DEVELOPMENT OF A PHYSICALTHERAPY PATIENT-CARE PLAN FOR BREAST CANCER RELATED LYMPHEDEMA UTILIZING COMPLETE DECONGESTIVE THERAPY AND INTERMITTENT PNEUMATIC COMPRESSION

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ABSTRACT

Breast cancer is the most common cancer in the world and the improvements in therapeutics have led to improved survival rates (Treede et al., 2019). Breast cancer-related lymphedema is a progressive swelling due to the accumulation of protein and fluid in the interstitial space that may occur after removal of, or damage to, lymph nodes or lymphatic vessels as is common during cancer treatment (Gillespie et al., 2018). The internationally accepted current recommended best practice for lymphedema treatment commonly known as Complete Decongestive Therapy (Michopoulos et al., 2020). Intermittent Pneumatic Compression is an adjunct modality for controlling lymphedema (Dunn, et al., 2022). The aim of this study was to develop a Physical Therapy Patient-Care Plan for Breast Cancer Related Lymphedema utilizing Complete Decongestive therapy and Intermittent Pneumatic Compression. The results revealed that Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression is most effective in stage 2 Breast Cancer Related Lymphedema. Moreover, the study also indicated that it was effective in both phases of lymphedema treatment, well tolerated and remarkably free of complications. Lastly, the experts considered the developed plan of care acceptable in Breast Cancer Related Lymphedema management. It was concluded in the study that optimal treatment parameters should be followed to ensure effectiveness of Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression in Breast cancer Related Lymphedema.

Keywords: Breast Cancer Related Lymphedema, Complete Decongestive Therapy, Intermittent Pneumatic Compression

INTRODUCTION

Breast cancer is the most common cancer in the world, accounting for 11.7% of all new cancer cases in 2020 (The Global Cancer Observatory. Cancer Fact Sheets, 2020). The improvements in therapeutics have led to improved survival rates of 91% and 84% at 5- and 10-years, respectively (American Cancer Society. Breast Cancer Facts & Figures 2019–2020), with estimates of over 3.8 million survivors in the United States alone (American Cancer Society. How Common Is Breast Cancer? Breast Cancer Statistics. [(accessed on 29 June 2021)]. Most of these survivors are treated surgically with varying forms of mastectomy, breast-conserving surgery, and lymph node dissection (Treede et al., 2019). Breast cancer-related lymphedema (BCRL) is a progressive swelling due to the accumulation of protein and fluid in the interstitial space that may occur after removal of, or damage to, lymph nodes or lymphatic vessels as is common during cancer treatment (Gillespie et al., 2018). Acquired interruption or damage to the axillary lymphatic system after surgery or radiotherapy for breast cancer can lead to regional or generalized accumulation of lymph

fluid in the interstitial space, known as secondary lymphedema. (Chang et al., 2021). Breast cancer survivors face a high risk of BCRL, particularly if axillary dissection was carried out. Almost 90% of BCRL occurred during the first two years after radiotherapy (Rupp et al., 2019). Secondary lymphedema can cause limb and shoulder pain, heaviness, tightness, and decreased range of motion. Leading to disfigurement, and functional impairment, and results in poor functional recovery, chronic disability, and impaired quality of life (Pappalardo et al., 2021). Diagnosing lymphedema is challenging, especially in the early stages of the disease, with varying definitions and objective tools available for diagnostic assessment. Clinicians do not universally agree on what measurement and criteria define lymphedema (McLaughlin et al., 2019). Existing guidelines suggested that circumferential tape measurements are acceptable as a minimum standard provided, they are completed with a non-stretch tape measure and at multiple points on each arm. Lymphedema is commonly diagnosed when a 2 cm difference or more in arm circumference at a single anatomic level measured or a 200 ml limb volume difference between the affected and nonaffected limbs is observed. Physical examination techniques include water displacement volumetry, sequential circumferential arm measurement, infrared laser perometry, and tissue bioelectrical impedance spectroscopy. However, the most common methods in determining volume in clinical practice are water displacement and circumferential measurements. (Mayrovitz, 2021).

According to Executive Committee of the International Society of Lymphology (2020), the internationally accepted current recommended best practice for lymphedema treatment commonly known as Complete Decongestive Therapy (CDT). This therapy includes various techniques, such as manual lymphatic drainage (MLD), external compression garments and bandages, skincare, and exercises guided by specially trained therapists. (Borman et al., 2022). CDT is divided into Phase I Decongestion; acute management consists of a 4-week program is performed in an out-patient clinical setting. Phase II Maintenance conducted at home by the patient and/or family and involves continued proper skin care and exercise, simple (or self-) manual lymphatic therapy, and use of a compression sleeve and glove during the day and compression bandaging at night.

There were some evidences that CDT can help reduce lymphedema, but studies to date have been underpowered, varied in their treatment protocols and assessment methods, and lacked sufficient duration of follow-up to demonstrate any long-term treatment effect for this chronic condition. CDT is time consuming, involving weeks of intensive care with daily treatment sessions and ongoing maintenance treatments less frequently. Another consideration of CDT is that the MLD component usually requires a trained therapist. Currently, invasive treatments are often reserved for those that fail conventional CDT without data to support the ideal treatment sequence and future studies are required to further investigate the sequencing of treatment approaches. (Borman et al., 2022).

Intermittent Pneumatic Compression (IPC) is another modality for controlling lymphedema. This technique uses pneumatic pumps to relive the formation of edema and remove fluid that has accumulated in the limbs with external compression. Pneumatic pumps apply single or multiple compartments around the affected extremity and the devices function through the application of fixed or intermittent pressure for a certain period. (Sanal-Toprak et al., 2019). IPC can be used in the treatment of lymphedema as an adjunct to CDT, adaptations to these plans are becoming more popular and that can be incorporated into patient self-management regimens. (Dunn, et al., 2022). Pneumatic compression has been used for more than 40 years in the management of lymphedema. Modes of application have evolved with little consensus regarding optimal treatment parameters or dosage. Low-level evidence of moderate quality

shows significant outcomes achieved with dosage times of 45–60 minutes, applying pressures between 30 and 60 mmHg in sequential IPC programs. Methodological limitations in most studies suggested caution in drawing conclusions. (Phillips et al., 2019) Some studies have investigated the efficacy of IPC, but the results are conflicting, and these studies did not establish optimal application parameters. More research is needed to identify the sensitive and specific parameters that would accurately reflect the outcome and to establish clinical settings that would be preferred for using IPC. Thus, the study aimed to development of a Physical Therapy Patient-Care Plan for Breast Cancer Related Lymphedema utilizing Complete Decongestive therapy and Intermittent Pneumatic Compression, which could serve as a basis for Physical Therapist in recommending optimal treatment intervention in managing breast cancer related lymphedema. Moreover, the result of this developed plan of care will be beneficial for breast cancer patient beginning with diagnosis and continuing through cancer treatment and survivorship. Lastly, it can be implemented to other types of lymphedema, such as head, neck and lower extremity that will further determine its effectiveness and contribute to the continuous improvement and development of another treatment plan of care.

Objective of the Study

The overall objective of this study was to develop a Physical Therapy Patient-Care Plan for Breast Cancer Related Lymphedema utilizing Complete Decongestive therapy and Intermittent Pneumatic Compression. Specifically, this study had the following aims to know (1)what are the optimal treatment parameters of applying Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression in Breast cancer Related Lymphedema (2) what stage of Breast cancer Related Lymphedema is Complete Decongestive Therapy with Intermittent Pneumatic Compression most effective (3) what phase of lymphedema treatment is Complete Decongestive Therapy with Intermittent Pneumatic Compression most effective (4) are there any reported adverse events associated in the use of Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression in Breast cancer Related Lymphedema (5) what Physical Therapy patient plan of care for Breast cancer Related Lymphedema can be developed.

