THE DEVELOPMENT OF AN E-LEARNING RESOURCE ON LOWER LIMB LYMPHEDEMA FOR CONTINUING CARE NURSES

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Abstract

Background: Lymphedema is a progressive condition that leads to a build-up of fluid in the interstitial spaces, often causing swelling to a limb. The condition is thought to be under-recognized and under-treated. Continuing care nurses (CCNs) are expected to treat and manage lower limb lymphedema in the community setting, but many lack the knowledge and skills to manage this care safely. **Purpose:** To develop an e-learning resource for CCNs at Central Health on the assessment, treatment, and management of lower limb lymphedema in the community setting. **Methods:** 1) comprehensive literature review, 2) consultations with CCNs and other key stakeholders at Central Health, 3) environmental scan to find existing e-learning resources, and 4) development of an e-learning resource. **Results:** The literature supported that lymphedema was under-recognized, under-treated, and a neglected public health issue. The consultations supported a need for education on lymphedema and key topics were identified to cover in the e-learning modules. In the environmental scan, there were no e-learning resources specific to CCNs found. Based on the findings from the literature review, consultations, and environmental scan, an e-learning resource was developed. The resource consists of three modules that cover an overview of lymphedema, assessment, treatment, and management of lower limb lymphedema. The modules contain reflective exercises, case studies, interactive activities, and quizzes to test knowledge and provide information on lymphedema. **Conclusion:** This e-learning resource will be available through the Learning Management System at Central Health, with the expectation that CCNs complete the three modules prior to attending a one-day workshop on lymphedema management.

Keywords: lymphedema, lymphoedema, chronic edema, lower limb, lower leg, lower extremity, prevalence, impact, assessment, treatment, management, e-learning, adult learning

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To those who work in lymphedema research and practice, thank you for sharing any known e-learning resources. The lymphedema community may be small but is globally connected online.

To those who live with lymphedema/chronic edema, I hope that by informing and educating others, the treatment and management of lymphedema will improve.

This practicum project is dedicated to my son, James, who lives with primary lymphedema. He is why I involved myself initially in lymphedema care and why I continue to be passionate about teaching others about lymphedema/chronic edema.

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Lymphedema/chronic edema is a progressive condition that has been defined as a swelling that lasts more than three months (Keast et al., 2019; Moffatt et al., 2019). The chronic swelling causes impairment or failure of the lymphatic system to drain fluid from the interstitial spaces back to the venous system resulting in fluid congestion in the affected area (Moffatt et al., 2019; Thomas et al., 2017). Lymphedema usually affects a limb but may affect the head, neck, trunk, or genital regions of the body (Franks et al., 2006; Klernäs et al., 2017; Moffatt et al., 2003). Described as a hidden global epidemic that is under-recognized and under-treated, lymphedema/chronic edema affects millions worldwide (Keast et al., 2019; Moffatt et al., 2019). The terms lymphedema and chronic edema are often used interchangeably, resulting in some confusion around a standard definition. Most current definitions consider all chronic edema as lymphedema (Keast et al., 2019; Moffatt et al., 2019). For this practicum project, either term was used, indicating one of the same conditions.

There are increasing numbers of people living in the community with lymphedema/chronic edema (Morgan et al., 2005; Thomas et al., 2017; Todd, 2014). Continuing care nurses (CCNs) at Central Health are often required to treat and manage clients in the community who have chronic edema in their lower limbs. Various co-morbid conditions may contribute to the development of lower limb edema, such as morbid obesity, chronic venous insufficiency, cardiovascular disease, peripheral vascular disease, renal disease, respiratory disease, immobility, trauma, cancer, repeated skin infections, and genetic or hereditary causes (Todd, 2018). Despite the many causes, the treatments and management of all types of chronic edema remain similar. Continuing care nurses need to have the necessary skills to assess and treat this condition, including a knowledge base of when a further medical assessment is required before any treatments are carried out. The continuing care nurse (CCN) must also have the

knowledge to teach their clients to self-manage their condition, while involving the client as a true partner in their care.

Past evaluations of a mandatory one-day workshop on lymphedema management have highlighted the need for CCNs to have additional skills, information, and education on lymphedema/chronic edema to manage their clients in the community more efficiently and effectively. This was the impetus for the practicum project and the development of an e-learning resource on the assessment, treatment, and management of lymphedema. The development of the e-learning resource was not meant to take the place of the face-to-face workshop but to provide an additional resource to the CCNs for them to complete prior to attending the one-day workshop held at Central Health. The resource will also be available to the CCNs on an as-needed basis should they need to refer or review.

Goal and Objectives

The overall goal of this practicum project was to develop an evidenced-based e-learning resource for the CCNs of Central Health on the assessment, treatment, and management of lower limb lymphedema in the community setting.

The practicum objectives were:

1. To assess the learning needs of CCNs at Central Health in caring for clients with lower limb lymphedema;
2. To identify available e-learning resources and assess their relevance to the proposed project on the development of an e-learning module for the assessment, treatment, and management of lower limb lymphedema;
3. To determine if community nurses have a knowledge deficit about lymphedema, and if so, to identify what are the gaps in their knowledge;

4. To investigate why a gap in lymphedema care is a problem and how it may be addressed through education delivery;
5. To develop the e-learning module on the assessment, treatment, and management of lower limb lymphedema for the continuing care nurses of Central Health; and
6. To demonstrate advanced nursing practice competencies.

Overview of Methods

There were several methods used in the development of this practicum project. A literature search was conducted, and current evidenced-based literature was reviewed. The results of the review supported that community nurses had a knowledge gap about lymphedema. The review focused on what the knowledge gaps were and why these gaps were a problem. The results of the literature review helped to determine how to address these knowledge gaps through education delivery. A copy of the literature review can be found in Appendix I of this practicum report.

Consultations with key stakeholders determined that the CCNs had a knowledge gap about lymphedema. The CCNs' perceived knowledge gaps were identified through the analysis of responses to the questionnaires completed and returned. A copy of the consultation report can be found in Appendix II. An environmental scan was also completed of specified contacts to inquire about the existence of any e-learning resources on lymphedema. The environmental scan results concluded that there were no e-learning resources specific to lower limb lymphedema available. A copy of the environmental scan report can be found in Appendix III of this practicum report.

The combined results of the literature review, consultations, and environmental scan supported the decision to develop the e-learning resource on the assessment, treatment, and

management of lower limb lymphedema for the CCNs at Central Health. The e-learning resource was developed based on these findings, which represented the completion of this project's overall goal. A copy of the e-learning resource can be found in Appendix IV of this practicum report.

Summary of the Literature Review

A comprehensive literature search was conducted using the electronic databases: The Cumulative Index to Nursing and Allied Health Literature (CINAHL); PubMed; and Nursing and Allied Health Database. A librarian's service from Memorial University was utilized to assist with the literature search plan and to narrow the search. Keywords, such as lymphedema, lymphoedema, chronic edema and lower limb, lower leg, and lower extremity, were used to begin the search. Additional keywords such as prevalence, impact, assessment, treatment, management, e-learning, face-to-face learning, nursing education, adult learning, staff development, and training were further used to focus the search. Date boundaries of 15 years were applied. Once article titles were scanned and relevant articles reviewed, nine studies were chosen for critical appraisal.

The nine studies chosen to inform the review consisted of four qualitative studies and five quantitative studies. The qualitative studies were critically appraised using the Critical Appraisal Skills Program (CASP; 2020) tool for qualitative studies. The quantitative studies were reviewed using the Public Health Agency of Canada (PHAC; 2014) critical appraisal tool kit for quantitative research. Of the four qualitative studies reviewed, two of the studies, one by Morgan et al. (2005) and the other by Watts and Davies (2017), used focus groups. The other two qualitative studies by Hodgson et al. (2011) and Glogowska et al. (2011) used participatory action research and a narrative design, respectively. All four qualitative studies were of medium

credibility. The five quantitative studies consisted of two randomized controlled trials (RCTs), one by Bloomfield et al. (2010) and the other by Keefe and Wharrad (2012), two non-randomized controlled trials (NRCTs) by Mehrdad et al. (2011) and Sung et al. (2008), and an uncontrolled before and after (UCBA) study by Thomas et al. (2017). The RCTs and NRCTs were of strong design and medium quality. The UCBA study was considered a weak design of low quality. The literature summary tables located in the literature review further describe these studies in detail and can be found in the appendix of the literature review located in Appendix I of this report.

The review of the literature showed that there was evidence to support that knowledge gaps in lymphedema care existed, and this was a problem. Research by Keast and Towers (2017) and Moffatt et al. (2019) supported that lymphedema was a problem but acknowledged there was limited understanding of the true prevalence of lymphedema. Studies by Morgan et al. (2005), Thomas et al. (2017), and Watts and Davies (2017) confirmed there were increasing numbers of people living with lymphedema/chronic edema in the community setting. While studies confirmed that community nurses needed to play an integral role in caring for persons with lymphedema (Morgan et al., 2005; Thomas et al., 2017), there was limited research on how to do this. Only two studies, one by Thomas et al. (2017) and the other by Watts and Davies (2017), addressed an educational strategy for community nurses on lymphedema care. A common theme that emerged from the literature was that lymphedema was under-recognized, under-treated, and a neglected public health concern (Keast et al., 2019; Moffatt et al., 2019; Rockson & Rivera, 2008).

There were no studies found that used e-learning in the education of community nurses in the care of persons with lymphedema. Therefore, the search was broadened to include the use of

e-learning with nurses in other areas of health-related care. The aim was to determine if e-learning might be of benefit for providing information and education to nurses.

Five studies were reviewed. They supported various aspects of e-learning and lecture-based learning with nurses and nursing students in the health care setting. These studies by Bloomfield et al. (2010), Glogowska et al. (2011), Keefe and Wharrad (2012), Mehrdad et al. (2011), and Sung et al. (2008) suggested potential advantages and disadvantages to e-learning. Of importance, Glogowska et al., Keefe and Wharrad, Mehrdad et al., and Sung et al. suggested that blending e-learning with traditional face-to-face learning should be considered in nursing education. Bloomfield et al., Glogowska et al., Keefe and Wharrad, and Sung et al. further suggested that e-learning was flexible, which allowed nurses to learn on their own time and pace. Therefore, considering this research, it was determined that using a blended form of learning that uses a combination of e-learning and face-to-face learning may improve how education is delivered to the CCNs at Central Health.

Based on the limited evidence found, the completion of the literature review supported the plan to develop an e-learning resource on the assessment, treatment, and management of lower limb lymphedema. The literature review did not address what nurses specifically needed to know about lymphedema. Therefore, it did not guide content for the resource. Two studies by Thomas et al (2017) and Watts and Davies (2017) that studied aspects of an *On-the-Ground* education program did not address specifics in what the education program included, but focused more on the potential economic benefits and impact of offering the program. There were no studies found about teaching nurses about lymphedema. Therefore, literature about teaching nurses about other health issues were sought to support the teaching method of e-learning. The

development of the resource would not replace the face-to-face teaching already offered to the CCNs of Central Health but would aim to enhance the learning method already in place.

As part of the literature review, Knowles Adult Learning Theory was discussed to understand and link the theory of adult learning with how CCNs were motivated to learn. The adult learning theory by Knowles (1984) was described in Candela (2020) and suggested that nurses draw on past experiences when learning and use these experiences to guide them in their work. These experiences help the nurse to focus on what might be relevant in their daily work and what might motivate them to learn. The CCNs at Central Health had revealed, through consultations, a need for useful education and training that would benefit their daily work. The CCNs suggested e-learning was an additional resource that could be accessed as needed and on their own time, allowing for greater flexibility and self-directedness in learning. The studies reviewed by Bloomfield et al. (2019), Glogowska et al. (2011), Keefe and Wharrad (2012), and Sung et al. (2008) all supported the advantages of the flexibility and convenience of e-learning. This was consistent with adult learning theory and the importance of adult learning to be flexible and convenient.

In summary, the outcome of the literature review was used to inform the development of the e-learning resource on the assessment, treatment, and management of lower limb lymphedema. The literature review did not inform the content of the resource. The studies reviewed confirmed that there were increasing numbers of people living in the community with lymphedema (Morgan et al., 2005; Thomas et al., 2017; Watts & Davies, 2017). Morgan et al. (2005) and Watts and Davies (2017) also suggested community nurses would be needed to care for these clients with lymphedema in the community setting. However, there were limited studies on how nurses should address these issues. Only two studies addressed an educational strategy to

teach community nurses about lymphedema. Additional studies that were reviewed to find educational strategies for teaching nurses suggested that e-learning might be of benefit and that a blended learning approach that incorporates e-learning with traditional face-to-face learning should be considered when teaching nurses. These findings supported that e-learning might be a valuable added learning resource for providing information and education to the CCNs at Central Health that would supplement the face-to-face workshop already offered on lymphedema management. The development of an e-learning resource was considered relevant and useful to the CCNs in their practice and the nurses believed the resource would add flexibility and convenience to their learning. This finding was consistent with adult learning theory and the principle of relevance discussed in Candela (2020).

Summary of Consultations

Consultations were held with two groups of stakeholders at Central Health. The two groups consisted of 71 CCNs and four nurse colleagues. The four nurse colleagues were the Manager of Home and Ambulatory Services, Director of Home and Ambulatory Services, Regional Enterostomal Therapy Coordinator, and the Clinical Lead – Home and Community Nursing. Each group were emailed a group-specific questionnaire requesting input on the perceived learning needs for the CCNs on caring for clients with lower limb lymphedema. Having input from those who might benefit from the development of an e-learning module aimed to ensure the learning needs of CCNs were considered and addressed. A copy of the completed consultation report can be found in Appendix II of this practicum report.

Sixteen CCNs and four nurse colleagues completed and returned the voluntary questionnaires. The questionnaires were group-specific and structured, consisting of yes/no or open-ended questions. Questionnaires could be retuned anonymously if the participant preferred.

Content analysis was completed, and the responses were categorized based on similarities, which created themes. While this project did not require review by the Health Research Review Board, a Health Research Ethics Screening Tool was completed. It can be found in the appendix of the consultation report located in Appendix II of this report.

The four nurse colleagues and fifteen of the CCNs indicated that an e-learning resource on lymphedema may benefit the CCNs at Central Health. Both groups believed that e-learning on lymphedema would be considered an additional learning resource that could be used as a *refresher* and would be completed on an as-needed basis to supplement the face-to-face learning already provided in the form of a workshop at Central Health. Both groups were consistent with what content should be included in the learning resource. The groups suggested content on anatomy, physiology, and pathophysiology of lower limb lymphedema was needed. They also suggested that information and education on the assessment, treatment, and management of lymphedema were necessary to include. The nurse colleagues suggested a need to understand the links between lymphedema and obesity, cellulitis, and wounds. Other topics of interest included the use of a Doppler, completing holistic assessments, skin care, and the use of various types of compression were suggested to be included in the e-learning resource.

