/1/18*) ● Survey regarding presentation and tracking outcomes data sheet (4/2/18)	● Email communication about meeting logistics sent to Shaffer on 2/21/18 ● Compiled main points of evidence and created draft presentation on 3/19/18 ● Outcomes survey created on 3/19/18 ● Meeting w/George to review outcomes survey on 3/26/18 ● Met w/Olsen on 4/6/18 to discuss CAT findings. Meeting was moved due to logistical reasons and scheduling ● Email sent to Olsen w/finalized PowerPoint to share w/the lymphedema team as well as outcome survey and CAT references on 4/6/18

*Dates are subject to change until Shaffer confirms date for next team meeting.

Activities and Products Completed

Our knowledge translation consisted of three main components. The first component was to submit an abstract explaining our research to a lymphedema conference, per Shaffer's request. Shaffer felt that this was very important and was something she had wanted previous groups to do as part of their knowledge translation. When looking for conferences to submit to, we found that the Annual Lymphedema Conference was not in session this year. However, the International Lymphoedema Framework Conference was taking place this summer in the Netherlands. We discussed this option with Shaffer, and she encouraged us to submit an abstract. The process for writing and submitting the abstract was challenging. The turn-around time between email communications with Shaffer and the deadline for submitting the abstract was narrow. Additionally, the time zone difference added extra complications for submission. The abstract needed to be 250 words and was to be submitted by February 14th, 2018 at midnight Netherlands time. Due to these complications, the abstract was written and submitted to the conference without further discussion with our project chair or mentor. After submitting the abstract, we notified the project chair and mentor and discussed the logistics of the situation.

The second component of our knowledge translation was to create an outcomes data tracking sheet to monitor lymphedema client outcomes, and determine the referral process for lymphedema clients at MultiCare. In order to create this data sheet, we had to consider the pertinent information practicing clinicians would collect from clients and how this information would be synthesized and analyzed. A large purpose of the survey was to determine who was referring lymphedema clients, when the referral was made, the time between referrals and initial occupational therapy evaluations as well as what type of education or treatment was provided to the client. The draft template was then presented to both our research chair and mentor for

feedback. The final template was presented to Olsen, the supervisor for the lymphedema team at MultiCare, during the meeting on April 6th. Olsen commented that one of the other lymphedema therapists had developed a similar Excel spreadsheet to compile outcome data at the beginning of this year. At the end of the meeting, Olsen commented that she would take this template to that therapist and discuss further development of outcomes tracking.

The final component for our knowledge translation was to present our findings to Olsen, Shaffer's supervisor. The presentation consisted of a condensed form of our CAT table including our abstract, an overview of the development of our research question, the summaries of the evidence, and the implications of our findings. The PowerPoint was sent to Olsen in advance to facilitate an informed discussion rather than a slide-by-slide presentation. During the discussion, Olsen appeared to be very open to the ideas presented and interested in what the authors had found. She asked us questions regarding the various levels of evidence and recent research. While discussing the current referral process for lymphedema clients at MultiCare, Olsen reported that there is an oncologist who is referring clients on a regular basis, but that it is challenging to get the surgical oncologists to refer clients preoperatively. She commented that a lack of preoperative and limited postoperative interactions with clients at risk of lymphedema, is the greatest barrier to implementing early intervention strategies. At the end of the presentation, we discussed how to best disseminate this information to the MultiCare team. It was determined that we would send Olsen a list of our CAT references, our PowerPoint and survey. She would then provide that information to the rest of the team.

Outcomes and Effectiveness

Outcomes of the knowledge translation were measured with different tools. The effectiveness of our conference submitted abstract could not be evaluated due to its denial into the conference. No reviewer feedback was provided upon denial to use as outcome data. Upon reflection, the submission of the abstract was measurable as a group learning opportunity. There was a short deadline for abstract submission that required quick group collaboration and lack of editing or revision from our collaborator, mentor, or chair. Additionally, we submitted the abstract with the intent to present comparatively to only submitting as a poster presentation. This preference could have impacted the revision for submission into the conference.

The data sheet we created to track outcomes of lymphedema clients was presented to Olsen as a possible way to support the implementation of a surveillance method. She disclosed a peer had created an Excel tracking sheet and that she would consult with that individual to consider the addition of outcomes we had considered. For example, time between referral date and an appointment with a lymphedema therapist.