LITERATURE REVIEW

Pathophysiology of Lymphedema

The lymphatic system plays two important functions in the human body. It maintains the fluid balance of the body by returning the protein deposits and extra tissue fluid extravasated from the blood capillaries to the circulation system. Besides, the lymphatic vessels carry germs and pathogens to the lymph nodes so that the immunological defense mechanism is activated. In the human body, the lymphatic system performed two important functions. Through the return of excess tissue fluid and protein deposits from blood capillaries to the circulatory system, it preserves the body's fluid equilibrium. Also, to activate the immune defense process, germs and pathogens are transported through lymphatic vessels to the lymph nodes. Varghese, Smitha. (2021) Studying the lymphatic system's normal anatomy is essential to understanding the pathogenesis of lymphedema. Pre-collectors, lymph-collecting vessels, and lymph capillaries are the three types of lymphatic vessels. The vessels were located superficially and placed underneath the epidermis. Lymph capillaries are formed by endothelial cells that connect loosely with each other in an overlapping pattern. An endothelial cell and the surrounding tissue are connected by a fibrous anchoring filament. The endothelial cell connections widen when there is an excess of interstitial fluid present. The

endothelium cells are drawn outward to collect the edema fluid inside the lumen, and this is accomplished by the anchoring filaments' action. In the deep dermis, the capillaries connect with larger pre-collectors. Pre-collectors only allow lymph flow in one direction due to their valve form. Efferent pre-collectors are larger vessels that run vertically through the subcutaneous tissue, formed when pre-collectors unite within the dermis. The subcutaneous fat layer's collectors are connected to the efferent pre-collectors. The collectors contain a triple-layered wall made up of smooth muscle cells, endothelial cells, and collagen fibers with fibroblasts. They are positioned horizontally in the subcutaneous tissue. The lymph flow is propelled by the fibroblasts' regular contraction. Based on their physical connection to the deep fascia, the collectors are further divided into superficial and deep veins. While superficial vessels do not exhibit this preference, deep vessels do follow the arteries. Before entering the vein, every lymphatic channel joins at least one lymph node. This provides that before the lymph nodes trigger the immune system, infections or cancer cells are not discharged into the systemic blood circulation.

In 2018, The concept of 'lymphosome' suggested that the lymphatic vessels in a particular region connect to the same subgroup of regional lymph nodes. Suami & Scaglioni (2018). Lymph from the lower body below the diaphragm and the left side of the body above the diaphragm is transported by the thoracic duct, which is the largest lymph vessel in the body. The thoracic duct empties into the left venous angle, which is formed by the left subclavian and left jugular veins. Lymph from the right side of the body above the diaphragm is transported by the right lymphatic duct, which empties into the right venous angle formed by the junction of the right subclavian and right jugular veins. Fluids normally diffuse into interstitial spaces at the arteriolar end of the capillary and filter back into the capillary at the venular end. Up to 90% of fluids filtered into the interstation from capillaries are reabsorbed into the venous side. The remaining 10% (or ore) of fluids and proteins are removed from the interstitial by small, terminal (one-way) lymphatic vessels. The normal outward flow of fluids slightly exceeds the inward flow, and the net filtrate enters the lymphatics and drains back into the bloodstream. This process creates stable interstitial pressure. If large molecules accumulate, such as in obstructed lymph transport because of axillary treatment, sufficient effective osmotic pressure develops and causes excessive fluids in the interstitial space. (Földi's textbook of lymphology: for physicians and lymphedema therapists 2012).

Lymphedema occurs when the lymphatic load exceeds the transport capacity of the lymphatic system, which causes filtered fluid to accumulate in the interstitium. This imbalance between interstitial fluid production and transport may be due to congenital malformation of the lymphatic system, or damage to lymphatic vessels or lymph nodes leading to a reduction in the numbers of lymph channels or obstruction of the available channels. Persistent accumulation of lymphatic fluid promotes proliferation of adipocytes and deposition of collagen fibers in the extracellular matrix and around capillary and collecting lymphatics. This protein-rich swelling condition is called lymphedema. (Executive Committee of the International Society of Lymphology 2020).

Causes and Risks of BCRL

With the steady increase in the number of long-term survivors of early breast cancer due to ongoing medical advancements, emphasis on treating the chronic complications of treatment, including Breast cancer-related lymphedema (BCRL), has increased. This resulted from disruption to the lymphatic system that prevents adequate drainage from lymphatic vessels causing protein-rich lymph fluid to accumulate in the interstitial space (Sleigh et al., 2023)

Several risk factors have been identified for the development of BCRL. Risk factors are subdivided into patient-specific and treatment-specific risk factors. Patient- specific factors include body mass index (BMI) at the time of diagnosis, subclinical edema, and cellulitis on the side of treatment (McEvoy et al., 2021). The independent treatment- related risk factors for BCRL include mastectomy and axillary lymph node dissection (ALND), as well as radiation therapy (RT), and chemotherapy (Michelotti et al., 2019).

Radiation Therapy

Radiation therapy (RT) remains an essential part of complex breast cancer therapy that according to recent treatment trends are based on both the risk status and use of individualized RT technique chosen also considering the input from the patient. (Polgar et al., 2022) Radiotherapy causes DNA break and subsequent cell death. This affects the cancer cells more severely than the normal cells. Around 7 million patients receive radiotherapy worldwide every year. Improved cure rates of all malignancies have resulted in more providers being confronted with a large number of patients with a wide range of chronic morbidities in long-term survivors. Hence all providers must be aware of the common adverse effects of radiation therapy. There are two major types of radiation therapy, external-beam radiation therapy was the most common type and delivers radiation from a machine outside the body and internal radiation therapy radioactive material placed into cancer or surrounding tissue (Majeed et al., 2023) Side effects of radiotherapy are classified as acute (early), consequential, or late effects on normal tissues over time. Acute radiation toxicity is seen within a few weeks after treatment and usually involves intermitotic cells (skin and mucosa). Consequential effects are seen when acute complications are not treated and cause persistent damage. Late complications emerge months to years after exposure and usually involve postmitotic cells (liver, kidney, heart, muscle, and bone). Radiation-induced lymphedema causes local swelling and obstructive symptoms. Treatment is usually patient directed, including physiotherapy, limb elevation, compression therapy, manual lymphatic drainage, or complete decongestive therapy and intermittent pneumatic compression in severe cases.

Rupp et al., (2019) conducted a study entitled Frequency and risk factors for arm lymphedema after multimodal breast-conserving treatment of nodal positive breast cancer - a long-term observation. The study aimed to investigate the rate of BCRL and its risk factors in the long-term using self-reported symptoms. Data was collected from 385 patients who underwent multimodal therapy for nodal positive breast cancer, including breast conserving surgery, axillary dissection, and local or locoregional radiotherapy. Two validated questionnaires were used for the survey of BCRL. These were analyzed collectively with retrospective data. Results have shown 23.5% (n = 43) suffered a permanent BCRL (stage II-III) after a median follow-up time of 10.1 years (4.9-15.9 years); further 11.5% (n = 23) reported at least one episode of reversible BCRL (Stage 0-I) during the follow-up time. 87.1% of the patients with lymphedema developed this condition in the first two years. The researcher concluded that almost 90% of BCRL occurred during the first two years after radiotherapy.