Participants in both groups suggested that e-learning might be a more cost-effective and a convenient way to deliver lymphedema education. The CCNs specifically requested the e-learning resource to be interactive, easy to read, and contain pictures of people with lymphedema. The CCNs also recommended using video links, which would help them learn specific skills, such as compression bandaging. While many of the CCNs still preferred face-to-face learning over e-learning, fifteen of the CCNs believed that e-learning would be of benefit to supplement the current workshop learning on lymphedema.

In consideration of the consistent themes identified between the two groups, and their support for e-learning to be used as a supplement to the current method of learning, it was concluded that the input of these two groups would be used in the development of the e-learning resource on the assessment, treatment, and management of lymphedema.

Summary of Environmental Scan

An environmental scan was conducted by targeting two groups of sources. Emails were sent to seven personal contacts and eleven website administrators to inquire about the existence of any e-learning resources they might have on the assessment, treatment, and management of lower limb lymphedema. The sources were also asked to share any e-learning resources they might have on lymphedema. The eleven website administrators were select health authorities, lymphedema organizations, and associations provincially, nationally, and internationally. The practicum project was explained, and the confidentiality of any information shared was assured. All resources shared were analyzed for relevance to the practicum project, such as content included and presentation style. A copy of the full environmental scan report can be found in Appendix III of this practicum report.

Ethical approval by the Health Research Ethics Review Board was not required. The Health Research Ethics Authority Screening Tool was completed and can be found in the appendix of the environmental scan report located in Appendix III of this practicum report.

Two personal contacts and three website administrators responded to the email. None of these sources had e-learning resources on lymphedema specific to their programs or organizations. The sources collectively provided three links to e-learning modules from other organizations. There were also suggestions to search four additional websites and to contact a researcher from Wales, United Kingdom.

None of the e-learning modules reviewed fully addressed the assessment, treatment, and management of lower limb lymphedema. Out of the four additional websites suggested, only one allowed access to e-learning without charging a fee. The Klose Training website (www.Klosetraining.com) was reviewed and provided access to four training videos on lymphedema. These videos provided some of the desired content on assessment, treatment, and management of lymphedema but were not specific to lower limb lymphedema care. The researcher from Wales was sent the same email as was sent to the sources contacted in the initial scan. This researcher provided a link to six training videos that contained basic information about lymphedema. This information was suited to patients and health care providers who might want to know more about lymphedema. These videos were not specific to nursing care or lower limb lymphedema.

All five video links/e-learning modules that were reviewed provided some of the content and presentation styles identified by the stakeholders during the consultation process. All contained components of the assessment, treatment, and management of lymphedema and were illustrated with pictures of persons with lymphedema. Four modules/videos had included content on anatomy, physiology, and pathophysiology, with causes of lymphedema, diagnosis, and signs and symptoms of lymphedema reviewed. The use of animated videos were found in three. These were all important considerations identified by the stakeholders during consultation and were pertinent to the planned development of an e-learning resource for the CCNs at Central Health.

While none of the video links/e-learning modules contained all the information needed for the CCNs, the limited resources identified were helpful to see what content was included and how technology was used to deliver the e-learning on lymphedema. The results of this environmental scan were considered, and ideas were used in the development of the e-learning

resource on the assessment, treatment, and management of lower limb lymphedema for the CCNs at Central Health.

Summary of the Resource

After completing the integrative literature review, consultation process, and environmental scan an evidenced-based e-learning resource was developed for the CCNs of Central Health. The e-learning resource consisted of three interactive e-learning modules on the assessment, treatment, and management of lower limb lymphedema. The complete resource manual can be found in Appendix IV of this practicum report.

It is the expectation that the CCNs will complete these modules prior to attending the one-day workshop on lymphedema management that is already available at Central Health. The resource will be available on the Learning Management System at Central Health and will be accessible to the CCNs at any time should they wish to review it at their convenience. The modules also will be available on the Learning Management System to any health care provider at Central Health who may want to learn more about lymphedema.

The e-learning resource was based on the literature review findings, consultations with stakeholders, and the environmental scan. The e-learning resource contains the evidenced-based information and education necessary for the CCNs to care for clients with lymphedema in the community setting. While each of the three e-learning modules contained in the resource manual focuses on specific topics, the modules consistently use the same format for the learner.

Each of the e-learning modules contains:

- An introduction
- A list of learning objectives
- Content relevant to the module topic

- A reflective exercise
- Illustrations, photographs, and tables
- Links to educational videos
- Links to additional learning or information
- A case study
- An interactive exercise
- A quiz
- A conclusion

As the CCN progresses through the modules, they are invited to partake in the various activities the modules offer. The material is written in an easy to understand context, utilizing photographs, illustrations, tables, and videos to support further and make relevant the learning for nurses. While there was no one e-learning resource found during the environmental scan that fully addressed community nurses' learning needs, ideas were taken from the modules/videos reviewed to assist with decisions on content to include and how to present the information through an e-learning context. Any terms identified throughout the modules that might require further explanation were initially bolded and can be found in the glossary section located in Appendix A of the e-learning resource. A copy of the e-learning resource can be found in Appendix IV of this practicum report.

The first module is an overview of lymphedema. This module defines lymphedema/chronic edema in broad terms and why lymphedema is a problem. The module contains information on the prevalence and impact of lymphedema and why community nurses need knowledge about lymphedema. The basic anatomy, physiology, and pathophysiology of the lymphatic system were described using illustrations and videos to explain the different concepts

and how the lymphatic system and cardiovascular system work together. The module also contains an overview of the types and causes of lymphedema and a link to additional learning on lymphedema should the learner wish to learn more.

The reflection exercise and case study encourage the learner to think about their own experience with clients and lymphedema and then apply their knowledge through use of critical thinking in a case study. The interactive exercise uses a *drag and drop* format to engage the learner to apply their knowledge of how fluid moves between the circulatory system and lymphatic system. Finally, a quiz consisting of *true* and *false* questions aims to test information retained on completion of the module. The answer keys for Module One can be found in Appendix B of the e-learning resource manual.

The second module focuses on the assessment of lower limb lymphedema. This module covers the different stages of lymphedema and describes the basic skin assessment and characteristics associated with the different stages of lymphedema. The module also provides information on how obesity, cellulitis, and wounds may contribute to the development of lymphedema. Assessment considerations and possible contraindications for compression are identified such as identifying lower limb characteristics seen in venous and arterial disease, and how, when, and why a Doppler assessment is calculated and conducted. The module focuses on what history should be taken and what physical assessment should be carried out. This includes conducting a basic lower limb assessment, documentation, and basic limb circumference measurement of lower limbs.

The reflection exercise and case study require the learner to reflect on what they would look for in their clients with lymphedema and requires the learner to apply their knowledge of assessment to complete the questions in the case study. These exercises encourage the learner to

think critically about assessment of clients with lymphedema. Colourful pictures, videos, illustrations, and additional links to learning aim to further enrich the learner's e-learning experience. The interactive activity uses a *drag and drop* exercise to examine if the learner can take the information provided and use the information to calculate an ankle brachial pressure index assessment. Finally, the quiz uses a multiple-choice questioning format to test retention of information presented. The answer keys for Module Two can be found in Appendix C of the e-learning resource manual.

The third module focuses on the treatment and management of lower limb lymphedema in the community setting. The learner should be able to name the basic components of lymphedema management and be able to describe the current treatments for managing lymphedema. The various types of compression used in treating lymphedema are discussed with pictures to aid the learner in identifying the different types of compression systems. Videos are used to engage the learner in how to measure for compression stockings and how to don and doff compression stockings. The use of images and videos throughout the module aims to provide practical information to the learner for use in their day to day practice.

The interactive activity uses a *drag and drop* exercise to further emphasize the five basic components of lymphedema management. Finally, a multiple-choice quiz tests information retained upon completion of the module. The answer keys for Module Three can be found in Appendix D of the e-learning resource manual.

The three e-learning modules are housed in the e-learning resource, which also contains a pre-test, post-test, glossary of terms, and appendices containing the answer keys to the various case studies, interactive activities, and quizzes contained within the individual modules. The CCNs are encouraged to take the pre-test before starting the e-learning modules to self-assess

what they might already know about lymphedema care. Upon completing the three modules, the CCNs are again encouraged to take the same test as a post-test to self-assess if any additional learning or information has been retained.

In developing this e-learning resource, it was very important to create an e-learning resource that addressed the identified knowledge gaps in lymphedema care within the community setting. It was also important that the content of the modules would cover what was important and relevant to the CCNs and applicable to their practice. The majority of the CCNs and all of the nurse colleagues consulted during the consultation process identified that an e-learning resource would be an additional learning resource and of potential benefit to the CCNs in learning about the assessment, treatment, and management of lower limb lymphedema in the community setting. More importantly, the CCNs and nurse colleagues believed the resource would address a gap in care for persons with lower limb lymphedema in the community setting. The demonstrated interest by the CCNs during the consultations was considered a positive step towards motivating the CCNs to learn more about lymphedema care. The ability of CCNs to avail of their learning in a setting that would be convenient and accessible at any time was also seen as a motivating factor. Creating an e-learning resource to draw on the experiences of the CCNs through the completion of various activities, such as reflective exercises and case studies aimed to engage the CCNs to make evidenced-based decisions in care.

Understanding what motivates nurses to learn and how nurses use their experience to learn is consistent with Knowles' (1984) Adult Learning Principles, described by Candela (2020), and was what provided the theoretical framework for the development of this e-learning resource. The Adult Learning Principles that specifically guided the development of the e-learning resource were the principles of *Relevance* and *Experience.* The principles of relevance

and experience suggested that learners want to learn what is relevant to them and will use their experience when learning new things. This was facilitated in the resource by including content that was identified by the CCNs as relevant and then engaging the learner with critical thinking exercises so that the CCNs could use their experience when completing the activities. While the motivation to learn is thought to be internal, the development of this e-learning resource was considered relevant to the CCNs in their daily practice and was intended to provide a convenient additional learning resource that the CCNs will use to learn about the assessment, treatment, and management of lower limb lymphedema. The resource more importantly is meant to prepare the CCNs for the mandatory one-day workshop on lymphedema and provide a blended learning experience for the CCNs at Central Health.

Discussion of Advanced Nursing Practice (ANP) Competencies

The Canadian Nurses Association (CNA; 2019) has developed advanced nursing competencies, which align with the CNA's core competencies. These competencies act to guide nurses in their designated role as a nurse and in their clinical environment. It is the responsibility of the individual nurse to practice safe and ethical care. On the completion of this practicum project, I have demonstrated elements of four of these competencies. The four competencies demonstrated are *Educational competencies, Research competence, Leadership, and Consultation and collaboration.* Some of the ANP competencies demonstrated throughout this practicum project include the following:

1. Educational competencies:
    - The CNA indicates the advanced practice nurse (APN) is committed to the professional growth and education of all health care providers, clients, and their families. This was demonstrated by the completion of the e-learning resource for

the CCNs on the assessment, treatment, and management of lower limb lymphedema. The completed resource is evidence-based and will be accessible to all nurses and health care providers at Central Health to address their learning needs on lower limb lymphedema care.

- The CNA indicates the APN is committed to educating health care providers, which may be accomplished through planning and coordinating educational programs, identifying nursing and other health care provider needs, and/or identifying the needs of the clients served. During the practicum, I demonstrated the ability to plan for an educational program by conducting the literature review, consultations, and environmental scan to identify the learning needs of the CCNs in developing the e-learning resource. The results were used in the development of the e-learning resource content and the educational strategies used to create the e-learning resource.
- The APN may choose to disseminate new knowledge through presentations and publications at multiple levels, such as municipal, regional, national, and international events. At this time, I have completed a PowerPoint presentation on the practicum project and presented the project to my practicum supervisor and some of the nursing faculty and nursing students at Memorial University.

2. Research competence:

    - The CNA indicates the APN should be able to identify, critically appraise, and apply research to practice. In completing this practicum project, I have completed an integrative review of the literature to identify knowledge gaps in lymphedema care. To do this, I have critically appraised quantitative and qualitative studies to

find the evidence to support the development of an e-learning resource on the assessment, treatment, and management of lower limb lymphedema in the community setting. The studies were appraised using the PHAC (2014), critical appraisal tool for quantitative studies and the CASP (2020) tool for qualitative research. The limited evidence found from reviewing the individual studies was synthesized to support the e-learning resource content.

- During the practicum project, research skills were utilized to conduct consultations with stakeholders and an environmental scan of specific contacts/sources. The consultations and environmental scan results were analyzed and utilized to determine the learning needs of the CCNs at Central Health and how best to facilitate the learning through an online medium. The results of the consultations and environmental scan were used to develop the e-learning resource.

3. Leadership:

    - Advanced practice nurses are considered leaders where they work, change agents, who seek new ways to practice and improve care for their clients. Through my work in lymphedema management, I have recognized that there are gaps in lymphedema care. This was first highlighted following the review of evaluations conducted following one-day workshops on lymphedema management at Central Health. Nurses completing the evaluations suggested there was a need for further learning on lymphedema and that e-learning might be a way to address this need. This was the impetus for this practicum project. Through consultations with management at Central Health, I have secured the support to develop an

additional e-learning resource to meet the continued learning needs of the CCNs at Central Health. My immediate manager has been kept updated on the progression of the project through completion.

4. Consultation and collaboration

    - The CNA has indicated that the APN must consult and collaborate with stakeholders and colleagues throughout the organization and on provincial, national, and international levels. I have conducted consultations and communication with other health care stakeholders through a structured consultation process and environmental scan. Through direct consultation with the CCNs and nurse colleagues, I have identified gaps in the current educational resources provided to the CCNs. Through direct consultation with the CCNs and select nurse colleagues, the learning needs of the CCNs were identified, and these needs were addressed in the development of the e-learning resource on the assessment, treatment, and management of lower limb lymphedema. I also conducted an environmental scan that reached sources nationally and internationally, who provided information on what content should be covered in the e-learning resource, as well provided ideas on how to deliver the e-learning to nurses. The results of the environmental scan helped to inform the content and presentation style of the resource.

Next Steps

The e-learning resource will be uploaded to the Learning Management System at Central Health. It is the expectation that all CCNs will complete the e-learning modules before attending the mandatory one-day workshop on lymphedema care already provided at Central Health. The CCNs will continue to have access to the e-learning resource on an as-needed basis for review at their own convenience. In addition, all health care providers at Central Health will have access to the e-learning resource should they want to learn more about lymphedema.