The in-service was measured by direct conversation throughout the presentation and a follow-up survey that will be collected from Olsen via email. From direct feedback, Olsen reported the in-service did provide novel ideas that she was excited to implement. For example, a possible video for pre-op education that would support a surveillance method treatment approach. In the follow-up survey, Olsen indicated that she did learn new information including the role of surveillance methods in the MultiCare system. Additionally, she found the most pertinent and impactful information in our discussion to be about using technology for educating clients as well as the reinforcement that exercise is supported for daily function in clients at risk

of developing lymphedema. Furthermore, Olsen commented that future UPS research groups could assist in creating client education videos.

Evaluation of the Overall Process of Project

Our research group was particularly excited for our research topic especially because we had been exposed to Shaffer and her clinical reasoning during a guest lecture in biomechanics. We originally wanted to follow-up on last year's project, however after meeting with Shaffer our research took a different direction while still supporting Shaffer's current needs. Research for our topic was fairly accessible, as related to breast cancer. Originally, with Shaffer's guidance we did want to include research of various cancer, however the research emphasized breast cancer even without using breast cancer as a search term. One minor challenge faced during the research phase was observing the trends in lymphedema research. Our research question specifically focused on early intervention however, trends in lymphedema research included many risk factor studies. Having a support team of faculty to problem solve with was supportive in addressing this challenge. Through this project we were able to engage with clinicians and potentially set-up future student research groups to contribute to lobbying for lymphedema management, specifically supporting treatment that would decrease the progression of lymphedema to an irreversible stage.

At the beginning of the process our group of three established communication around roles we would each fill to facilitate the efficiency of the group as we moved through the year long process. Setting these roles ahead of time, in addition to open communication throughout the process facilitated completing the parts of the project in a timely manner. Additionally, our meetings were tracked on a data sheet to support team member accountability and as a reflection of how much time we were committing to the project.

We feel accomplished in completing our CAT, especially after our meeting with Olsen. Seeing all of our hard work being well received and valued by a practicing clinician who has potential to effect change on a systems level, was rewarding and motivating. This project was eye-opening to the vast opportunities we will have as future occupational therapists and we could not be more excited to engage in our new role as entry-level practitioners.

Recommendations for the Future

One of our findings suggested the potential for implementation of surveillance methods as it is not contraindicated by available research. This lead to our group developing an outcomes tracking worksheet which could be utilized to understand trends in lymphedema referrals over time. Of particular interest, is tracking elements which may support wider use of preventive lymphedema intervention as opposed to treating lymphedema once it has already progressed past Stage 1. During the meeting with Olsen it was discovered there is currently a physical therapist in oncology at MultiCare who has been informally tracking clinical outcomes since the start of 2018. The value of clinical outcomes tracking is frequently overlooked because of time constraints evident in medical workplaces. Future student research could be directed towards supporting widespread implementation of an outcomes tracking system within a large scale medical network like MultiCare. If students were to dedicate research in this direction they may be able to access the outcomes data currently being tracked by the physical therapist mentioned above. Furthermore, research groups may be able to analyze this data in effort to extrapolate meaning from the synthesis of currently tracked outcomes data.

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Appendix A

Outcomes Data Tracking Sheet

Oncology referral date: Referring physician/location: __PCP __Surgeon __Oncology __Other:_____ Oncology appointment date:	
Referral date to OT:	
OT appointment date:	
Bioimpedance Score *Intake:* Stage of Lymphedema: 0 1 2 3 *Follow-up 1:* Stage of Lymphedema: 0 1 2 3 *Follow-up 2:* Stage of Lymphedema: 0 1 2 3 *Follow-up 3:* Stage of Lymphedema: 0 1 2 3	
OT treatment plan: □Education □Compression garment: OTC/Custom □Home program __Occupation __Self-massage __ROM (Passive / Active) __ Strengthening □Other:_____	

Appendix B

Knowledge Translation Follow-up Survey

1. Was there new information presented to you today?

   Y/N If yes, please describe.

2. What was the most pertinent information presented today?

3. Is there potential for this information to be impactful to the MultiCare system?
   If yes, how so? What are potential support/barriers?

4. Has a past research group from the University of Puget Sound created an impactful change within the MultiCare organization?
   Y / N Briefly describe

5. What next steps could student researchers take to support the implementation or translation of this information?

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