McDuff et al., (2019) also conducted a study entitled Timing of Lymphedema After Treatment for Breast Cancer: When Are Patients Most At Risk? This study aimed to determine when the risk of lymphedema is highest after treatment of breast cancer and which factors influence the time course of lymphedema development. It involves 2,171 women who received surgery for unilateral or bilateral breast cancer. Results revealed with a median

follow-up of 4 years, the overall estimated 5-year cumulative incidence of lymphedema was 13.7%. Patients receiving axillary lymph node dissection (ALND) with regional lymph node radiation (RLNR) experienced the highest 5-year rate of lymphedema (31.2%), followed by those receiving ALND without RLNR (24.6%) and sentinel lymph node biopsy with RLNR (12.2%). Overall, the risk of lymphedema peaked between 12 and 30 months postoperatively; however, the time course varied as a function of therapy received. Early-onset lymphedema (<12 months postoperatively) was associated with ALND (HR [hazard ratio], 4.75; P < .0001) but not with RLNR (HR, 1.21; P = .55). In contrast, late-onset lymphedema (>12 months postoperatively) was associated with RLNR (HR, 3.86; P = .0001) and, to a lesser extent, ALND (HR, 1.86; P = .029). This study concluded that ALND is associated with early-onset lymphedema, and RLNR is associated with late-onset lymphedema.

Another study performed by Salinas-Huertas et al., (2022), entitled Risk factors for lymphedema after breast surgery: A prospective cohort study in the era of sentinel lymph node biopsy. The objective was to investigate the incidence of lymphedema after breast cancer treatment and to analyze the risk factors involved in a tertiary level hospital. This prospective longitudinal observational study involved 232 patients who underwent surgery for breast cancer for over 3 years post-breast surgery. Sentinel lymph node biopsy (SLNB) or axillary lymphadenectomy (ALND) were mandatory in this cohort. In total, 201 patients met the inclusion criteria and had a median follow-up of 31 months (range, 1-54 months). Lymphedema was diagnosed by circumferential measurements and truncated cone calculations. Patients and tumor characteristics, shoulder range of motion limitation and local and systemic therapies were analyzed as possible risk factors for lymphedema. Results showed that most cases of lymphedema appeared in the first 2 years. 13.9% of patients developed lymphedema: 31% after ALND and 4.6% after SLNB ($p < 0.01$), and 46.7% after mastectomy and 11.3% after breast-conserving surgery ($p < 0.01$). The lymphedema rate increased when axillary radiotherapy (RT) was added to radical surgery: 4.3% for SLNB alone, 6.7% for SLNB + RT, 17.6% for ALND alone, and 35.2% for ALND + RT. The researcher concluded that the main risk factors for lymphedema were the more radical surgeries (ALND and mastectomy). The risk associated with these procedures appeared to be worsened by the addition of axillary radiotherapy.

Axillary Surgery Type

Axillary lymph node dissection (ALND) plays an essential role in the surgical management of breast cancer. The information obtained from pathologic examination of the removed lymph nodes helps to determine the pathologic staging of the disease and is an integral part of the treatment of breast cancer. ALND was beneficial for patients with breast cancer because it controls regional nodal disease and may improve overall survival. Complications after ALND were wound infection, lymphedema of the arm, lymphangitis, arm numbness, and limitation of arm movement. The precise incidence of BCRL was difficult and complicated to determine as a result of the prolonged period of latency from breast cancer treatment to initial BCRL signs or symptoms. There was no doubt that the extent of axillary surgery is a significant risk factor. ALND results in greater lymphatic disruption than SLNB and can quadruple the rate of BCRL.1-4 Removal of more lymph nodes and the total number of positive lymph nodes are consistently cited as BCRL risk factors but were likely corollaries for extent of dissection or need for multimodality therapy, respectively. Currently, the progression of breast cancer clinical trial development has focused on strategic de-escalation of locoregional therapy, particularly to the axilla. (McLaughlin et al.,2020). Naoum et al., (2020) conducted a study entitled Quantifying the Impact of Axillary Surgery and Nodal

Irradiation on Breast Cancer-Related Lymphedema and Local Tumor Control: Long-Term Results From a Prospective Screening Trial. The purpose of the study was to independently evaluate the impact of axillary surgery type and regional lymph node radiation (RLNR) on BCRL rates in patients with breast cancer. Patients with invasive breast cancer were enrolled in a lymphedema screening trial and according to axillary surgery approach: sentinel lymph node biopsy (SLNB) alone, SLNB+RLNR, axillary lymph node dissection (ALND) alone, and ALND+RLNR. All patients received baseline preoperative and follow-up measurements after treatment. Lymphedema was defined as a ≥ 10% relative increase in arm volume arising > 3 months postoperatively. The primary end point was the BCRL rate across the groups. The secondary end points were 5-year locoregional control and disease-free-survival. The result of this cohort study showed that the 5-year cumulative incidence rates of BCRL were 30.1%, 24.9%, 10.7%, and 8.0% for ALND+RLNR, ALND alone, SLNB+RLNR, and SLNB alone, respectively. Multivariable Cox models adjusted for age, body mass index, surgery, and reconstruction type showed that the ALND-alone group had a significantly higher BCRL risk (hazard ratio [HR], 2.66; P = .02) compared with the SLNB+RLNR group. There was no significant difference in BCRL risk between the ALND+RLNR and ALND-alone groups (HR, 1.20; P = .49) and between the SLNB-alone and SLNB+RLNR groups (HR, 1.33; P = .44). The 5-year locoregional control rates were similar for the ALND+RLNR, ALND-alone, SLNB+RLNR, and SLNB-alone group (2.8%, 3.8%, 0%, and 2.3%, respectively). It was concluded that even if RLNR adds to the risk of lymphedema, the main risk factor is the type of axillary surgery used.

Hara et al., (2023) conducted a study entitled Lymphedema After Axillary Lymph Node Dissection in Breast Cancer: Prevalence and Risk Factors-A Single-Center Retrospective Study. Likewise, this study aimed to identify the prevalence and risk factors for lymphedema after ALND in patients with breast cancer. This retrospective study included 175 patients with breast cancer who underwent ALND in the Nagasaki University Hospital, Japan. Patients were divided into two groups according to the presence or absence of lymphedema. Surgical and pathological findings were compared between the two groups. Lymphedema was prevalent in 20% of the study participants, and the mean time interval from surgery to development of lymphedema was 479 days. A study determined that the prevalence of lymphedema in was 20%. Findings suggested that smoking, RT, and dissection of >18 ALNs are risk factors for lymphedema. Aggressive and empiric ALND was associated with axillary lymph duct damage.

Another study conducted by Zheng et al., (2023) entitled the influence of axillary surgery and radiotherapeutic strategy on the risk of lymphedema and upper extremity dysfunction in early breast cancer patients. The purpose of the study was to explore the risk factors for BCRL and upper extremity dysfunction (UED) in patients with early breast cancer after modern comprehensive treatment and to compare the toxicity of different treatment strategies. A total of 1369 female patients with breast cancer who underwent adjuvant radiotherapy were retrospectively reviewed. The incidence, severity, and risk factors for BCRL and UED were evaluated. The result of this study revealed that after a median follow-up of 25 months, a total of 249 patients developed BCRL; ALND, increased number of dissected nodes, right sided and hypofractionated radiotherapy were found to be significant risk factors. It was concluded that aggressive ALND remains the primary risk factor for BCRL and UED. Others cause and risk factor such as breast reconstruction (Jeon et al., 2023, Lee & et al., 2017), adjuvant docetaxel-based chemotherapy (Jian et al., 2024, Tokumoto et al., 2022 & Aoishi et al., 2020), high body mass index (Leray et al, 2020, Tsai et al., 2020 & Wang et al., 2023) and

cellulitis (Jørgensen et al., 2021 & Cheng et al., 2022) may affect subsequent development of lymphedema.