The plan is to present an overview of the practicum project virtually to the appropriate managers, directors, and the CCNs at Central Health. I have also accepted an invitation and confirmed a date to present this practicum project during The College of Registered Nurses of Newfoundland and Labradors' (CRNNL) Tuesday teleconference sessions in the new year. The confirmed date to present is April 27th, 2021. Finally, in the future, it is hoped that I can present at the national conference hosted by the Canadian Lymphedema Framework. Currently, the national conference has been delayed due to the pandemic restrictions affecting us globally. There may be an opportunity to present virtually if the national conference goes ahead online.

The plan will be to evaluate this e-learning resource on an ongoing basis once it is uploaded to the Learning Management System at Central Health. Upon completion, the participant will be invited to take an electronic evaluation survey of the content provided and presentation method used in the e-learning resource. This has yet to be developed, but the plan is to link the evaluation to a survey questionnaire through a software program such as SurveyMonkey® (www.surveymonkey.com).

Dulko (2007) suggested that even though nurses may complete education and are made aware of best practice, it does not necessarily mean a change in practice will take place or

evidenced-based practice will be adhered to. To evaluate the CCNs' practice, and to determine if the information and education provided to the CCNs results in a change of practice or improvements in client care, a practice audit may be considered. This might be initiated by the Regional Lymphedema Nurse who reviews the chart of a client with lymphedema to determine if the plan of care is consistent with evidenced-based practice. For example, the chart review can determine if compression is being used and if so, has there been any reduction in the client's edema. If inconsistencies are noted or care is not supported by evidence, feedback can be provided to the CCN to discuss issues with care. The CCN may need to complete additional education and training such as completing the e-learning modules again, attending the one-day workshop, or spending one-on-one time with the Regional Lymphedema Nurse who can ensure competency skills such as compression bandaging are proficient. If there is an area where CCNs consistently are not applying best practice, the e-learning modules may be revised to include more detail on a specific learning need for all CCNs.

Conclusion

The overall goal and purpose of this practicum project was to develop an evidenced-based e-learning resource for the CCNs of Central Health on the assessment, treatment, and management of lower limb lymphedema in the community setting. This was accomplished by conducting an integrative literature review, consultations with stakeholders, and an environmental scan to determine community nurses' learning needs in caring for persons with lower limb lymphedema in a community setting. Evidence gathered from the studies reviewed supported a knowledge gap in lymphedema care, with limited evidence to support a strategy for addressing this gap. The consultations and environmental scans further clarified the learning

needs of the CCNs on lymphedema care and how to best address the delivery and design of an e-learning resource for the CCNs of Central Health.

In this final report, an overview of the methods used was detailed, along with summaries of the literature review, consultations, environmental scans, and e-learning resource. Copies of the full reports of these summaries and the e-learning resource can be found in appendices A, B, C, and D, respectively which are included at the end of this practicum report.

The process of developing this e-learning resource allowed me to demonstrate advanced nursing competencies in the areas of education, research, leadership, and consultation and communication. These were discussed in more detail earlier in this report under the heading of *Discussion of Advanced Nursing Competencies.*

Finally, the plans for implementation and evaluation were highlighted in this report and will be the focus of the next phase of this project. Additional dissemination plans such as presenting at a national conference and participating in a presentation for the CRNNL are two ways I plan to further meet the ANP education competency for dissemination of educational projects on a provincial and national level.

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Appendices

Appendix I: Literature Review Report

The Development of an e-Learning Resource on the Assessment, Treatment, and Management of Lymphedema: A Review of the Literature

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Lymphedema has been described as an accumulation of a protein-rich fluid in the interstitial spaces of the tissues (Arrivé et al., 2018; Grada & Phillips, 2017; Ridner, 2013). Lymphedema/chronic edema is a progressive, chronic condition that causes swelling most commonly to a limb, but may involve the trunk, head, neck, or genital regions (Franks et al., 2006; Klernäs et al., 2017; Moffatt et al., 2003). Globally lymphedema is thought to be under-recognized, under-treated, and a neglected public health issue (Keast et al., 2019; Moffatt, Keeley, & Quéré, 2019; Rockson & Rivera, 2008).

There are increasing numbers of people living in the community with lymphedema/chronic edema (Morgan et al., 2005; Thomas et al., 2017; Todd, 2014), with the etiologies of the edemas varied (Leard & Barrett, 2015; Thomas et al., 2017). Continuing care nurses are often required to treat and manage clients with lymphedema to their lower limbs (Thomas et al., 2017; Todd, 2014). Two studies conducted in the United Kingdom by Morgan et al. and Thomas et al. suggested it was essential to increase the skills and knowledge base of community nurses to manage patients with lymphedema in the community effectively. Past evaluations of a one-day workshop on lymphedema management offered at Central Health have highlighted that continuing care nurses want additional information and education on the assessment, treatment, and management of lymphedema. The nurses have indicated a need for a better understanding of lymphedema to achieve the competencies required to treat this chronic, progressive condition. Comments noted in the evaluations suggested e-learning may be an additional way to provide information and education to the continuing care nurses at Central Health. Managers have also expressed an interest in providing education online through the Learning Management System at Central Health. These factors were the impetus to consider

developing an e-learning module on the assessment, treatment, and management of lower limb lymphedema for the continuing care nurses at Central Health.

I will argue that e-learning can be used in addition to or as part of a blended learning method that can supplement the learning opportunities already available at Central Health. The review will discuss the educational strategies of e-learning and face-to-face learning, and some of the pros and cons of these specific methods. The purpose of this literature review is to review the current evidenced-based literature to determine if community nurses have a knowledge deficit about lymphedema. If so, the review will investigate what are the gaps in their knowledge. The review will address why knowledge gaps in lymphedema care are a problem and how to address these gaps through education delivery.

Methods

A librarian at the Health Sciences Center, Memorial University, was consulted to assist with the literature search plan. The literature search was conducted using the electronic databases: The Cumulative Index to Nursing and Allied Health Literature (CINAHL); PubMed; and Nursing & Allied Health Database. Keywords, such as lymphedema, lymphoedema, chronic edema and lower extremity, lower limb, and lower leg, were consistently used to initiate the search. Further keywords, such as prevalence, impact, assessment, treatment, management, e-learning, face-to-face learning, nursing education, adult learning, staff development, and training, were further used to find the necessary literature. The date boundaries included studies published in the past 15 years (2005-2020). Fifteen years was used to ensure all relevant studies were included. A total of 332 article titles were scanned for possible relevance, with 120 abstracts downloaded for additional review. Of these, 37 were read for relevance to the literature review.

An additional three studies were identified in the reference section of relevant studies and were read. Limiters of English language and peer-reviewed were also applied.

A total of nine studies were chosen to inform the review. The details of the studies by **Bloomfield** et al. (2010), **Glogowska** et al. (2011), **Hodgson** et al. (2011), **Keefe and Wharrad** (2012), **Mehrdad** et al. (2011), **Morgan** et al. (2005), **Sung** et al. (2008, **Thomas** et al. (2017), and **Watts and Davies** (2017) can be found in the literature summary tables located in the Appendix of this review. Bold text of the author's name will be used throughout subsequent sections to signify that the study can be found in the literature summary table. Quantitative studies (analytic and descriptive) were appraised using the Public Health Agency of Canada (PHAC; 2014), critical appraisal tool (CAT). Qualitative studies were reviewed using the Critical Appraisal Skills Program (CASP; 2020). An explanation of the credibility rating for CASP can be found in the legend for the literature summary table located in the Appendix.

Overview of Lymphedema

Lymphedema was historically classified as either a primary or secondary type (Arrivé et al., 2018). Primary lymphedema results from hereditary or genetic malformations in the lymphatic system, while secondary lymphedema results from an acquired cause, such as an injury to the lymphatic system, from an obstruction or an interruption to lymphatic flow (Arrivé et al., 2018; Grada & Phillips, 2017; Tiwari et al., 2003). The terms lymphedema and chronic edema are often used interchangeably, which has caused some confusion around a standard definition. Chronic edema is an umbrella term that has commonly described edema as any swelling lasting more than 3 months (Keast et al., 2019; Moffatt, Keeley, & Quéré, 2019). Keast et al. and Moffatt, Keeley, and Quéré reported that any chronic edema would ultimately lead to lymphatic dysfunction, hence secondary lymphedema. Therefore, these authors indicated most

current definitions consider all chronic edema as lymphedema. For this literature review either term will be used, indicating one of the same conditions.

Secondary lymphedema is more common than primary lymphedema. The development of secondary lymphedema is often not attributed to a single cause but is multifactorial, making it more challenging to treat. Some of the more common causes of secondary lymphedema include cancer, cardiovascular disease, chronic venous insufficiency, diabetes, hypertension, infection, obesity, trauma, and radiation (Hampton, 2010; Keast et al., 2019). Moffatt, Keeley, and Quéré (2019) further suggested that immobility, drugs, lipedema, and vascular malformations can further create complex patient profiles, which contribute to the development of secondary lymphedema.

The presence of risk factors may contribute to the progression of lymphedema. Obesity, recurrent cellulitis, and wounds are three health conditions that may increase the risk of edema progression when coexisting with lower limb lymphedema (Moffatt, Gaskin, et al., 2019). Three cross-sectional studies were reviewed for data collected on obesity, cellulitis, and the presence of wounds in persons with chronic edema. One of the cross-sectional studies took place in the United Kingdom (Moffatt, Gaskin, et al. 2019) (n = 2541) while another took place in Canada (Keast et al., 2019) (n = 68). Keeley et al. (2019) conducted a multinational, cross-sectional study with 8,140 participants from four countries (France, Italy, Turkey, and the United Kingdom). The large study by Moffatt, Gaskin, et al. aimed to determine the prevalence of chronic edema in three urban-based community nursing services while the small single-site study by Keast et al. aimed to determine the prevalence of chronic edema in an adult population attending a wound clinic. The study by Keeley et al. was a large multi-site study that explored the similarities and differences in the complexity of patients attending lymphedema services. All

three studies used the Lymphedema Impact and Prevalence International (LIMPRINT) core tool to collect data about weight, presence of a wound, and history of cellulitis. The three studies were of weak design. The studies by Keeley et al. and Moffatt, Gaskin, et al. were of medium quality. The study by Keast et al. was considered of low quality because the of the small number of participants, which represented a significant limitation.

Obesity was noted in the participants of all three studies, with Keast et al. (2019) reporting that 47.06% had a body mass index of more than 40. In the study by Moffatt, Gaskin, et al. (2019), obesity and morbid obesity occurred in 34.9% of the participants. The study by Keeley et al. (2019) reported many of the participants were obese (34.5%) or morbidly obese (18.4%). These three studies suggested that obesity and morbid obesity are complexities seen in persons with lymphedema.

Cellulitis was also a common issue seen in the participants of the three studies. Keast et al. (2019) reported a history of cellulitis in 72.06% of the participants. Moffatt, Gaskin, et al. (2019) reported a history of cellulitis affected 24.7%, with Keeley et al. (2019) reporting 34.7% of their participants having at least one episode of cellulitis in the past year, with 23.4% of these patients requiring hospital admission. Recurrent cellulitis is known to increase the risk of poorer health outcomes. Therefore, it is essential for continuing care nurses to recognize this risk and to assess when further medical assessment and treatment may be required.

The presence of wounds was highlighted in all three studies. Keast et al. (2019) noted that the most prominent comorbid condition in their patients was venous disease, with 39.71% having a wound history. Moffatt, Gaskin, et al. (2019) reported that most of their participants (73.6%) with chronic edema also had a concurrent wound, with more than 40% requiring twice-weekly wound care visits from a community nurse. A further 13.7% needed a daily visit for

wound care. The study by Keeley et al. (2019) only reported the presence of a wound in 6.9% of participants. The low number of wounds may be attributed to some health services in this study reporting mainly breast cancer-related lymphedema (BCRLE), with the presence of wounds not common in these populations.

The presence of obesity, history of cellulitis, and the presence of wounds adds to the complexity of care in persons with lymphedema. All three studies indicated that persons with chronic edema associated with complex coexisting issues, increase their risk for edema progression. Keast et al. (2019) further suggested that as the prevalence of lymphedema increases, there will be a further burden on the health care system to manage care. Continuing care nurses at Central Health see clients with chronic edema and complex coexisting issues, such as obesity, cellulitis, and wounds. It is, therefore, important for the continuing care nurses to have the knowledge and skills to assess and treat these clients in the community setting to slow or prevent the progression of lymphedema.

Progression of lymphedema in the lower extremities is known to cause issues with mobility. As mobility declines, the calf muscle pump fails, and edema increases (Parmar et al., 2006). The studies by Keast et al. (2019), Moffatt, Gaskin, et al. (2019), and Keeley et al. (2019), discussed previously, all demonstrated that decreased mobility increased the risk of swelling in persons with lymphedema. The Canadian study by Keast et al. predominantly consisted of lower extremity lymphedema participants. There were associated mobility issues in 62% of the participants in this study. The participants rated standing more than 30 minutes and walking long distances as severe/extreme, which caused them to reduce their daily living activities. A reduction in activity is also a risk factor for developing lymphedema (Keast et al., 2019). The study by Moffatt, Gaskin, et al. acknowledged the potential impact obesity and reduced mobility

would have on persons with lymphedema/chronic edema. The authors reported that only 28.4% of the participants in their study could walk without an assistive device supporting the concern that mobility issues affect persons with lymphedema/chronic edema. Keeley et al. reported mobility issues were also a factor in the participants they studied, with 40.8% of those with lower limb lymphedema using an assistive device or were chair/bed bound. Keeley et al. suggested immobility alone can cause lymphedema.

Despite the many factors that may contribute to the development of secondary lymphedema, the treatments and management of lymphedema remain similar. The importance of nurses conducting comprehensive assessments and obtaining skills to provide competent care to their clients is paramount to ensuring that safe, appropriate treatment and management plans are developed for and with clients who experience lymphedema. Engaging the client actively in care early on fosters client centeredness, with a goal to support clients in attaining eventual self-care. Lymphedema is a progressive, life-long condition, with no cure that has implications not only for a person's quality of life (QoL) and health but also for the health care system as a whole, in terms of health outcomes and costs (Grada & Phillips, 2017; Moffatt, Keeley, & Quéré, 2019).