Diagnosis of Lymphedema

There were several different advance techniques in the diagnosis of BCRL, where clinicians do not universally agree on what measurement and criteria define lymphedema. Furlan et al., (2021) diagnosed lymphedema in their recent study when there is a 2 cm difference or more between the affected and contralateral upper limb (UL) was detected in at least two contiguous measurement points (MPs) and just one MP or a 200 ml limb volume difference between the affected and nonaffected limbs is detected. (Pappalardo et al., (2021), summarized BCRL diagnostic methods advantages and disadvantages. The most frequently used method is circumferential tape measurement is also an inexpensive, reliable, and highly accessible measurement tool in a variety of healthcare settings. Josephine., (2019) conducted as study entitled Evaluation of Lymphedema Prevention Protocol on Quality of Life among Breast Cancer Patients with Mastectomy. They used this method to measure arm circumferences predetermined sites on the side of mastectomy. The arm was measured circumferentially at 10 cm above and below the olecranon process and at elbow, wrist, interphalangeal thumb, and mid palm. More than 2 cm difference in the arm circumference on the side of mastectomy with reference to the unaffected arm was considered as lymphedema. It was a reliable method (r=0.9) to check the arm circumference. However, since the measurement process takes substantial time for both patient and provider, the perceived low cost of this technique needs to be reconsidered in the context of these important disadvantages. Furthermore, it is common for multiple providers to measure the arm for lymphedema screening purposes. As such, inter-rater variability can generate error with the tape measurement without significant training and provider experience, reducing the consistency and accuracy of values obtained.

Mayrovitz (2021) mentioned in his study entitled Noninvasive Measurements of Breast Cancer-Related Lymphedema, that Water displacement measurements (WDM) were considered by many to be the “gold standard” for volume measurements. Insertion of the arm into a water-filled volumeter causes a water volume equal to the inserted arm volume to be displaced and captured as overflow. Although accurate, this technique does not provide information on the shape of the extremity and cannot be used with open wounds. Another disadvantage was it is time-consuming and needs intensive cleaning to meet hygienic standards. The need for a strict protocol to ensure accuracy and it depends on patient mobility to implement, were some reasons why it is not routinely used in clinics.

The disadvantages associated with the methods in measuring BCRL have led to well-validated and more efficient measurement devices. One such device for measurement is perometry. This device uses an infrared optoelectronic device that can measure the volume of the swollen limb and then compare it to the healthy limb. It works by means of infrared scanning to calculate the circumference of multiple areas of the limb creating a 3-D image of the limb. De Vrieze et al., (2019) concluded that perometry is the best measurement method for evaluating excessive arm volume over time in terms of reliability, low error rate, low cost, few limitations, and the time spent. Another modern measurement technique is Bioimpedance Spectroscopy (BIS). Pappalardo et al., (2021), he described that BIS calculates the rate of electrical current transmission through the tissues by comparing impedance and resistance in the extracellular fluid between the lymphedematous limb and the healthy limb using a low-level current (<30 kHz). This device is safe, painless, and rapid which provides objective data

even for the early detection of lymphedema and it is repeatable. A limitation to this technique is that it measures only patients who have undergone unilateral breast surgery, excluding those who receive bilateral breast surgery. In conclusion, lymphedema diagnostic methods vary. Each method presents its own appropriateness for application in clinical practices. For example, water displacement method was the most reliable ("gold standard") method for measuring edematous arms and legs but not practical for patients with wounds. Circumferential measurement is a simple and low-cost technique but cannot directly calculate limb volume and is subject to inter- and intra-rater reliability issues. The high cost of perometry limits its application, although it can calculate limb volume quickly and accurately. Finally, BIS can detect subclinical swelling, but radiological imaging may not be practical because of their high costs unless causation and management require further investigation.

Classification of Lymphedema

International Society of Lymphology (2020) developed a staging system combining two components on physical examination softness or firmness of the limb (indicating fibrotic soft-tissue changes) and the effect of elevation. Within each stage, the severity of functional impairment is denoted based on volume differences assessed as minimal (5%–20% increase in limb volume), moderate (20%–40% increase), or severe (>40% increase). Lymphedema is classified as stage I, II, or III and quantified as mild, moderate, or severe. Stage I lymphedema pits on the application of pressure but reverses with limb elevation. Stage II lymphedema no longer pits on pressure because of excess fat deposition and tissue fibrosis and no longer reverses with elevation. Stage III lymphedema is characterized by progressive swelling with trophic skin changes, including papules, warts, skin folds, tissue bulges, and often open draining wounds, leading to severe impairment in mobility and high risk of infection.

The common subjective clinical symptoms of patients with lymphedema in the upper limb are swelling, numbness, heaviness, tightness, stiffness, decreased coordination and mobility, limb fatigue or weakness. However, symptom presentation is broad and not all patients experience these symptoms. Next, during the physical examination, evaluation of the swollen limb should provide information regarding size, presence of scars, comparison with the healthy limb, skin condition and sensation. Objective clinical signs can include skin changes such as reddening, hyperkeratosis, thickening/firmness of tissues. Pitting edema is commonly seen at the end of the latent phase, with a depression formed in the skin after fingertip pressure as the lymph is pushed into the surroundings. Later, non-pitting edema is characterized by hypertrophied adipose tissue with fibrosis. Stemmer's test is commonly performed, and it is considered positive when it is difficult or impossible to pinch the skin at the base of the toes or at proximal phalanx of the fingers due to severe fibrosis. Patients with BCRL are susceptible to recurrent episodes of cellulitis that may increase adipose tissue deposition. Jørgensen et al., (2021).

Effects of Lymphedema

Beaman (2019) conducted a study entitled Introduction of the Lymphedema Action Plan: Clinical Advancement in Proactive Lymphedema Care. The study discussed that Lymphedema could have a large effect on physical, psychological, emotional, and even financial well-being and thus needs to be included as an integral part of the patient's oncology treatment plan. Lymphedema may negatively affect quality of life, it can increase

the risk of poor self-esteem, unhealthy body image, depression, physical discomfort, isolation, and anxiety. Also, shoulder impairment, decreased strength, and functional disability have also been linked to lymphedema. Munoz et al., (2023) added that lymphedema can cause a decrease in muscle strength and range of motion of the shoulder, sensory disturbances, hypersensitivity, fatigue, and physical symptoms such as swelling, pain, heaviness, tightness, and discomfort, which can lead to functional upper-limb impairments.
Also, in the study of Sun et al., (2020) entitled the influence of breast cancer related lymphedema on women's return-to-work, were they expressed the detrimental effect of BCRL on women's work and career over and above the initial impact of breast cancer in the long term. It was associated with multiple adverse work outcomes such as decreased work productivity, delay in returning to work, reduced earnings, unemployment, more time off from work, and reduced work capacity.

Lastly, Anbari et al., (2021) studied the impact of breast cancer-related lymphedema on rural and small-town Survivors' return-to-work and quality of life: A multiple-case study. described how BCRL influences the work experiences and quality of life (QoL) of survivors. Following the onset of limb swelling, the patient is predisposed to infection, cellulitis, and lymphangitis, and sometimes followed by life-threatening septicemia. Moreover, when asked in what ways lymphedema interfere with aspects of daily living, women most often report that clothing and appearance are negatively affected by the condition, followed by effect on daily routine and activities. Furthermore, one of the major problems identified by women is the necessity to wear compression sleeves; they described this experience as ugly, terrible, un-feminine, and uncomfortably warm, particularly in summertime because of the need to conceal their arms by wearing special clothing.

Treatment of Lymphedema

Davies et al., (2020) developed a clinical practice guideline stating that interventions for cancer-related lymphedema are needed at various time points along the clinical trajectory, beginning at diagnosis of breast cancer and continuing through cancer treatments and survivorship. Evidence-based recommendations, based on an individual's clinical presentation, are needed to guide the clinician's decision when recommending interventions. Treatment of lymphedema associated with breast cancer can include combined modality approaches, compression therapy and therapeutic exercises.