Occurrence and Impact

The lack of a consistent definition for lymphedema has contributed to lymphedema being misdiagnosed or undiagnosed in the general population (**Hodgson** et al., 2011; Moffatt, Franks, et al., 2019). Moffatt, Keeley, and Quéré (2019) and Rockson (2019) suggested that the true extent and burden of lymphedema is unknown, therefore underestimated. Researchers from the International Lymphedema Framework (ILF) and national affiliates designed international epidemiology studies to determine the scope and impact of the problem of lymphedema (Moffatt, Keeley, & Quéré, 2019). These studies, known as the LIMPRINT studies, have been conducted

by the ILF and the various national affiliates. The researchers used a standardized international protocol and sampling framework to create a core data tool that ensured all participating countries collected consistent data (Moffatt, Franks, et al., 2019; Moffatt, Keeley, & Quéré, 2019). Using mainly cohort and cross-sectional designs, the researchers followed an identified cohort over time or described a group at one point in time.

Occurrence

The total number of people with lymphedema globally is unknown. To determine the true prevalence of lymphedema, the number of people with lymphedema would need to be counted, which is not practical or feasible (Moffatt, Keeley, & Quéré, 2019). Rockson (2019) and Moffatt, Keeley, and Quéré indicated that prevalence data to date has mainly been estimated through the extrapolation of data from existing health care databases, case ascertainment, and cross-sectional-based prevalence studies.

The World Health Organgnization estimated that lymphatic filariasis alone has infected more than 120 million people worldwide, eluding to the potential magnitude of the problem (Grada & Phillips, 2017). In Canada, **Hodgson** et al. (2011) acknowledged there were no data available to indicate the prevalence of lymphedema in Canada. Through researching statistics available on conditions that cause lymphedema, Keast and Towers (2017) extrapolated data to determine a potential prevalence of lymphedema in Canada. It was estimated that approximately one million Canadians have been affected by lymphedema. This 2.9% prevalence rate was considered a very conservative estimate by the authors. Lymphedema in morbidly obese individuals alone was estimated at 570,000 persons in Canada (Keast & Towers, 2017).

Four cross-sectional studies were reviewed to determine the prevalence of chronic edema in heterogeneous populations. All four studies were part of the LIMPRINT group of studies,

which used the same standard core tool to collect data. The studies were conducted in four separate countries (Australia, Canada, Denmark, and the United Kingdom), with types of health services and numbers of participants across the four countries differing. A study conducted in Australia by Gordon et al. (2019) (n = 222) included participants from four different health services to determine the numbers of people with chronic edema within these services. A second study in Denmark by Noerregaard et al. (2019) determined the prevalence of chronic edema in an inpatient service and compared the numbers with cases of chronic edema identified in a lymphedema service clinic and three other primary care settings. The other two prevalence studies, a small Canadian study by Keast et al. (2019) and a large study by Moffatt, Gaskin et al. (2019) were described in a previous section. Cross-sectional studies are of weak design. The studies by Moffatt, Gaskin, et al. (2019), Gordon et al. (2019), and Noerregaard et al. (2019) were considered medium quality. The study by Keast et al. (2019) was considered of low quality as previously discussed in an earlier section.

All four studies found chronic edema in all types of health services studied. Gordon et al. (2019) reported a prevalence of chronic edema at all four sites studied. A residential care site had 54% of participants with chronic edema. Three other sites, a community-delivered service, a hospital-based service, and a wound treatment center, reported chronic edema in 24%, 28%, and 100% of their participants, respectively. The participants ranged in age from 22 to 102 years and were 60% female. Only 7% of participants had primary lymphedema. The study by Keast et al. (2019) reported 95.5% of their participants had lower extremity lymphedema, with more than 90% of the participants being older than 45 years of age. There were more males (57%) than females (43%), with 7.3% having primary lymphedema and 92.65% secondary lymphedema. This study was associated with 88.3% of participants having Stage II lymphedema. In the study

by Moffatt, Gaskin, et al. (2019), three sites combined reported 1440 participants, or 56.7% had chronic edema. Women represented 58.5% of the participants, with men 41.5%. There were 95.1% of the participants aged 50 years and older. This study did not distinguish between primary and secondary lymphedema. The study by Noerregaard et al. (2019) reported that in the hospital setting, chronic edema was present in 39% of the participants. The lymphedema service setting reported chronic edema in 57% of the participants, while the three community settings reported chronic edema in 35%, 7%, and 1%, respectively. While women and men were mostly represented equally in the hospital setting (50.9% and 49.1%), there were more women than men (55.1% and 44.9%) noted to be affected by lymphedema in the lymphedema service clinics and community settings. Primary lymphedema was reported in 1.1% of the participants in the hospital setting, and 13% of the lymphedema service/community settings combined.

Although the true extent of the problem is unknown, the limited evidence indicates there is a problem. Overall, there was chronic edema/lymphedema seen in every setting in the studies reviewed. The most prevalent type is secondary lymphedema. Chronic edema appears to be more common as persons age. All studies except Keast et al. (2019) reported more women than men having chronic edema. The study by Keast et al. was conducted in a lower extremity wound clinic, which did not see women with breast cancer-related lymphedema (BCRLE), possibly explaining why women were not seen in increased numbers in this clinic. The other sites included participants with BCRLE, which may skew the data towards more women than men having chronic edema. The studies reviewed support the argument that chronic edema exists in various settings, which include community health. The study by Moffatt, Gaskin, et al. (2019) concluded that between 52% and 69% of patients have lymphedema/chronic edema in the community. These authors considered lymphedema a growing public health problem within the

community that needed urgent, effective service provision. The authors suggested a potential impact on patient quality of life, health care costs, and limited resources if the issue was not addressed. This supports that nurses will need to be able to care for persons with chronic edema in the community setting. At Central Health, continuing care nurses are increasingly responsible for the care of clients with chronic lower limb edema. Therefore, nurses will require skills and knowledge to treat these persons. The literature reviewed supported that chronic edema/lymphedema exists in the community setting and provides an evidence-based support for the need for education of continuing care nurses at Central Health in the care and management of these clients.

Impact on Quality of Life

It has been suggested that health-related quality of life (HRQOL) is impacted in persons with lower limb lymphedema. Three cross-sectional studies and one cohort study evaluated HRQOL in persons with lymphedema. All HRQOL tools used were validated, with the LYMQOL and the Lymphedema Quality of Life Inventory (LyQLI) tool designed specifically for HRQOL assessment in persons with lymphedema. One of the cross-sectional studies was by Keast et al. (2019), which took place at one site in Canada (n = 68), while another study took place at two sites in Sweden (n = 200) (Klernäs et al., 2019). Mercier et al. (2019) conducted a large, multinational (Canada, Denmark, France, Ireland, Japan, and Turkey) cross-sectional study, with 1094 participants. A cohort study by Franks et al. (2006), with 228 participants, took place at multiple sites in the United Kingdom. The studies by Keast et al., Mercier et al., and Klernäs et al. all used HRQOL tools specific to lymphedema, with Keast et al. and Mercier et al. using LYMQOL + EQ-5D and LYMQOL + EQ-5D-3L, respectively. Klernäs et al. used the LyQLI to measure lymphedema's impact on HRQOL in their participants. The study by Franks

et al. assessed HRQOL using multiple tools (SF-36, Barthel, McGill, and EQ5D). These tools were more generic HRQOL tools that could be applicable to a wide variety of health conditions.

The three cross-sectional studies (Keast et al., 2019; Klernäs et al., 2017; Mercier et al., 2019) utilized a weak design whereas the cohort study by Franks et al. (2006) is a moderate design. Two of the studies were appraised as medium quality (Klernäs et al., 2017; Mercier et al; 2019). In comparison, the study by Keast et al. was considered low quality due to the study sample size being very small, which the authors acknowledged presented a significant limitation to interpreting their data.

All four of the studies reported decreased HRQOL in persons with lymphedema. Overall, participants in the study by Keast et al. (2019) rated HRQOL at a mean of 0.51 ± 0.33, where 1.0 is the best quality of life. Mercier et al. (2019) used the EQ-5D and LYMQOL, visual analogue tools, with EQ-5D scored between 0-100 (with 100 being the best quality of life) and the LYMQOL, scored between 0-10 (with 10 being the best quality of life). The results were equal between the two tools, with EQ-5D scoring 63.6 (SD = 20.2) and the LYMQOL scoring 6.3 (SD = 2.0).

The studies by Klernäs et al. (2017) and Franks et al. (2006) used different validated tools to assess HRQOL. Klernäs et al. reported that lymphedema affected HRQOL in three domains (physical, practical, and psychosocial), with 20% of the patients reporting major impacts on quality of life. The results overall showed poorer HRQOL in persons with lymphedema when compared with the Swedish population. Franks et al. used four separate tools (MOS SF-36, Barthel Scale, McGill questionnaire, and EQ5-D) to determine HRQOL at baseline and 24 weeks. Some participants received treatment with compression bandaging (45.7%) or stockings (21.3%), with 32.9% of participants receiving no treatment at all. The results showed HRQOL

improved the greatest in the treatment groups. Although HRQOL improved over time in persons with lymphedema, the results consistently showed poorer HRQOL in physical, emotional, and social functioning compared to the general United Kingdom population.

Overall, the four studies used validated HRQOL tools to assess lymphedema's impact on the participants' quality of life. All studies appeared to indicate that quality of life was impacted in persons with lymphedema. Although the study by Keast et al. (2019) was very small, the results were considered consistent with the findings in other studies. Therefore, the impact on quality of life should be a consideration in caring for this population. At Central Health, quality of life of patients with lymphedema is a concern. Currently, no validated tool is used to assess HRQOL specific to lymphedema at Central Health. In developing the proposed e-learning module for nurses, content on HRQOL should be considered as one of the components covered in the e-learning module for continuing care nurses at Central Health.

Need for Health Care Resources

Having lymphedema is believed to increase the reliance on health care resources for care. The cross-sectional study previously described by Moffatt, Gaskin, et al. (2019) suggested increasing reliance on community nurses can overwhelm an already stressed health care system. Finding cost-effective measures to improve patient outcomes, such as reducing cellulitis, healing wounds associated with lymphedema, and improving quality of life may reduce the need for health care resources. A journal article by Benbow (2009) discussed the challenges of managing secondary lymphedema in the United Kingdom suggesting that more was needed to improve service provision around lymphedema care and to relieve the burden to providers and patients. This article was not a study and represented the opinion of the author. Neither the study nor the

article demonstrated with evidence that lymphedema was the sole cause for increased reliance on health services. Therefore, this is an assumption that requires further study.

The Canadian qualitative study by **Hodgson** et al. (2011) used Open-Space Technology in a participatory action framework to engage participants in an interactive approach to determine priorities, barriers, and resource issues encountered in lymphedema care. The participants (n = 108), which included health care professionals, researchers, patients, and industry representatives, identified that lack of access to lymphedema services was a barrier to Canadians' care with lymphedema. The study cited lack of funding sources, inequities in provincial health policies, limited treatment clinics, or adequately trained providers as the main barriers to care. These barriers to care potentially increase health care costs if lymphedema progresses as patients may be predisposed to the impact of decreased quality of life, and the related risks of cellulitis, wounds, and decreased mobility.

Need for Nurses' Knowledge and Skills

The presence of lymphedema in the community is not new. Moffatt et al. (2017) suggested that community nurses see significant numbers of patients with chronic edema, reporting up to 69% of their patients are affected. This is also a reported concern at Central Health and is why the lymphedema program was established back in 2011. The lymphedema program at Central Health has grown, placing increased demands on the Regional Lymphedema Nurse's caseload. This has prompted discussions around improving the knowledge and skills of the continuing care nurses at Central Health to manage lymphedema in the community better. Despite having a mandatory one-day workshop on the assessment, treatment, and management of lymphedema, continuing care nurses have expressed the need for additional learning. The evaluations completed by nurses following the one-day workshop have suggested a need for

more resources on lymphedema care. This has been the impetus for this practicum project and the planned development of an e-learning module to supplement the continuing care nurses' learning needs. Existing research around what nurses know or don't know about lymphedema is very limited. Most of the research has been done in the United Kingdom, but it is likely relevant to the needs of continuing care nurses at Central Health. Two studies were reviewed to understand the learning needs and knowledge gaps of those who provide care to persons with lymphedema. A summary of the studies reviewed can be found in the Appendix.

The two studies evaluated were qualitative studies of medium credibility. One of the studies by **Morgan** et al. (2005) (n = 54) was conducted in the United Kingdom. This study aimed to assess the educational needs, knowledge, and skill of community nurses in providing care to patients with lymphedema in the community setting. The second study by **Hodgson** et al. (2011) (n = 108) aimed to create a national strategy and agenda for lymphedema in Canada. Part of that strategy was to explore the educational needs of health care providers. The study by Morgan et al. used eight focus groups to explore the experiences of community nurses who treat lymphedema while Hodgson et al. used a participatory action research framework as discussed in the previous section.

The two studies by Hodgson et al. (2011) and Morgan et al. (2005) reported that knowledge deficits were a concern in lymphedema care. Hodgson et al. indicated education was needed about the lymphatic system while Morgan et al. listed a variety of educational needs, such as the anatomy, physiology, and pathology of the lymphatic system, causes of lymphedema, treatment and management, and the role of compression, skin care, and exercise. Morgan et al. also highlighted that nurses need to understand the impact of lymphedema on quality of life and the need for skills to manage inflammation and infection. The two studies reviewed supported

that there was a knowledge deficit about lymphedema in the health care setting. This is consistent with what has been identified at Central Health and supports that this is not a unique problem to Central Health.

Interventions to Address Knowledge Gaps

The previous section provided evidence that knowledge gaps in lymphedema management exist. However, this evidence is acknowledged to be limited and weak. Considering this, there is also little evidence on what educational strategies have been studied to address this knowledge gap in lymphedema care. In conducting the literature search, I was only able to find two studies that used an educational strategy to deliver education to community nurses. The studies by **Thomas** et al. (2017) and **Watts and Davies** (2017) were part of a Welsh *On the Ground Education Project* (OGEP) conducted in the United Kingdom, which involved nurse educators providing direct education on lymphedema to community nurses in a practice setting. The study by Thomas et al. (n = 100) was an uncontrolled before and after study that purposively recruited community nurses in which educators worked directly with to provide education on lymphedema. This study investigated the economic benefits of implementing the OGEP for community nurses who manage chronic lymphedema with wounds. Data were collected on the use of resources, costs, and outcomes of participants at baseline, with follow up after three months, once the educational intervention known as OGEP was provided. The qualitative study by Watts and Davies (n = 12) used three focus groups with nurses who recalled their experiences with participating in the OGEP. The authors aimed to examine the impact of an OGEP for community nurses in managing their patients with chronic edema, as well as any perceived benefits for patients due to nurses having engaged in the OGEP program. In both studies (Thomas et al., 2017; Watts and Davies, 2017), the same education strategy of OGEP was

provided. There was not structured learning on predetermined topics, instead the OGEP educators provided education directly to nurses in the community by working with the community nurse on a case by case basis to increase the community nurses' knowledge and improve care to individuals with lymphedema. Watts and Davies found the implementation of the OGEP increased the community nurses' perceived knowledge and awareness of lymphedema but stressed the extent to which knowledge was retained was unknown. The findings revealed a concern that many nurses would not change practice as nurses expressed that they were already overstretched and would have difficulty implementing more preventative care. The study by Thomas et al., which was focused more on the economic benefits of introducing an educational program for community nursing, found there was a trend seen towards a decreased use of resources such as community nurses' time in those who had received the OGEP. Thomas et al. reported that community nurses' visits decreased over three months when compared with baseline ($p < .001$). There was a decrease in the cost of community nurse visits post OGEP, with the mean patient cost of £1207.8 per patient before education compared to £ 565.8 post OGEP. Thomas et al. also reported a reduction in cellulitis from 62 episodes at baseline to 11 post OGEP. Despite these findings, Thomas et al. suggested that this type of education delivery might not be realistic to continue as one-on-one nursing education is likely not feasible in the long term. The authors expressed a need to find other educational strategies to address the knowledge gap in lymphedema care. Both authors suggested that the benefits seen, such as reduced use of resources or improvements in patient outcomes, such as cellulitis, may not be solely attributed to the OGEP education as other factors might be contributing.

I completed a thorough literature search and determined there were no studies available on the use of classroom or e-learning to deliver education to nurses on lymphedema care.

Therefore, a broader search of the literature was undertaken to investigate the blended use of these methods for learning in health care. At Central Health, the intention is to use a combination of classroom/workshop learning, and an additional resource of an e-learning module to deliver education and information to continuing care nurses on the assessment, treatment, and management of lymphedema. Continuing care nurses have identified through evaluations completed following a one-day workshop that an e-learning module may support their learning needs. The review of the literature aimed to investigate whether or not the development of an e-learning module will benefit these nurses as an additional educational resource for their learning. I plan to use the evidence found in the literature to go forward with this practicum project.

Five studies were reviewed to understand the use of e-learning in the health care setting. All studied various topics and aspects of the use of e-learning and lecture-based learning by nurses or student nurses in the health care setting. Two studies compared e-learning to face-to-face. A randomized controlled trial (RCT) by **Bloomfield** et al. (2010) in the United Kingdom sought to determine whether the skills and theory of handwashing could be more effectively learned and retained with e-learning compared to face-to-face. A second study was a non-randomized controlled trial (NRCT) conducted in Iran by **Mehrdad** et al. (2011). This study used a cross-over method to compare the effectiveness of e-learning and face-to-face learning in nursing students engaged in a maternal child course. In the NRCT by **Sung** et al. (2008) in South Korea, they compared a medication education program for nurses that used blended learning (e-learning and traditional learning), with a program using traditional, lecture-based learning. A fourth study by **Keefe and Wharrad** (2012) conducted an RCT in the United Kingdom to study the development of an e-learning resource to supplement existing resources on pain education. Keefe and Wharrad quantitatively measured the impact on knowledge and attitudes toward pain

management in student nurses. A fifth study was a qualitative study from the United Kingdom, which was conducted by **Glogowska** et al. (2011) to study nursing students' perceptions of a blended learning approach to learning.

The studies by Bloomfield et al. (2010), Keefe and Wharrad (2012), Mehrdad et al. (2011), and Sung et al. (2008) were of strong design and medium quality. The qualitative study by Glogowska et al. (2011) used the narrative model to interview participants and was considered of medium credibility. The studies by Bloomfield et al. (n = 245), Keefe and Wharrad et al. (n = 233), Mehrdad et al. (n = 32), and Sung et al. (n = 50) all had small sample sizes, which impacted the researchers' ability to generalize the findings of their respective studies. The study by Glogowska et al. (n = 17) was small, with some respondents having completed their learning several months before the study, suggesting recall bias might be a factor in the responses.

The RCT by Bloomfield et al. (2010) and NRCT by Mehrdad et al. (2011) found no significant difference in learning outcomes between teaching methods (face-to-face or e-learning), suggesting one method was as effective as the other. Bloomfield et al. used knowledge scores to show that test scores increased in both groups despite learning method used, with no significant difference detected between the scores in the two groups when compared at two, and four weeks post learning. At two weeks both the intervention and control group achieved a median test score of 13, with a test ranged from 0-16 (p = .149). At 8 weeks, while fewer people completed the test, the median score remained at 13 (p = .201). Mehrdad et al. evaluated learning outcomes by a final test. The learning outcomes were similar, with no significant difference noted between the types of learning methods used. The mean for the traditional method was 14.23 ±3.36 while the mean for the e-learning was 14.35 ±2.89 (p > .05).

The studies by Keefe and Wharrad (2012) and Sung et al. reported significant differences in the test results between two teaching methods. Keefe and Wharrad reported the intervention group's (e-learning) test response accuracy as a mean of 73.1%, with the control group (traditional learning) having a mean test score of 53.8%. They found a significant difference between mean scores (19.2 percentage points, 95% CI = 15.5-22.9 $p < .001$). Similarly, Sung et al. reported the mean score after education was significantly higher in the intervention group (82.21 ± 8.75), who received blended learning (e-learning and traditional), versus the control group (67.92 ± 7.17) that received only lecture-based learning, which was a significant difference between the two groups ($p <.001$). The qualitative study by Glogowska et al. (2011) indicated that blended learning shows potential for improving the quality of learning in health care and may be cost effective. Themes emerged with the authors finding that integration between e-learning and face-to-face learning was lacking and their needed to be a balance between online and face-to-face components. The participants indicated online learning should be completed before face-to-face learning, with time allotted during face-to-face to discuss the online material. The participants also reported issues about what content should be taught online and content that is better suited for the classroom.

All five studies suggested potential advantages to e-learning. Bloomfield et al. (2010), Glogowska et al. (2011), Keefe and Wharrad (2012), and Sung et al. (2008) highlighted that e-learning was flexible, allowing students to learn on their own time and pace. Bloomfield et al. and Mehrdad et al. (2011) indicated e-learning supported autonomy in the students' learning. Sung et al. reported e-learning would be more cost-effective in terms of human resources and the ability to decrease teaching hours for faculty. In this study the control group received 10.5 hours of lectures while the e-learning group only received three hours of lectures. The authors

concluded this reduction in face-to face teaching hours might potentially reduce the future costs for teaching faculty. Glogowska et al. suggested some topics may be better suited to specific modes of delivery, such as anatomy and physiology, which were thought to be more suitable for online learning.

The authors highlighted some of the disadvantages to e-learning and face-to-face learning. Bloomfield et al. (2010) suggested that face-to-face learning lacked flexibility and consistency in teaching. Glogowska et al. (2011) posited e-learning might cause social isolation and be a challenge for those who do not have the necessary computer skills. Glogowska et al. further suggested practice-based concepts may not be easily taught by e-learning and should be taught face-to-face.

The studies by Glogowska et al. (2011), Keefe and Wharrad (2012), Mehrdad et al. (2011), and Sung et al. (2008) all suggested that blended learning should be considered in nursing education. These authors suggested blended learning was a way to enhance how education is traditionally delivered to nursing students. While there may be advantages and disadvantages to both methods of learning when used in isolation, it is reasonable to assume that combining the two methods may improve the way education can be delivered.

Considering this literature review, I believe the limited evidence supports moving forward with the development of an e-learning module on the assessment, treatment, and management of lymphedema. Previous consultations with management and the continuing care nurses at Central Health have revealed their interest in having an additional learning resource to supplement the one-day learning workshop already provided. The development of an e-learning module is not meant to replace face-to-face teaching but to enhance the learning method already in place. Therefore, the module on lymphedema will provide an additional resource to help

address gaps identified through consultations, and supplement learning as needed for the continuing care nurses at Central Health.

Theoretical Framework

In completing this practicum project, the plan is to develop an e-learning module on the assessment, treatment, and management of lower limb lymphedema for the continuing care nurses at Central Health. This e-learning module will be available to all continuing care nurses through the Learning Management System at Central Health. It will be the expectation that all continuing care nurses complete the learning module prior to attending a mandatory one-day workshop on lymphedema care. The module will also be available for access on an as-needed basis for those nurses who want to review. In order to make the e-learning experience effective, I plan to develop an interactive module that uses technology to engage and involve the learner in the experience. Using case studies, videos, pictures, interactive quizzes, and reflective exercises that encourage the nurse to participate in active learning aims to provide a more enriched learning experience on lymphedema. I plan to use a theoretical framework that incorporates the principles of adult learning to guide this process. The development of this e-learning module will focus on Knowles Adult Learning Theory (1984).

Knowles Adult Learning Theory

The theory of andragogy was largely popularized by Knowles (1984) who believed that the education of adults was fundamentally different from children, requiring an initiative from the learner to address their own learning needs and goals, including the most appropriate learning strategies to attain the goals (Levett-Jones, 2005; Ludlow et al., 2007). The development of this e-learning module will focus on two principles of Knowles Adult Learning Theory. The

principles of *Relevance* and *Experience* suggest that adults want information and learning that is relevant to their work, applicable to their practice and recognizes that adults bring a range of life experiences to their learning that serve as a useful resource when learning (Candela, 2020).

At Central Health, the continuing care nurses have expressed a need for additional education on the assessment, treatment, and management of lymphedema. They have indicated this through evaluations completed following a one-day workshop and through consultations during this practicum project. The nurses have indicated through the consultation process what they would like to see included in the learning module. I plan to use the continuing care nurses' ideas to inform the content of the e-learning module on lymphedema. The nurses also indicated the need for an interactive module that includes pictures, videos, and quizzes. I will use these suggestions when developing the module by including pictures, embedding video links, and creating an interactive quiz which gives immediate feedback to make the module more relevant and applicable to the nurses who use it. In consideration that adult learners bring a wide range of experiences to learning it is important that the e-learning module engage the learner to draw on these experiences when learning about lymphedema. Through use of case study presentation, I plan to involve the learner by using interactive technology where they can choose the appropriate plan of care for the case study clients. The continuing care nurses will be encouraged to use their experience and knowledge to assess and make decisions in the care of the cases presented. This aims to promote critical thinking and engage the learner to apply what they have learned. Opportunity to reflect on these decisions will be provided at the end of each case study.

Summary and Conclusion

Lymphedema is a chronic, under-recognized, and under-treated condition that affects Canadians and a greater population worldwide. Canadians are an ageing population that live with

multiple co-morbid health issues, which increases a person's vulnerability to conditions such as lymphedema/chronic edema. As increased numbers of people live with chronic disease in our community, it is reasonable to assume that continuing care nurses will be required to treat and manage clients with lymphedema in the community (Todd, 2018). The purpose of this literature review was to review the current evidenced-based literature to determine if community nurses have a knowledge deficit about lymphedema and if so, what are the gaps in their knowledge. The literature review also sought to learn why knowledge gaps in lymphedema care are a problem and how to address these gaps through education delivery.

The outcome of this review is intended to inform the development of an evidenced-based e-learning module for continuing care nurses on the assessment, treatment, and management of lymphedema. The studies reviewed confirmed there are increasing numbers of people living in the community with chronic edema/lymphedema (**Morgan** et al., 2005; **Thomas** et al., 2017; **Watts & Davies**, 2017). It was also recognized that continuing care nurses play an integral role in caring for these clients with lymphedema in the community (Morgan et al., 2005; Watts & Davies, 2017). To do this, nurses need access to educational modalities to support their learning and reinforce evidenced-based practice in the care of persons with lymphedema. The review also demonstrated that HRQOL was impacted in persons with lymphedema. This was confirmed in the studies by Franks et al. (2006), Keast et al. (2019), Klernäs et al. (2017), and Mercier et al. (2019), which all reported decreased HRQOL in persons with lymphedema. Two of these studies, Franks et al. and Klernäs et al. also showed HRQOL to be lower in persons with lymphedema compared with the general population in both the United Kingdom and Sweden, respectively.

It was demonstrated that lymphedema often coexists in the presence of multiple comorbidities, increasing the complexity of care needed for these patients. Of concern were the risks of lymphedema associated with obesity, cellulitis, and wounds and how lymphedema impacts HRQOL and affects limited health resources (Keast et al., 2019; Moffatt, Gaskin, et al., 2019).

Studies by **Hodgson** et al. (2011), Morgan et al. (2005) confirmed that knowledge gaps exist in nurses and health care providers in caring for persons with lymphedema and an education strategy was needed to address this issue. There were only two studies (Thomas et al., 2017; Watts & Davies, 2017) available that addressed using a specific education strategy to teach community nurses about lymphedema care. The study by Thomas et al. reported there was a decrease in community nurse home visits required following the implementation of the OGEP. These authors cautioned that the decrease in visits may not be solely related to the education program. In the study by Watts and Davies the participants reported their experience of participating in the OGEP, which they believed improved their understanding and knowledge of lymphedema. The participants also indicated having greater confidence in assessing for lymphedema. Due to the limited studies available that address educational strategies for teaching about lymphedema, the literature was broadly searched to find educational strategies for teaching nurses in health care. The five studies (**Bloomfield** et al., 2010; **Glogowska** et al., 2011; **Keefe & Wharrad**, 2012; **Mehrdad** et al., 2011; and **Sung** et al., 2008) reviewed, all suggested potential advantages to e-learning, with the studies by Glogowska et al., Keefe and Wharrad, Mehrdad et al., and Sung et al. suggesting a blended learning approach in nursing education should be considered.

Guided by the principles of adult learning, the development of an e-learning module will provide an additional educational opportunity for continuing care nurses at Central Health. This e-learning module will consider the principles of relevance and experience to guide the development of the module. Through using nurses' ideas for content and presentation, gained through consultations, the aim is to produce a module that is relevant to the learning needs of the continuing care nurses at Central Health. Nurses will also be encouraged to draw on their experiences through active participation in case studies, which will be interactive and reflective. Having a continuing care nursing workforce competent in the care they provide will foster an environment that is safe and client-centered, building capacity within community health to support clients who live with lymphedema as they ultimately aim to achieve self-care.