Complete Decongestive Therapy (CDT)

According to Executive Committee of the International Society of Lymphology (2020), the internationally accepted current recommended best practice for lymphedema treatment is a two-phase decongestive lymphedema treatment (DLT), also commonly known as complex physical therapy (CPT) or complete decongestive therapy (CDT). Borman et al., (2022) specified in his study entitled Combined Complete Decongestive Therapy Reduces Volume and Improves Quality of Life and Functional Status in Patients with Breast Cancer-Related Lymphedema. CDT is a widely accepted universal first-line therapy for extremity lymphedema. This therapy includes various techniques, such as manual lymphatic drainage (MLD), external compression garments and bandages, skin care, exercises guided by specially trained therapists and self-education. CDT is divided into Phase I Decongestion; acute management consists of a 4-week program performed in an out-patient clinical setting. Phase II Maintenance conducted at home by the patient and/or family and involves continued proper skin care and exercise, simple (or self-) manual lymphatic therapy, and use of a

compression sleeve and glove during the day and compression bandaging at night. Studies of Mobarakeh et al., (2019) and Ochalek et al., (2019) enumerated several advantages can be obtained by a CDT including: (1) reduction of lymphedema volume, pain, and arm heaviness, (2) improvement of lymphatic drainage, (3) acceptable quality of life and (4) reduction of episodes of cellulitis. Although conservative therapy alone may provide enough symptomatic relief, it depends essentially on patient compliance and their capacity to wear life-long compression garments. A cross-sectional study conducted by Samanci et al., (2019) entitled Efficacy of complex decongestive therapy on breast cancer-related lymphedema., the study aimed to investigate efficacy of CDT on the occurrence of breast cancer related lymphedema. Patients were treated with active therapy schedule (manual massage for lymphatic drainage and exercise therapy, 45-60 min per day) by the same trained physiotherapist. Volumetric quantification by circumference measurement of affected and healthy extremities was used for diagnosis and follow-up of lymphedema in all patients. Results showed the data of the 47 patients complying with the criteria specified in these retrospective studies were evaluated. When the volumetric changes in the affected extremity were examined before and after lymphedema treatment, it was determined that the amount of lymphedema decreased after CDT (P=0.001). 31 (66%) patients received radiotherapy after mastectomy. This study concluded that CDT can be used for the management of breast cancer related lymphedema of limb.

Complementary study conducted by Michopoulos et al., (2020) aimed to evaluate the effectiveness and safety of complete decongestive therapy (CDT) of phase I in the Greek population with lymphedema. CDT was implemented in all patients for 20 sessions in a four-week treatment period. The edema's (excess volume (EV) and percent of excess volume (PEV)) measurements were carried out four times in the treatment period, whereas the percent reduction of excess volume (PREV) was calculated at the end of phase I. Moreover, every infection, trauma of skin, and pain of limb were recorded during the treatment. A significant reduction ($p<0.001$) between the pre-treatment and post-treatment values of EV and PE. The study concludes that the treatment of lymphedema with CDT phase I showed positive safety and great effectiveness on the treatment of lymphedematous limbs in the population of the study. The correct treatment of CDT phase I ensured safety and significant reduction of edema in patients with Lymphedema that predispose the success of phase II of CDT. Another study conducted by Keskin et al., (2020) which aimed to evaluate the results of the intensive phase of complete decongestive therapy, and to determine the predictive factors for the response to treatment in patients with breast cancer-related lymphedema. Researchers concluded that the most important predictive factors for the efficacy of treatment were found to be percentage of excess volume and education level. Patients with breast cancer should be followed up regularly and receive complete decongestive therapy in the early stage of lymphedema.

Early studies questioned whether exercising lymphedema patients would be safe. However, recent studies by Panchik et al., (2019) have indicated that several forms of exercise appear to be safe interventions for clinicians to use when treating this population and offer benefits such as improved quality of life, strength, body mass index, and mental health and decreased pain and lymphatic swelling. Additionally, exercise interventions such as supervised aerobic exercise and progressive resistance exercise have been reported to have significant potential effects on the prevention of BCRL. Hayes et al., (2022). This was supported by Bloomquist et al., (2019) that breast cancer survivors benefitted from supervised heavy-load resistance exercise during chemotherapy without increasing lymphedema risk. Lastly, strengthening exercises should be added into the treatment of patients undergoing CDT to gain better

functional potential. Baklaci et al., (2020). There were some evidence that CDT can help reduce lymphedema, but studies to date have been underpowered, varied in their treatment protocols and assessment methods, and lacked sufficient duration of follow-up to demonstrate any long-term treatment effect for this chronic condition. CDT is time consuming, involving weeks of intensive care with daily treatment sessions and ongoing maintenance treatments less frequently. Another consideration of CDT is that the MLD component usually requires a trained therapist. Currently, invasive treatments are often reserved for those that fail conventional CDT without data to support the ideal treatment sequence and future studies are required to further investigate the sequencing of treatment approaches. (Borman et al., 2022)

Intermittent Pneumatic Compression (IPC)

Another non-invasive, technological treatments for BCRL exist. Pneumatic Compression Device (PCD) such as Intermittent pneumatic compression (IPC) pumps have been used to treat BCRL, but there is unclear evidence demonstrating their efficacy. This technique uses pneumatic pumps to relive the formation of edema and remove fluid that has accumulated in the limbs with external compression. Pneumatic pumps apply single or multiple compartments around the affected extremity and the devices function through the application of fixed or intermittent pressure for a certain period. (Sanal-Toprak et al., 2019). IPC can be used in the treatment of lymphedema as an adjunct to CDT, adaptations to these plans are becoming more popular and that can be incorporated into patient self-management regimens. Some studies evaluating IPC, however, have demonstrated its usefulness in BCRL management. Szolnoky et al., (2009) sought to assess the use of IPC in conjunction with CDT involving MLD. Twenty-seven women were randomly placed in either cohort and LE was measured via circumferential arm measurement and a self-reported symptom questionnaire at the beginning and end of therapy, and 1 and 2 months after the initiation of therapy. Though both groups exhibited volume reduction, there was significantly more reduction in the IPC cohort at all time points. All patients, no matter the treatment method, experienced volume reduction with no significant difference between the two cohorts. They further noted that IPC may be preferential to patients with BCRL as the treatment can be done while at home. A series of clinical trials and systematic reviews have tried to investigate the benefits of IPC. However, the results have been controversial, and no conclusion has been reached on the influence of IPC on lymphedema. More recently, Zaleska et al., (2019) reported that IPC devices can lower tissue fluid pressures, increase flow volume, and decrease skin stiffness, moving subcutaneous extracellular water away to proximal regions of the limb. There was limited low to moderate quality evidence for use of IPC in lymphedema treatment, but home use should be considered for the maintenance phase.

Pneumatic compression has been used for more than 40 years in the management of lymphedema. Modes of application have evolved with little consensus regarding optimal treatment parameters or dosage. Low-level evidence of moderate quality shows significant outcomes achieved with dosage times of 45–60 minutes, applying pressures between 30 and 60 mmHg in sequential IPC programs. Methodological limitations in most studies suggest caution in drawing conclusions. Phillips et al., (2019). Over the past few decades IPC has improved significantly. Several studies have assessed the efficacy of IPC. Jayasree (2021) conducted a study entitled, Diagnosis and management of secondary lymphedema. The study revealed that intermittent pneumatic compression squeezes the edema tissue fluid to the regions with normal lymphatic drainage. These devices are filled with air and active sequential compression is applied from distal to proximal part of the limb mimicking the normal lymph flow. This helps in reducing the limb volume and prevents further swelling and

development of fibrotic complications. IPC can be used both in hospitals and at home, for a minimum period of 2 hours a day. IPC was another approach to MLD, and it can reduce the need for labor intensive MLD which can be delivered only by specially trained practitioners. Advanced Pneumatic Compression Device can be programmed to deliver pneumatic compression identical to MLD and patients can get customized and more efficient treatment at home. MLD and pneumatic compression therapies are contraindicated in patients with uncontrolled hypertension, acute deep vein thrombosis, active infection, or acute inflammation at the site. A similar study conducted by Dunn et al., (2022) endorsed IPC devices to develop so that their function mimics the process and principles of MLD. The increase in lymphedema volume observed after discontinuation of IPC suggests that regular treatment is required to maintain its associated effects.

METHODOLOGY

This study on determining the development of a Physical Therapy patient-care plan for Breast Cancer Related Lymphedema utilizing Complete Decongestive Therapy and Intermittent Pneumatic Compression, utilized the descriptive developmental research. Ibrahim (2016) discussed that this research method involves designing, developing, and evaluating instructional programs, processes, and products by means of meeting set criteria on internal consistency and effectiveness. Based on the results of the systematic review, the researcher developed a Physical Therapy patient plan of care for Breast Cancer Related Lymphedema. This plan of care was evaluated by experts who are perceptive to share their knowledge, experience, and expertise using Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression. Experts provided valuable insight into the underlying causes of problems, what has been tried and failed, what has been tried and worked, and future trends to watch. The findings were discussed comprehensively and developed a Physical Therapy patient-care plan for Breast Cancer Related Lymphedema utilizing Complete Decongestive Therapy and Intermittent Pneumatic Compression.

The respondents of the study consisted of five (5) experts who are presently treating lymphedema with Complete Decongestive Therapy and Intermittent Pneumatic Compression. Purposive sampling was utilized in the study. The reason for this was due to a shortage of respondents who could be included in the survey. There are also a limited number of experts that have worked using Complete Decongestive Therapy and Intermittent Pneumatic Compression to treat and manage Breast Cancer Related Lymphedema. The five (5) qualified respondents were selected based on the following criteria: a) healthcare professionals, clinical experts or certified lymphedema therapists who currently treating lymphedema using Complete Decongestive Therapy and Intermittent Pneumatic Compression; b) utilizing using Complete Decongestive Therapy and Intermittent Pneumatic Compression for more than three (3) years; c) willing to participate in the study as a respondent without a conflict of interest. The study utilizes a researcher made questionnaire among experts to evaluate general acceptability of the developed plan of care in Breast Cancer Related Lymphedema. It authenticates the recommended treatment parameters, procedure, effectiveness, and willingness to use this combined treatment for Breast Cancer Related Lymphedema. To ensure that the questionnaire was clear and acceptable to the intended respondent. Three (3) respondents, including the researcher's adviser, who were not part of the sample population were given a dry run. It established content validity by determining if respondents felt comfortable answering the questionnaire, given its length and other potential impediments to obtaining favorable replies. The time frame of this study was conducted in the academic year 2022-2023.

Statistical tools such as weighted mean was the statistical tool used to analyze the data collected to determine general acceptability of the developed plan of care as evaluated by experts in Breast Cancer Related Lymphedema management.

RESULTS

The results were fulfilled based on the systematic review and patient-care plan for Breast Cancer Related Lymphedema evaluated by experts.

What are the optimal treatment parameters of applying Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression in Breast cancer Related Lymphedema?

Complete Decongestive Therapy in combination with IPC must be 15 sessions, in which the IPC pressure used was between 40-50 mmHg for 30 minutes during intensive phase and 60 minutes in maintenance phase.

What stage of Breast cancer Related Lymphedema is Complete Decongestive Therapy with Intermittent Pneumatic Compression most effective?

CDT in combination with IPC is most effective in stage 2 BCRL.

What phase of lymphedema treatment is Complete Decongestive Therapy with Intermittent Pneumatic Compression most effective?

CDT in combination with IPC is most effective in both intensive phase and maintenance phase of lymphedema treatment.

Are there any reported adverse effects associated in the use of Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression?

There were no reported adverse events associated in the use of Complete Decongestive Therapy in combination with IPC in BCRL

What Physical Therapy patient plan of care for Breast cancer Related Lymphedema can be developed based on the results of the systematic review?

The researcher developed a Physical Therapy patient plan of care for Breast Cancer Related Lymphedema.

Patient Evaluation

Following treatment for breast cancer, the onset of lymphedema is insidious and is typically characterized by slowly progressive swelling of the upper extremity ipsilateral to the axillary node dissection or radiation treatments. Typical signs and symptoms of lymphedema include progressive upper extremity swelling, skin changes, limb pain and discomfort, restricted range of motion, and nonpitting edema. At first, the swelling may be apparent only in the proximal portion of the limb, or it can affect only a portion of the distal limb including the digits. The most common methods in determining volume in clinical practice are water displacement and circumferential measurements. Insertion of the arm into a water-filled volumeter causes a water volume equal to the inserted arm volume to be displaced and captured as overflow. While circumferential tape measurements are completed with a non-stretch tape measure and at multiple points on each arm. Lymphedema is commonly diagnosed when a 2 cm difference or more in arm circumference at a single anatomic level measured or a 200 ml limb volume difference or more between the affected and nonaffected limbs is observed.

Phase 1 – Intensive or Reductive Phase

During this phase, daily treatment will commence for fifteen (15) sessions, five days a week for three (3) weeks. It will start with first component of Complete decongestive therapy (CDT) which is manual lymphatic drainage (MLD) for thirty (30) minutes, followed by Intermittent Pneumatic Compression (IPC) set at forty to fifty (40-50) mmHg pressure for thirty (30) minutes. Then application of short stretch compression bandage for twenty-three (23) hours. Decongestive exercises should be performed while wearing a compression bandage. During the two-day rest period it is recommended to continue MLD and apply a short stretch bandage. This phase aims to reduce the size of the extremity, reverse any distortion in the shape, soften the subcutaneous tissue, and improve the overall health of the skin. Proceed to maintenance phase after 15 sessions.

Phase 2 – Maintenance Phase

Phase II is conducted five (5) days a week in an outpatient setting or at home. This phase begins immediately after the first phase, with the aim of maintaining the first phase's achievements and requiring the patient's and/or family lifelong commitment. MLD will be replaced with IPC at a pressure of forty to fifty (40-50) mmHg for sixty (60) minutes. During the day, a Class 2 compression garment with a pressure of 20-30mmHg will be used. To maintain containment, this will be replaced at night with a short stretch compression bandage. Continue decongestive exercises while wearing a compression garment and bandage. Additionally, for the remaining two days of the week, it is recommended to wear the daytime compression garment and short stretch compression bandage at night.

At the end of treatment, remeasurement of limb volume reduction is a typical approach to quantify the extent of lymphedema and evaluate the therapeutic efficacy. A monthly reassessment will be conducted to monitor the size of the affected extremity. Return to intensive phase if the circumference of the affected extremity increased by more than 2 cm or the limb volume increased by more than 200 ml from baseline. And if the circumference of the affected extremity remains less than 2 cm or the limb volume remains less than 200 ml from baseline, continue with the maintenance phase. It is imperative to check compression bandages and garments to see if they need to be replaced.

What is the general acceptability of the developed plan of care as evaluated by experts in Breast cancer Related Lymphedema management?