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Appendix – Literature Summary Tables

CI	Confidence Interval
LE	Lymphedema
NRCT	Non-randomized Controlled trial
OGEP	On-the-Ground Education Project
p	*p* value
QoL	Quality of Life
RCT	Randomized Controlled Trial
CASP	Critical Appraisal Skills Program • High credibility: most of the relevant CASP criteria were answered as "yes" and none were answered "no". • Medium credibility: some of the relevant CASP criteria were answered "yes", and most were answered as "can't tell", with no more than one item answered as "no". • Low credibility: the majority of the relevant CASP criteria were answered as "can't tell" or "no".

Study/Design	Methods	Key Results	Comments
Authors: Bloomfield et al. (2010) **Design:** RCT **Purpose:** To determine whether nursing students could learn and retain handwashing (theory and skills) more effectively with e-learning versus face-to-face	**Country:** United Kingdom **Participants:** (N = 245) • Recruited from a total population of first year nursing students **Groups:** • Allocated to groups by computerized random number generation • Blinding not possible Control Group: (*n* = 113) • Convention teaching method Intervention Group: (*n* = 118) • Computer-assisted method **Data Collection:** • Collected at four points during the study • Baseline data collected from participant questionnaire • Pre-test given on handwashing to all participants prior to reaching intervention • Knowledge test repeated immediately following teaching session, at two, and 8 weeks post education	**Results:** Handwashing knowledge test scores: Comparison between study groups **Baseline** **Intervention Group** Range: 2-16 Median: 9 **Control Group** Range: 0 – 16 Median: 9 *p* = .753 **2-Week follow-up** **Intervention group** Range: 4-18 Median: 13 **Control Group** Range 3-19 Median: 13 *p* = .149 **8-Week follow-up** **Intervention Group** Range: 8-17 Median: 13 **Control Group** Range: 8-17 Control: 5-17 *p* = .201	**Strength of Design: Strong** **Quality: Medium** **Comments:** • Findings support the use of e-learning as an alternative to face-to-face learning • Evidence is inconclusive to support one method over the other • Authors conclude that e-learning is as effective as face-to-face learning **Computer-assisted Learning:** • was effective in teaching handwashing (theory and practice) • provided flexibility, autonomy, was cost and time efficient • promotion of active learning • develops computer skills **Conventional Learning:** • Face-to-face does not ensure teaching consistency • Lacks flexibility • Does not accommodate diverse learning needs **Limitations:** • High drop-out rate • Differences not statistically significant at 8 weeks due to low power from a small number of participants at 8 weeks

Study/Design	Methods	Key Results	Comments
Authors: Glogowska et al. (2011) Qualitative Study Narrative Method **Purpose:** The purpose of this study was to explore students' perceptions of a blended approach to learning **Note:** This study is part of a larger mixed-method study	**Country:** United Kingdom **Participants:** 17 participants took part in questionnaire and a follow up interview • 16 were nurses, 1 was an allied health professional **Methods:** Interview • 25 of 40 agreed to be interviewed • 17 participants interviewed, 8 were not successful in contacting • Interviews were audiotaped and transcribed • Content analyzed with themes emerging	**Findings:** **Themes** Integration: • Integration between online and face-to-face was lacking • Lack of time to discuss online content, face-to-face • Online content and face-to-face content were disjointed • Online should be completed before face-to-face • 6 participants felt more face-to-face time was needed Content: • Issues about what content should be face-to-face and what should be online • Suggested practice-based learning should be face-to-face and more factual learning completed online Balancing online with face-to-face learning: • 6 participant felt more face-to-face learning was needed	**Qualitative Study: Narrative Method** **Credibility: Medium** • CASP criteria. Clear how data were collected. Interview plan used. Audiotaped. • Thematic analysis used • Discussed findings in detail an in context of other studies • Unclear if researcher examined own bias, influence, or role • Saturation not addressed • Triangulation not used **Comments:** • Difficult to achieve a balance between online and face-to-face learning • Integration of online and face-to-face learning is important to the student experience • Online learning may cause social isolation and disengagement in learning • How and where topics are covered is important. For example, anatomy and physiology may be a topic for online learning, whereas practice-based learning should be done face-to-face • Online learning can be convenient, cost effective, and provides flexibility in learning • This study had a low response rate (24%) • Some of the participants completed online learning several months prior to the interview, which may attribute to recall bias • Blended learning shows potential for improving the quality of learning in health care

Study/Design	Methods	Key Results	Comments
Authors: Hodgson et al. (2011) **Design:** Qualitative Participatory Action Research **Purpose:** Aim to construct a national strategy and agenda for lymphedema	**Country:** Canada **Setting:** Day-long meeting **Participants:** • 108 attendees, representative of key stakeholder groups (national representation) • Lymphedema therapists 25.9% • Patient advocates 16.6% • Industry representatives 14.8% • Physicians 11% • Nurses 9.25% • Researchers 6.5% • Government/policy makers 4.6% • Educators 3.7% • Others 7.4% **Data Collection:** • Open Space Technology • Videotaped/Written notes • Consensus building using large group briefing and knowledge transfer sessions • Before and after small group discussions to construct themes • 2 Researchers independently analyzed the video and written proceedings, then compiled the results	**Key issues identified:** • Lack of awareness of lymphedema • Insufficient education • Insufficient research • Limited access to treatment and management **Lack of Awareness** • Lack of knowledge among health care providers **Insufficient Education** • Need education for health care providers • Need education about lymphatic system • Need evidenced-based information to diagnose lymphedema • Need education in undergraduate health care programs **Insufficient Research** • Prevalence data • Effective treatments • Impact on Quality of Life • Cost analysis **Limited Access to Treatment** • Large geographical regions • Health is a provincial responsibility • Not enough trained specialists	**Qualitative Study: Participatory Action Research** **Credibility: Medium** • CASP criteria • The setting was described (one day meeting in Toronto) and methods for data collection were explicit. • Used Open Space technology, video tape, field notes • Researchers roles articulated. Two of the researchers independently reviewed the data • Used peer consultation • Themes identified independently by 2 researchers then discussed between researchers • Potential researcher bias was not discussed • No in-depth discussion of analysis process • Findings were clear and detailed • Triangulation not used **Comments:** • Participants identified education is key to developing and promoting best practice care • Need for consensus on treatment, using best practice guidelines • An education working group for Canadian Lymphedema Framework is developing basic standards of education for lymphedema • This study is a beginning, with aim to establish a long-term national strategy for lymphedema care in Canada

Study/Design	Methods	Key Results	Comments
Authors: Keefe & Wharrad (2012) **Design:** RCT **Purpose:** To develop e-learning resources to supplement existing resources on pain education and to quantitatively measure impact on knowledge and attitudes toward pain management in student nurses	**Country:** United Kingdom **Setting:** University teaching hospital, East Midlands **Population:** *N* = 233 students (4 cohorts) **Sample:** *N* = 206 • Subjects randomly assigned Intervention group: e-learning & questionnaire (n = 42) • Group subdivided into e-learning on assessment (n = 23) and treatment (n = 19) of pain Control Group: classroom instruction & questionnaire (n = 164) **Data Collection:** • Questionnaire to test knowledge & and attitude survey on pain was given to all participants • The participants completing the e-learning intervention was repeated to score assessment & treatment related question accuracy	**Results:** **Control group:** Questionnaire response accuracy (M = 53.8%) **Intervention group:** Questionnaire response accuracy (M = 73.1%) Significant difference found between control and intervention subjects' mean scores (19.2 percentage points, 95% CI = 15.5-22.9 $p < .001$)	**Strength of Design: Strong** **Quality of Study: Medium** **Comments** Study suggested e-learning: • has the potential to improve knowledge by almost 20% • incorporating with classroom may enhance student engagement • flexible **Limitations:** • potential for voluntary response bias • no long-term follow-up to test knowledge retention

Study/Design	Methods	Key Results	Comments
Authors: Mehrdad et al. (2011) **Design:** NRCT Cross-over **Purpose:** To compare the effectiveness of e-learning and face-to-face learning in nursing students in a maternal child course	**Country:** Iran **Setting:** Tehran University of Medical Sciences **Sample:** $n = 32$ • 3rd semester nursing students **Methods:** • Cross-over design used to compare two teaching methods with the same group • 1st four weeks students received lecture-based education • Remainder of course by e-learning • Learning outcomes and opinions of students were assessed at the end of course **Data Collection:** • Student opinion towards educational methods measured by self-administered 35-item, Likert scale questionnaire • Student learning outcomes measured by a final test on educational content • Data was collected from all students • Content analysis of open-ended questionnaire-based questions, themes extracted	**Results:** Student opinion indicated students perceived e-learning to be more effective on their: • Capability ($p < .005$) • Interdependency ($p < .005$) Lecture-based learning rated higher than e-learning in: • Effectiveness ($p < .0005$) • Motivation ($p < .001$) **Learning Outcomes:** • No significant difference was found between the two teaching methods • Traditional method: mean 14.23 ± 3.36 • e-Learning method: mean 14.35 ± 2.89 • $p > .05$	**Design of Study: Strong** **Quality: Medium** **Comments:** Authors suggested: • e-learning is as effective as traditional teaching method • students reported a "deeper" understanding of course with e-learning method • e-learning promoted independence in learning • students not familiar with computer-based technology • e-learning designers need to focus on more attractive, interactive technology • e-learning considered a method to be used along with traditional methods (blended learning) or as an alternative when in-class method not possible Students reported: • traditional learning as a more effective approach to teaching/learning • more motivation to learn in the traditional method of learning **Limitations:** • Small sample size

Study/Design	Methods	Key Results	Comments
Authors: Morgan et al. (2005) **Design:** Qualitative Narrative Analysis **Purpose:** To assess the educational needs of community nurses in their knowledge and skill in caring for patients with lymphedema	**Country:** United Kingdom **Setting:** 8 Focus group sessions with community nurses **Participants:** N = 54 community nurses • Community nurses each attended one of the 8 focus groups **Data Collection:** **Focus Groups** • Focus group data analyzed using content analysis and themes were identified • Focus groups audiotaped • Facilitated by a moderator and a note taker • Questions posed to the group to encourage an exchange of personal experiences **Questionnaire** • Structured questionnaires given to community nurses who attended focus groups **Questions asked about:** • Current knowledge and skill in treating patients with lymphedema • What training nurses had received and what education they required?	**Focus Groups** • All participants agreed they needed more knowledge and skills to treat and manage LE • Many expressed only a basic knowledge, skill, and understanding of LE • Consensus that more training and education was needed • All groups expressed concern about recognizing LE • All groups expressed a lack of knowledge about the risks to patient with LE • Difficulty accessing resources to manage LE in the community **Questionnaires** • 100% of participants completed • Majority of nurses rate their knowledge and skill in managing LE as adequate or poor **Perceived Education Needs** • Anatomy, physiology and pathology of lymphatic system • Causes • Management of inflammation/infection • Treatments of LE • Understanding the impact of LE on QoL • Role of compression, skin care, and exercise	**Qualitative Study: Focus Groups** **Credibility: Medium** • CASP criteria • Focus groups open to all community nurses in district • Clearly described and justified the setting • Not clear who recruited participants • Two researchers with roles specified (one as moderator and the other notetaker) • Analysis process clearly shown through use of a graphic • Themes and interpretative summaries • Audiotaped and note taking • Reference provided for analytic method • Data clearly displayed in tables • Potential researcher bias not discussed. Researcher role not critically examined **Comments:** • Community nurses in this study have expressed a need for education and training in the assessment, treatment and management of LE • There majority of participants throughout all focus groups indicated that current knowledge base was adequate or less than adequate • This study was a first step to understand the needs of community nurses in managing LE in the community setting • Assessed perceived current level and skill of community nurses • The authors considered the perceptions and insights of community nurses valuable in order to develop education programs for nurses on lymphedema

Study/Design	Methods	Key Results	Comments
Authors: Sung et al. (2008) **Design:** NRCT **Purpose:** To determine the effects of a medication education program using blended learning (e-learning and traditional learning), with traditional, lecture-based learning	**Country:** Republic of Korea **Setting:** Samsung Medical Center **Sample:** N = 50 new nurses **Intervention Group:** • Blended learning: *n* = 26 • Received e-learning and lecture-based **Control Group:** • Lecture-based: *n* = 24 **Data Collection:** All participants completed: • Pre-test on knowledge of medication and a questionnaire on self-efficacy at beginning of study • Post-test/questionnaire on completion of course on knowledge on medication, self-efficacy, medication administration, and satisfaction with learning • Post-test 2 after 6 months on self-efficacy	**Results:** **Effects of Education:** Mean score after education was significantly higher in the intervention group • Intervention Group: 82.21 ± 8.75 • Control Group: 67.92 ± 7.17 • ($p < .001$) • Results showed knowledge increased after education in both groups Mean score for medication administration ability after education • Intervention Group: 3.81 ± 0.51 • Control Group: 3.94 ± 0.39 • ($p = .314$) **Satisfaction with Learning:** • No statistical differences were found between groups on satisfaction with the learning program.	**Strength of Design: Strong** **Quality: Medium** **Comments:** The authors suggested: • e-learning was an effective method to increase knowledge • e-learning was flexible as could be accessed anytime • blended learning was an effective way to teach medication administration to nurses • medication administration ability did not differ between groups • reduced lecture time seen as a benefit • e-learning reduced human resources needed to deliver course • e-learning is cost-effective once initial set-up costs are completed **Limitations:** • Multiple exogenous variables could not be controlled for • Limited number of participants • Convenience sampling may cause selection bias

Study/Design	Methods	Key Results	Comments
Authors: Thomas et al. (2017) **Design:** Uncontrolled before and after study **Purpose:** To investigate the economic benefits of implementing an On the Ground Education Project (OGEP) for community nurses for the management of persons with chronic lower limb edema and wounds (wet legs)	**Country:** United Kingdom **Setting:** Community **Participants:** • 100 patients purposively recruited, who had chronic edema **Methods:** • Pilot Service Evaluation • 2 Clinical educators provided education to community nurses (on the job) on treatment and management of lymphedema • Educators worked directly with community nurses to provide OGEP **Data Collection:** • Baseline data collected for use of resources, costs, and outcomes for patients • Data collected for three months on all visits for materials used • Patients reassessed at three months following the intervention of education to the community nurses • 2 nurses collected data on potential effects of OGEP	**Results:** • 97 participants' data were analyzed • 3 participants died before follow-up could be completed **Following Implementation of OGEP:** • Cost to implement OGEP per patient was £ 358 • Decrease in community nurse home visits ($p < .001$) • Decreased in cost of community nurse visits post OGEP, mean patient cost of £1207.8 compared to £ 565.8 post OGEP • Overall, decreased use in dressing supplies from baseline £ 52,419 compared to £ 19,667 post OGEP training • Reduction in cellulitis from 62 episodes at baseline to 11 post OGEP • Reductions in admission to hospital from 9 at baseline to 1 post OGEP	**Strength of Design: Weak** **Quality: Low** **Comments:** • Trend towards decreased use of resources from baseline to 3-month follow up • Pilot service evaluation showed there were deficiencies in community nurses management of LE in the community • Study questioned there was a lack of understanding of chronic edema management by community nurses • The evaluation provided a basis for establishing a best practice management program for community nurses on lymphedema • The OGEP model provides education to community nurses directly, one-on-one • OGEP considered by the authors as an educational intervention • The researchers found a lack of standardized care pathways for managing LE • Suggested importance of finding new ways to educate nurses on LE **Limitations:** • Education delivered during service delivery, which may not be realistic to continue • There was no comparison group • Not all benefits seen may be attributed solely to the OGEP education