Table 1 General acceptability of the developed plan of care as evaluated by experts in Breast Cancer Related Lymphedema management

Indicators	Weighted Mean	Interpretations	Rank
Parameters 1.I find recommended pressure acceptable, and safe for the treatment of BCRL.	4.40	Agree (Acceptable)	
2. I find the recommended treatment duration/time acceptable for the treatment of BCRL	4.60	Strongly Agree (Highly Acceptable)	
Averageweighted mean	**4.50**	Agree (Acceptable)	2

Procedure 1. I find the treatment algorithm helpful in the clinical decision making for the management of BCRL	4.40	Agree (Acceptable)	
2. I find the flow of interventions appropriately arranged for each phase of treatment.	4.20	Agree (Acceptable)	
Averageweightedmean	**4.30**	Agree (Acceptable)	4
Effectiveness 1. I believe the developed plan of care can significantly reduce breast cancer related lymphedema.	4.60	Strongly Agree (Highly Acceptable)	
2. I believe the developed plan of care is effective in controlling breast cancer related lymphedema.	4.80	Strongly Agree (Highly Acceptable)	
Averageweightedmean	**4.70**	Strongly Agree (Highly Acceptable)	1
Willingness to use 1. I will use this plan of care for the treatment of my BCRL patients	4.40	Agree (Acceptable)	
2. I will recommend this plan of care to my colleagues who are treating BCRL patients.	4.40	Agree (Acceptable)	
Averageweightedmean	**4.40**	Agree (Acceptable)	3
Overallweightedmean	**4.47**	Agree (Acceptable)	

DISCUSSION

The results are discussed and tabulated, with corresponding inferences and interpretations.

What are the optimal treatment parameters of applying Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression in Breast cancer Related Lymphedema?

Complete Decongestive Therapy in combination with IPC must be 15 sessions, in which the IPC pressure used was between 40-50 mmHg for 30 minutes during intensive phase and 60 minutes in maintenance phase. This coincides with the studies of Sanal-tropak et al., (2019) concluded that these parameters confirmed significant improvement ($p<0.05$) in the five measurement levels of the arm circumference. Similarly, shoulder ROM, pain, tightness, and heaviness sensations improved in both groups ($p<0.05$). Meanwhile, Tastaban et al., (2020) confirmed that IPC in combined with CDT significantly reduced the excess volume and sensations of heaviness and tightness for the patients with pitting edema. Moreover, Kozanoglu et al., (2022) revealed the long-term effects of combined therapy, not only have significant improvements in the circumference difference and grip strength also visual analog scale values for arm pain and shoulder pain during motion were declined.

What stage of Breast cancer Related Lymphedema is Complete Decongestive Therapy with Intermittent Pneumatic Compression most effective?

CDT in combination with IPC is most effective in stage 2 BCRL. Wherein at this stage, lymphedema is consistent volume change with pitting present and elevation rarely reduces the swelling and progressive tissue fibrosis occurs. Forner-Cordero et al., (2021) assessed these conservative treatments to 194 lymphedema patients with stage II BCRL. All patients improved after treatment and global mean of percentage reduction in excess volume (PREV) was 63.9%. Likewise, De Vrieze et al., (2022) recruited unilateral BCRL patients, were all received standardized lymphedema treatment during the 3-week intensive phase and 18 sessions of 30 minutes during the 6-month maintenance phase. There was a significant improvement in local tissue water, skin thickness, fibrosis, and flexibility in all participants. Another study by Liu et al., (2023) explored the effect of these conservative approaches, the volume and arm circumferences on stage 2 BCRL. Results proved that the volume and circumference after the treatment was lower than their baseline and the difference was statistically significant ($p < 0.05$). of affected arms were measured before and after treatment

What phase of lymphedema treatment is Complete Decongestive Therapy with Intermittent Pneumatic Compression most effective?

CDT in combination with IPC is most effective in both intensive phase and maintenance phase of lymphedema treatment. The findings were supported by Keskin et al., (2020) results showed that the median percentage reduction of excess volume was 27.7%. The history of skin infection was related to lower percentage reduction of excess volume ($P = 0.001$). Likewise, Michopoulos et al., (2020) evaluated the effectiveness and safety in the Greek population with lymphedema. The edema's excess volume (EV) and percent of excess volume (PEV) measurements were carried out four times in the treatment period, whereas the percent reduction of excess volume (PREV) was calculated at the end of phase I. A significant reduction ($p<0.001$) between the pre-treatment and post-treatment values of EV and PEV was found patients with upper limb lymphedema. The study concluded that a proper treatment of phase I ensures safety and a great reduction in edema in patients with lymphedema that influences the success of phase II. Furthermore, Borman et al., (2022) evaluated the functional status and quality of life (QoL) in the intensive phase. QoL was assessed by the European Organization for Research and Treatment of Cancer Core Cancer Quality of Life Questionnaire (EORTC QLQ-C30). Fifty females with mean age of 53.22 ± 11.2 years were included. The median duration of lymphedema was 12 months. The mean baseline limb and excess volumes were significantly decreased at the end of therapies. The Q-DASH and EORTC QLQ-C30 scores were also decreased significantly ($P< 0.05$)

Are there any reported adverse effects associated in the use of Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression?

there were no reported adverse events associated in the use of Complete Decongestive Therapy in combination with IPC in BCRL. In the study conducted by Michopoulus et al., (2021) results showed significant reduction 66.5% (interquartile after upper-limb Complete Decongestive Therapy, it was also observed no episodes of infection, sore, or pain during the treatment were recorded because of the proper skin and nail care, contributing to success of Complete Decongestive Therapy intervention. Likewise, it was mentioned in the study of Pajero et al., (2022) the adverse effects were light and included itching, reddening, and skin peeling, with no significant differences. No participant suffered serious adverse effects during any of the treatments. Moreover, De sire et al., (2021) piloted a study aimed to evaluate the efficacy of a synergistic treatment with Manual Lymphatic drainage and Intermittent Pneumatic Compression in reducing lymphedema in Type 2 Diabetes mellitus patients. The

results showed a significant decrease in limb lymphedema with no adverse effects, such as a fibrous tissue ring over the device sleeve's proximal border.

What is the general acceptability of the developed plan of care as evaluated by experts in Breast cancer Related Lymphedema management?

As to parameters, "I find recommended pressure acceptable, and safe for the treatment of Breast cancer Related Lymphedema" got a weighted mean of 4.40 while "I find the recommended treatment duration/time acceptable for the treatment of Breast cancer Related Lymphedema" had a weighted mean of 4.60. The average weighted mean of the recommended parameters was 4.50 and was ranked 2 which considered as acceptable parameters of the developed plan of care as evaluated by experts in Breast cancer Related Lymphedema management. One of the treatment parameters evaluated and accepted by the experts in the developed plan of care was the importance of compression therapy to treat lymphedema. This was confirmed in the study of Anuszkiewicz et al., (2023). That the main rule was to progressively reduce the pressure gradient from the highest in the distal wrist area to the lowest toward the arm and facilitates the movement of lymphatic fluid upward. Blom et al., (2022) investigated the proportion of women with mild Breast cancer Related Lymphedema, if they showed improvement of lymphedema after treatment with or without compression garments, differences in changes of lymphedema relative volume, local tissue water and subjective symptoms for 6 months.