Study/Design	Methods	Key Results	Comments
Authors: Watts & Davies 2017 Qualitative Study **Purpose:** To determine the impact of "On-the-Ground" education for community nurses in the management of patients with LE and any perceived benefits for their patients after nurses engage in the program	**Country:** Wales, United Kingdom **Setting:** 3 Focus group sessions **Participants:** 12 community nurses participated in 3 focus groups • Purposive sampling used • 3 separate localities • Participants had to have engaged in the OGEP program **Data Collection:** • Conducted by an experienced focus group researcher • Focus groups were digitally recorded • Discussion aided by a "loose" interview guide • Interviews were transcribed • Thematic analysis	**Results:** • Experiences of nurses reported as 2 main themes **Themes:** Professional practice outcomes: • All participants believed OGEP improved knowledge and understanding of LE • Greater confidence to assess LE Perceived benefit for patients: • Promoted proactive, preventative, holistic care	**Qualitative Study: Focus Group** **Credibility: Medium** • CASP criteria • Setting clearly described; purposive sampling • Researcher not known to participants • Experienced focus group researcher conducted focus groups • Clear description of analysis provided • Used thematic analysis framework (reference given) • Interview guide used • Critical examination of research bias was not provided • Digitally recorded, transcribed • Unclear if more than one researcher analyzed data • Findings detailed **Comments:** • Study provided valuable insight into the impact of the OGEP program on nurses • Raised community nurses' awareness of LE • Extent of knowledge retention is unknown • Study had limitations (time constraints, small sample) • Data obtained retrospectively (recall biases) **Barriers:** • Some felt that community nurses were already overstretched and would have difficulty implementing more preventative care • Many nurses reluctant to change practice

Study/Design	Methods	Key Results	Comments
			Benefits: • Nurses saw benefit that they could share their learning with patients • Improved confidence in assessment • Improved knowing when/how to refer to a LE specialist • All agreed new knowledge and skills had benefits for patients • Perceived to improve patient self-management and QoL • Immediate practice-based knowledge and skills transfer from engaging in OGEP had a positive influence on patients • Improved awareness of LE led to earlier interventions • Nurses reflection on practice • Nurses believed OGEP was a “step in the right direction”

Appendix II: Consultation Report

The Development of an e-Learning Resource on the Assessment, Treatment, and Management of Lymphedema: A Review of the Literature

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In Canada, it is estimated that one million Canadians live with some form of lymphedema/chronic edema (Keast et al., 2019). The terms lymphedema and chronic edema are often used interchangeably, with most current definitions considering all chronic edema as lymphedema (Keast et al., 2019; Moffatt et al., 2019). Characterized as a progressive swelling, lymphedema usually affects the limbs, but may affect other areas, such as the head, neck, trunk, or genital regions. Keast et al. (2019) and Moffatt et al. (2019) suggested that lymphedema is an under-recognized and under-treated, global, chronic health condition. The literature review, conducted for this practicum project, revealed that lower limb lymphedema is the most common form of lymphedema (Grada & Phillips, 2017; Moffatt et al., 2019). Once lymphedema develops, this life-long condition requires ongoing management and treatment (Benbow, 2009; Grada & Phillips, 2017; Todd, 2018). Many co-morbid conditions may contribute to the development of lymphedema, but treatment and management of all types of lymphedema remain similar. Early recognition and treatment of lymphedema require nurses to have the knowledge and skills to provide safe care. Moffatt et al. (2003) suggested that lymphedema management must be introduced to the front-line service providers to best address lymphedema in the community. A study by Morgan et al. (2005) suggested community nurses need education and training on the assessment and management of lymphedema.

Continuing care nurses at Central Health are often required to assess and provide care for clients with lymphedema to their lower limbs. To do this, the continuing care nurse needs to have the knowledge and skills to safely manage their clients with lymphedema in the community. Evaluations from previous one-day workshops indicated the need for more education on the assessment, treatment, and management of lymphedema. This was the impetus for this practicum project and the proposal to develop an e-learning module on lymphedema.

Following a thorough literature review, it was determined that consultations with two stakeholder groups were required to identify and consider the relevant needs of the stakeholders in this project. The purpose of these consultations was to determine the perceived priority learning needs of continuing care nurses at Central Health, related to the assessment, treatment, and management of lower limb lymphedema. This consultation report outlines the consultation process, analysis of the questionnaires and themes presented, comparisons between groups, and the implications for the development of an e-learning module on the assessment, treatment, and management of lower limb lymphedema.

Methods

Setting and Sample

The setting for the consultations was within the Home and Community Nursing Department at Central Health. Two large community health clinics and multiple rural community health clinics made up the setting, which covered a large geographical region in central Newfoundland and Labrador. The setting was appropriate as stakeholders could easily be contacted electronically via the Central Health email system.

Two groups of stakeholders were identified for consultation. The larger group consisted of 71 continuing care nurses that worked at the various community health clinics throughout the Central Health region. This group was considered the key stakeholders in this project and the target group to which the e-learning module would be directed. Continuing care nurses had previously identified, through evaluations conducted following a one-day workshop, a need for further educational resources on the assessment, treatment, and management of lower limb lymphedema. Therefore, this group was limited to continuing care nurses and not the total population of nurses who worked within Central Health. The second group, comprised of the

Manager of Home and Ambulatory Services, Director of Home and Ambulatory Services, Regional Enterostomal Therapy Coordinator, and the Clinical Lead – Home and Community Nursing, were chosen for their vested interest in the development of an e-learning module for continuing care nurses. All have responsibilities for ensuring education programs are provided to the continuing care nurses at Central Health. Previous informal discussions with these four stakeholders had identified a need for additional evidence-based resources for continuing care nurses to support assessment and safe, client-centered care to those living with lymphedema in the community setting.

Consulting these two stakeholder groups was important to ensure both groups had the opportunity to provide input into the development of an e-learning module on the assessment, treatment, and management of lower limb lymphedema. Having input that was representative of those who would use the e-learning module aimed to ensure the learning needs of continuing care nurses were considered and addressed. The purpose of getting support from the manager, director, and two colleagues was to facilitate the development of an additional, evidence-based, educational resource on the assessment, treatment, and management of lower limb lymphedema.

Data Collection

Data were collected using a group-specific questionnaire that was sent electronically on June 18th, 2020 via Central Health email to the two identified stakeholder groups. Each group received two reminder emails, with the deadline for responses requested no later than June 26th, 2020.

Seventy-one continuing care nurses were sent the initial email, with an attached questionnaire and a letter, explaining the practicum project and purpose of the questionnaire. A copy of the email, questionnaire, and letter can be found in Appendices A, B, and C respectively.

The questionnaire was structured and consisted of a combination of nine yes/no or open-ended questions that provided an opportunity for the continuing care nurse to elaborate on their choice of answer. The final question allowed for the nurse to agree to be contacted if further clarification was needed. The questionnaire was voluntary, and nurses had the choice of returning the questionnaire by email or anonymously through the Central Health internal mail system.

The Manager of Home and Ambulatory Services, Director of Home and Ambulatory Services, Regional Enterostomal Coordinator, and the Clinical Lead – Home and Community Nursing, all were sent an email, with a questionnaire and letter attached, explaining the practicum project and the purpose of the questionnaire. A copy of the email, questionnaire, and letter can be found in Appendices D, E, and F respectively. The questionnaire was structured and consisted of five yes/no or open-ended questions, which provided an opportunity for these select stakeholders to elaborate on their choice of answer. The manager, director, and two colleagues will herein be referred to as *colleagues* to ensure anonymity and to facilitate easier identification of this group.

Data Management and Analysis

The returned questionnaires (electronic and paper copies) from the two stakeholder groups were coded using a numbering system and stored electronically as a pdf file in different folders on a designated, password-protected laptop owned by Central Health. The paper copies once scanned were shredded.

Two tables for each group were developed in Microsoft Word to organize the data from each of the questionnaires. Tables created were stored on the protected drive of the designated laptop. Content analysis was used to count the responses and to categorize the data based on similarities, which created themes. Themes and categories were discussed with my practicum

supervisor prior to being finalized. The themes were further analyzed to determine if the themes identified were consistent with the literature review previously conducted. The two groups were initially analyzed separately, reviewing the comments for each question. The comments were grouped in a table under the corresponding question. Once responses were collated, the comments could be easily counted for frequency of the same reply or compared for the similarity of themes. A second table was created, with themes identified. The comments for this table were categorized under the specific theme that best supported the comment. Where a decision could not be made to which theme the comment should be placed, the comment was included under both themes.

Ethical Considerations

This practicum project did not require review by the Health Research Ethics Review Board as it was not a research project. The Health Research Ethics Screening Tool was completed and can be found in Appendix G of this consultation report. Permission to conduct the consultations by email was obtained through the Manager of Home and Ambulatory Services. I had access to the email addresses of my colleagues and all continuing care nurses at Central Health, with the ability to store all correspondence on the Central Health protected network. The questionnaires were voluntary, and a letter sent to each potential participant explained the practicum project and purpose of the questionnaire. Agreement to be consulted was assumed for those who returned the questionnaire. All returned questionnaires were numerically coded, and the data were aggregated. Therefore, the privacy of all participants in each group was secured.

Results

Seventy-one continuing care nurses and four colleagues were sent separate questionnaires electronically. Of the 71 questionnaires sent to the continuing care nurses, 16 were completed

and returned, representing a 22.5% return rate. All four of the colleague questionnaires were completed and returned. Information that could be categorized as numerical data was summarized in Table 1. The questionnaire for the continuing care nurses differed from the questionnaire sent to the colleagues. Therefore, responses could not always be compared by the question. The responses to each question were collated, and the results were reported as a summary and not as individual responses. Where possible, the responses of the two groups were compared and reported together to further synthesize and facilitate the flow of the analysis. The responses could be compared by themes as the same themes emerged from the comments reported by each group in the analysis.

Table 1

Continuing Care Nurses: Questionnaire Summary

Questions	Yes	No	Total
Have you completed the one-day workshop on lymphedema and bandaging offered through Central Health?	14	2	16
Was the one-day workshop sufficient in addressing your learning needs on lymphedema management?	12	1	13
Would you be willing to be contacted during the development of this e-learning module if needed?	11	5	16
Would an e-learning module on the assessment, treatment, and management of lymphedema be of benefit to increase your knowledge?	15	1	16
Do you have a preferred format for learning?	6	10	16

The first two questions, in the questionnaire posed to the continuing care nurses, were asked to obtain background and differed from those asked of the colleagues. The continuing care nurses were asked if they had completed the one-day workshop on lymphedema offered by Central Health, and if so, did the workshop address their learning needs on lymphedema management. The majority (14) of 16 participants indicated they had completed the one-day

workshop on lymphedema, which suggested many of the participants had some previous knowledge on assessment, treatment, and management of lymphedema. Twelve participants reported the workshop was sufficient. The participants who did not respond either did not attend a previous workshop or could not remember. An additional question asked the continuing care nurses if they would be willing to be contacted. This question was asked to obtain permission to contact specific nurses if further input was needed during the development of the e-learning module. There was a very positive response from the continuing care nurses to this question, with 11 of the 16 nurses agreeing to be contacted. The nurses were not further consulted during this consultation process, but their names and contact information were stored in a secure file on my laptop in case further consultation might be needed during the development of the e-learning module.

Fifteen of the continuing care nurses indicated that an e-learning module on the assessment, treatment, and management of lymphedema would be of benefit to increase their knowledge. This is further discussed in the section on *Mode of Delivery* in this consultation report. Six continuing care nurses had a preferred format for learning, with 10 nurses indicating no preference. Preference for learning face-to-face versus e-learning is discussed in a subsequent section in this report, with six nurses preferring face-to-face learning over an e-learning method.

Two broad themes emerged from the analysis of the responses from the two groups of participants. These themes were categorized as Content and Mode of Delivery.

Content

Each group was asked a question about what content they would like to see included in the e-learning module. Fifteen continuing care nurses and all four colleagues identified specific content they believed should be included. Consistent sub-themes emerged from both groups that there were learning needs for anatomy, physiology, pathophysiology, assessment, treatment, and management of lymphedema.

Anatomy, Physiology, and Pathophysiology

Both groups agreed that an e-learning module should contain content on the etiology of lymphedema, specifically, the link between cellulitis and lymphedema. While the continuing care nurses were further interested in the types and causes of lymphedema, such as obesity-related lymphedema, the colleagues identified understanding the links between venous disease and lymphedema, wounds and lymphedema, and skin and wound care as priorities.

Assessment

There was a consensus in both groups that knowing when to refer clients for specialized assessment was important. The participants in both groups suggested broad assessment skills would be needed, with the continuing care nurses wanting to know signs and symptoms of early lymphedema. The continuing care nurses also suggested the need to know how lymphedema affects the client mentally and physically, with the colleagues suggesting the e-learning module could improve the nurses' holistic assessment skills. The colleagues further indicated that clients with lymphedema should be identified early, which supported the need for assessment skills. The colleagues also suggested that continuing care nurses should be trained in the use of a Doppler for assessment.

The two consultants within community health that clients with lymphedema are commonly referred are the Regional Lymphedema Nurse and the Enterostomal Therapy Nurse. There is confusion on when and where clients with lymphedema should be referred. The continuing care nurses were more focused on when to refer to the lymphedema program, while the colleagues wanted to ensure the continuing care nurses knew where was most appropriate to refer. It was also recognized by the colleagues that Central Health has only one nurse dedicated to lymphedema management. Therefore, it would be important for continuing care nurses to have the right tools to manage these clients in the community setting, avoiding unnecessary referral to the lymphedema program.

Finally, a colleague indicated it was important for continuing care nurses to recognize that clients who require compression may not require a referral to the lymphedema program. This comment is best addressed under assessment of clients as continuing care nurses would need to have the appropriate assessment skills to determine when to refer to the lymphedema program.