Changes in local tissue water were measured by Tissue Dielectric Constant. Results showed greater reduction in lymphedema relative volume, at all time-points ($p \leq 0.005$), and in the highest Tissue Dielectric Constant ratio, when same site followed, at 6 months ($p = 0.025$), and subjective symptoms experienced reduced tension at ($p = 0.008$). It was verified that compression therapy was efficient in volume reduction in the early stage of lymphedema. McNeely et al., (2021) likewise conducted a parallel 3-arm, multicenter, randomized trial. Women were recruited from 3 centers in Canada and randomized to 3 groups. The primary outcome was the change in excess arm volume from the baseline to 12 weeks. Participants from all groups used a nighttime compression system garment from weeks 13 to 24. After the intervention, the addition of nighttime compression was found to be superior to standard care for both absolute milliliter reductions ($P = .006$) while the percentage reductions ($P = .002$) in excess arm lymphedema volume. Also significant within-group changes were seen for quality of life across all groups. The results of this multicenter randomized-controlled trial established a significant improvement in arm lymphedema volume from the addition of nighttime compression to daytime compression therapy.

As to procedure, "I find the treatment algorithm helpful in the clinical decision making for the management of Breast cancer Related Lymphedema" got a weighted mean of 4.40 while "I find the flow of interventions appropriately arranged for each phase of treatment" had a weighted mean of 4.20. The average weighted mean of the recommended procedures was 4.30 and was ranked 4 which considered as acceptable procedures of the developed plan of care as evaluated by experts in Breast cancer Related Lymphedema management. The experts responded to this developed plan of care find the treatment algorithm valuable in the clinical decision making and the flow of interventions on each phase of treatment in the management of Breast cancer Related Lymphedema. Donahue et al., (2023) summarized current Breast cancer Related Lymphedema prevention and treatment strategies. It was emphasized that early detection and appropriate care are vital to reduce the incidence and progression of Breast cancer Related Lymphedema. Complete decongestive therapy remains the standard of care for patients with Breast cancer Related Lymphedema and Intermittent pneumatic

compression, performed favorable in lymphedema management. It was found that progress in the prevention and treatment of Breast cancer Related Lymphedema continues, requiring advancements in early diagnosis, patient education, competent consensus, and the above-mentioned conservative therapies intended for lymphatic rehabilitation. Tastaban et al., (2020) confirmed that IPC in combined with CDT significantly reduced the excess volume and sensations of heaviness and tightness for the patients with pitting edema. Moreover, Kozanoglu et al., (2022) revealed the long-term effects of combined therapy, not only have significant improvements in the circumference difference and grip strength also visual analog scale values for arm pain and shoulder pain during motion were declined.

As to effectiveness, "I believe the developed plan of care can significantly reduce breast cancer related lymphedema" got a weighted mean of 4.60 while and "I believe the developed plan of care is effective in controlling breast cancer related lymphedema" had a weighted mean of 4.80. The average weighted mean of these two points was 4.70 and was ranked 1 which considered its effectiveness highly acceptable developed plan of care as evaluated by experts in Breast cancer Related Lymphedema management. All the experts evaluated the developed plan of care confidently believed that it could reduce and effectively control breast cancer related lymphedema. Kasseroller et al., (2023), re analyzed a previous study during a 3-week decongestion period. Sixty-one patients with unilateral breast cancer-related lymphedema were included. The patients received Complete Decongestive Therapy and Intermittent Pneumatic Compression. The patients showed a significant volume reduction (-155.23 mL (week 1), - 101.02 mL (week 2), - 61.69 mL (week 3), respectively; $p < 0.001$ each). Another study conducted by Duymaz et al., (2023) proved the efficacy of pneumatic compression in the treatment of 80 female patients with unilateral upper extremity lymphadenopathy diagnosed postoperatively in women with breast cancer who underwent mastectomy. All patients received treatment for a total of 15 sessions for 5 weeks, 3 days/week. After all the patients' age and body mass index (BMI) were recorded, the shoulder joint range of (ROMs) were measured by goniometer, circumferential measurements were measured by tape measure 4 times and on days 5, 10, and 15. When the circumferential and ROM measurements of the patients were examined, improvement was observed ($p=0.030$, 0.019, 0.044, < 0.001, and < 0.001). Moreover, Kozanoglu et al., (2022) revealed the long-term effects of combined therapy, not only have significant improvements in the circumference difference and grip strength also visual analog scale values for arm pain and shoulder pain during motion were declined.

As to willingness to use, both of the "I will use this plan of care for the treatment of my Breast cancer Related Lymphedema patients" and "I will recommend this plan of care to my colleagues who are treating Breast cancer Related Lymphedema patients" had a weighted mean of 4.40. The average weighted mean was 4.70 and was ranked 3 which considered its willingness to use an acceptable developed plan of care as evaluated by experts in Breast cancer Related Lymphedema management. The experts responded that they would utilize and recommend this developed plan of care to breast cancer related lymphedema patients. Respondents stated that the growing number of lymphedema patients requires the need for trained practitioners. This was mentioned in the study of Schulze et al., (2018) considered lymphedema as a pandemic, with around 250 million people suffering worldwide. Lymphatic diseases have significant public health implications, but few people are trained in their administration, putting a significant strain on health resources. This study was conducted to provide an overview of the approximate number of medical experts, professional groups, institutes, and companies dealing with lymphoedema in various nations. Findings showed the distribution amongst experts specialized in this discipline was uneven. The decline in

professional numbers can be identified across developed and developing countries, as well as between rural and urban areas. Countries did not meet the current need for tertiary level specialists in the field. Additionally, Anderson et al., (2019) entitled Lymphoedema therapists: a national and international survey, revealed that the American Lymphedema Framework Project (AFLP) surveyed lymphoedema therapists in the US in 2009 to describe their preparation, patient population, and care practices. The survey was expanded to trained therapists worldwide to describe and compare current and past therapist characteristics and practices. This survey also confirmed from 950 lymphedema therapists' most reported treatments were the various components of Complete Decongestive therapy. Less than 15% of therapists reported providing pneumatic compression devices, aquatic treatment, low-level laser, vibrator treatment, compression bandage only, reflexology, or other treatments. The majority (55%) of therapists recommended seven or more therapy alternatives. All the experts responded to this study mentioned that they will try to utilize this developed plan of care to other types of lymphedema such as head, neck, and lower extremity.

To sum the overall weighted mean of 4.47 revealed that the experts agreed and considered the developed plan of care acceptable in Breast cancer Related Lymphedema management.

CONCLUSIONS

Based on the salient findings of the study, the following conclusions were drawn: (1) Optimal treatment parameters should be followed to ensure effectiveness of Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression in Breast cancer Related Lymphedema, (2) Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression is an effective treatment for Breast cancer Related Lymphedema, (3) Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression can be used safely for the treatments in Breast cancer Related Lymphedema, (4) Adverse effects are expected, however, these are well tolerated by patients and (5) Experts recommended utilizing Complete Decongestive Therapy in combination with Intermittent Pneumatic Compression in Breast cancer Related Lymphedema.

In light of the findings and conclusions, the following are offered as recommendations for possible actions.

The researcher recommends the developed plan of care to Filipino physical therapist managing patients with breast cancer-related lymphedema. They should consider the individual's clinical presentation, patient preferences, and goals. This developed plan of care will be beneficial beginning with breast cancer diagnosis and continuing through cancer treatment and survivorship.

Similarly, the researcher recommends this developed plan of care for breast cancer related lymphedema patients, empowering knowledge about their condition helps them understand the rationale behind interventions, and self-management strategies which are necessary for their active participation and long-term success.

Furthermore, the researcher firmly recommends that all hospitals address the shortage of qualified healthcare practitioners dealing with breast cancer related lymphedema. Increasing the number of Complete Decongestive Therapy-trained personnel that will educate, support, and manage this unique patient population. Collaboration with other healthcare professionals,

including physicians, nurses, and allied health practitioners, is essential to delivering comprehensive patient care.

Lastly, the researcher recommends to future researchers the developed plan of care and its parameters be implemented to other types of lymphedema, such as lower extremity, head, and neck. This will further determine its effectiveness and contribute to the continuous improvement and development of another treatment plan of care.

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