Treatment and Management

Participants in both groups identified that treatment and management of lymphedema was a necessary component to include in an e-learning module. Continuing care nurses and colleagues wanted education on treatment with the various types of compression, including bandaging, addressed in the module. The colleagues indicated all continuing care nurses should be competent in the application of compression. The continuing care nurses suggested a *"quick resource guide,"* and information on alternate forms of compression would be useful to nurses who treat and manage lymphedema. The colleagues suggested that continuing care nurses see many clients with lymphedema in their practice. Therefore, nurses must be able to treat and provide education to their clients to encourage self-care management.

Mode of Delivery

The four colleagues and 15 continuing care nurses indicated there were benefits to e-learning for the delivery of education to continuing care nurses on the assessment, treatment, and management of lymphedema. The colleagues suggested e-learning would be a more *"efficient and time sensitive"* approach to learning especially for rural nurses and orientating new staff. Fifteen continuing care nurses believed e-learning would be of benefit to increase their knowledge of assessment, treatment, and management of lymphedema. Both groups indicated an e-learning module containing information on assessment, treatment, and management of lymphedema could be viewed as needed, and as a *"refresher"* for learning.

The continuing care nurses suggested that nurses have limited experience with lymphedema. Six of 16 participants suggested the e-learning module would be an *"extra resource"* for learning about lymphedema. They also commented that e-learning might work better for rural nurses, eliminating the need to travel to education sessions, which was considered more *"cost effective"* by the nurses. It was important for the continuing care nurses to have an e-learning module that was interactive, easy to read, and contained pictures of people with lymphedema. Nurses recommended the use of video links to enhance the learning experience, suggesting videos specific to bandaging would be of benefit. There was also a suggestion by the continuing care nurses that the e-learning module have a testing component built into the e-learning module. This would facilitate testing the recall of information that was contained in the module.

Overall, the continuing care nurses were divided on their preference for mode of delivery, with some nurses believing an e-learning module was a disadvantage to learning. The continuing care nurses were specifically asked about their preferred format of learning, with six nurses

indicating they preferred face-to-face learning and 10 nurses responding that they did not have a preferred format. The nurses who preferred face-to-face learning indicated a need for *"hands-on"* learning, such as through the one-day workshop offered by Central Health. Two of the nurses who preferred face-to-face learning commented that an e-learning resource would be convenient. Throughout the questionnaire, nurses were given the opportunity to comment freely on what they might like to add to the question asked. Eight nurses used free text on various questions to comment on their preference for e-learning. Despite the mixed messages from the continuing care nurses' group on e-learning, a majority of nurses considered the e-learning mode of delivery a relevant method in which to learn about the assessment, treatment, and management of lymphedema.

Summary and Implications

In summary, the questionnaire responses from both groups had consistent themes, which supported the need to develop an e-learning resource for continuing care nurses on the assessment, treatment, and management of lymphedema. These themes were consistent with those identified in the literature review conducted for this practicum project. The majority (19) of 20 participants from both groups indicated an e-learning module would be beneficial to continuing care nurses at Central Health. The need for content specific to the etiology of lymphedema was recognized in the responses of both groups. The continuing care nurses further suggested information on the signs, symptoms, and types of lymphedema should be covered in the content of the module. Participants in both groups identified the need for knowledge on the link between lymphedema and infection. Having assessment skills to determine when and where to refer was also acknowledged. There was consensus that continuing care nurses would need skills to treat and manage lymphedema, which may include the application of and measurement

for compression, and how to manage skin and wound care. A complete list of the suggested content and processes can be found in Table 2.

Table 2

Suggestions for e-learning content and processes

Content	Processes
Anatomy, Physiology, Pathophysiology	Application of: • Compression bandaging • Stockings
Causes/etiology of lymphedema	Easy to read literature, accessible at anytime
Cellulitis	How to measure: • Limbs • Stockings
Doppler assessment	How, when, and where to refer
Effects on patient mentally and physically • Quality of life	Links to videos
Holistic assessment	Testing Knowledge
Obesity and lymphedema	Use of pictures
Pharmacology and lymphedema	Use of interactive technology
Signs and symptoms	Use of a Doppler
Treatment and management of lymphedema • Compression bandaging and garments • Primary management • Skin care • Compression alternatives	
Types of lymphedema	
Wounds and lymphedema • Venous disease	

While some differences existed in how to deliver education on the assessment, treatment, and management of lymphedema, almost all agreed that there was a place for e-learning in the education of continuing care nurses at Central Health. The development of an e-learning module on lymphedema was not meant to replace in-person teaching, but to provide an additional learning resource that continuing care nurses could avail of prior to attending a one-day workshop on lymphedema. The module could also be used by the continuing care nurses on an

as-required basis to obtain evidence-based information. In conducting the extensive literature review before the consultation process, it was recognized that nurses would need an understanding of the assessment, etiology, pathophysiology, and types of lymphedema. The results of the questionnaires from both groups had components of what was reviewed in the literature. While the literature review focused heavily on measurement tools for assessment, it was only vaguely mentioned in the questionnaire responses. This may be due to continuing care nurses not seeing outcome measurement as a priority and/or the questionnaire not being specific enough to obtain this information. The results from consultations identified a need for education on compression therapy and on skin and wound care. The results did not report exercise as a component in treating lymphedema. This may be due to those participants not being aware of the role exercise plays in lymphedema management. In the literature review, studies reviewed incorporated exercise as a component of treatment. This supports the need for information on the benefit of exercise to be included in the e-learning module.

As the Regional Lymphedema Nurse for Central Health, I aim to ensure educational resources are provided to the continuing care nurses on the assessment, treatment, and management of lymphedema. As the sole practitioner working for the lymphedema program at Central Health, it is imperative that continuing care nurses work to their full scope of practice to alleviate some of the pressures and unnecessary referrals to the Regional Lymphedema Nurse's caseload. This will help to ensure better utilization of resources, and that clients will get the necessary treatment, from the right person, at the right time.

Conclusion

Consultations were carried out as planned with the key stakeholder groups identified in the consultation plan. Analysis of the questionnaires returned by the continuing care nurses and

colleague groups provided insight into what the perceived priority learning needs were for continuing care nurses, on the assessment, treatment, and management of lymphedema. The comments provided in the questionnaires provided a variety of ideas on what will inform the development of the e-learning module for continuing care nurses at Central Health. Consistent themes were noted throughout both groups. The participants of the nurses' and colleague groups suggested content on anatomy, physiology, and pathophysiology of lower limb lymphedema should be included in an e-learning module. The groups also suggested to include the link between obesity and lymphedema, venous disease and lymphedema, and cellulitis and lymphedema. The content sub-themes of assessment, treatment, and management were relevant to what was reviewed in the literature before conducting these consultations. The ideas expressed in the consultations will be integrated into the development of an e-learning module on lymphedema. Where new learning needs were identified, such as understanding the link between obesity and lymphedema, venous disease and lymphedema, and cellulitis and lymphedema, a further search of the literature will be required to determine the evidence surrounding these links to lymphedema.

Going forward it is important to consider that the participants of the continuing care nurses' group want an e-learning module that is easy to read and will include pictures of persons with lymphedema. The nurses suggested the module should be interactive, use video links, and testing to enhance the e-learning experience. This will need to be further explored by conducting an environmental scan to see what strategies others may have used in the development of an e-learning module on lymphedema. Finally, a further review of the literature on teaching strategies for e-learning would need to be completed prior to developing the e-learning module on the assessment, treatment, and management of lower limb lymphedema.

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Appendix A

Sample Email Continuing Care Nurses

Dear Continuing Care Nurses,

Please find attached a letter and questionnaire requesting your input in developing an e-learning module on the assessment, treatment, and management of lymphedema/chronic edema. I am currently completing my practicum project for the Master of Nursing Program at Memorial University and have chosen the development of an e-learning module as part of my practicum experience. As the major stakeholders in this project, I truly would value your input in ensuring your learning needs are addressed in the development of this module. Please take approximately 10-15 minutes to complete the short questionnaire, which can be returned via email or printed and sent anonymously via Central Health's internal mail.

I would greatly appreciate the questionnaire being returned by June 26th, 2020 so I can move forward with this important project. Thanking you in advance for your time and valued opinions.

Sincerely,

Bev

Bev Lanning BN, RN, CLT-LANA

Regional Lymphedema Nurse

Home & Community Nursing

3 Bell Place, Gander, NL

A1V 2T4

Phone: (709) 651-6266

Fax: (709) 651-2394

Appendix B

Practicum Project: Consultation Questionnaire

Continuing Care Nurses, Central Health

Please fill out the following questionnaire to the best of your ability. Feel free to add additional comments as needed. The questionnaire can be filled in electronically or you can print and send via internal mail.

1. Have you completed the one-day workshop on lymphedema and bandaging offered through Central Health?

   Yes No

2. Was the one-day workshop sufficient in addressing your learning needs on lymphedema management?

   Yes No

3. If no, what was missing?

4. Would an e-learning module on the assessment, treatment, and management of lymphedema be of benefit to increase your knowledge?

   Yes No

   Please feel free to comment further if needed.

5. What would you like to see included in an e-learning module?

6. Do you have a preferred format for learning?

   Yes No

7. If yes, please comment further.

8. Is there anything else you would like to add, which may influence the development of this learning module or address your specific learning needs?

9. Would you be willing to be contacted during the development of this e-learning module if needed?

   Yes No

Please provide contact information if agree to be contacted.

I would like to take this opportunity to thank you for completing this questionnaire and assisting me in my practicum project. Your opinions and ideas are very important to me in the development of a new learning module. I look forward to sharing the finished product with you in the fall.

Thank you,

Bev

Appendix C

Sample Letter Attached to Questionnaire

June 15th, 2020

Dear Continuing Care Nurses,

Many of you already know me through the Lymphedema Management Program at Central Health, but for those I have not met, my name is Bev Lanning and I work as the Regional Lymphedema Nurse for Central Health. I am currently completing my practicum project as part of the Master of Nursing Program at Memorial University and have chosen to develop an e-learning module on the assessment, treatment, and management of lymphedema/chronic edema.

Many of you have already attended the one-day workshop offered on lymphedema and bandaging. A review of past evaluations indicated that many would like additional resources for learning, with some suggesting an e-learning module may be of benefit.

As part of the consultation process it is very important for me to have your valued input on this project. As the main stakeholders, continuing care nurses have an opportunity to ensure your learning needs are addressed, which is why I would like to invite you to participate in a short questionnaire to allow you to express what you believe should be included in this module. The questionnaire will take approximately 10-15 minutes to complete and can be emailed back to me or printed and returned via internal mail anonymously.

Please feel free to contact me at (709) 651-6266 if you would like to discuss further. It would be greatly appreciated if you can send the completed questionnaire to me by June 26th, 2020 so that I can keep this project moving forward. Thanking you in advance for considering this request and assisting me in the completion of this important project. I look forward to sharing the finished project with you in the coming months.

Sincerely,

Bev Lanning RN, BN, CLT-LANA

Regional Lymphedema Nurse

Central Health

Gander, NL

Appendix D

Sample Email to Manager/Director/Colleagues

Dear (address to specific person),

Please find attached a letter and questionnaire requesting your input in developing an e-learning module on the assessment, treatment, and management of lymphedema/chronic edema. As you are aware, I am currently completing my practicum project for the Master of Nursing Program at Memorial University and have chosen the development of an e-learning module as part of my practicum experience. As part of the consultation process, I would greatly appreciate your input on this project. Please take approximately 10-15 minutes to complete the short questionnaire which can be returned via email or printed and sent via Central Health's internal mail.

I would greatly appreciate the questionnaire being returned by June 26th, 2020 so I can move forward with this important project. Thanking you in advance for your time and valued opinions.

Sincerely,

Bev

Bev Lanning BN, RN, CLT-LANA

Regional Lymphedema Nurse

Home & Community Nursing

3 Bell Place, Gander, NL

A1V 2T4

Phone: (709) 651-6266

Fax: (709) 651-2394

Appendix E

Practicum Project: Consultation Questionnaire

Manager/Director/Colleagues

Please fill out the following questionnaire to the best of your ability. Feel free to add additional comments as needed. The questionnaire can be filled in electronically or you can print and send via internal mail.

1. Do you believe an e-learning module on the assessment, treatment, and management of lymphedema would be helpful for continuing care nurses?

   Yes No

   Please comment:

2. Do you have any specific content you would like to see covered in the module?

   Yes No

   If yes, please comment:

3. Is there a specific technology you would like to see incorporated into the e-learning module?

   Yes No

   If yes, please comment further:

4. Do you think the e-learning module should be mandatory for continuing care nurses?

   Yes No

   Please comment why or why not:

5. Is there anything else you would like to add, which may influence the development of this learning module or address your concerns?

I would like to take this opportunity to thank you for completing this questionnaire and assisting me in my practicum project. Your opinions and ideas are very important to me in the development of an e- learning module. I look forward to sharing the finished product with you in the fall.

Thank you,

Bev

Appendix F

Sample Letter Colleagues Attached to Email Questionnaire

June 15th, 2020

Dear Nursing Colleagues,

As you are aware, I am currently completing my practicum as part of the Master of Nursing Program at Memorial University and have chosen to develop an e-learning module on the assessment, treatment, and management of lymphedema/chronic edema.

As part of the consultation process it is very important for me to have your valued input on this project. I would like to invite you to participate in a short questionnaire to better understand what you hope this e-learning module should accomplish, including how best to present the material. The questionnaire will take approximately 10-15 minutes to complete and can be emailed back to me or printed and returned via internal mail.

Please feel free to contact me at (709) 651-6266 if you would like to discuss further. It would greatly be appreciated if you can return the completed questionnaire to me by June 26th, 2020. Thanking you in advance for considering this request and I look forward to your comments and sharing this project with you once completed.

Sincerely,

Bev Lanning RN, BN, CLT-LANA

Regional Lymphedema Nurse

Central Health

3 Bell Place

Gander, NL

A1V 2T4

Appendix G: Health Research Ethics Authority (HREA) Screening Tool

Student Name: Beverly-Anne Lanning

Title of Practicum Project: The Development of an e-Learning Resource on Lower Limb Lymphedema for Continuing Care Nurses

Date Checklist Completed: July 10th, 2020

This project is exempt from Health Research Ethics Board approval because it matches item number 4 from the list below.

1. Research that relies exclusively on publicly available information when the information is legally accessible to the public and appropriately protected by law; or the information is publicly accessible and there is no reasonable expectation of privacy.
2. Research involving naturalistic observation in public places (where it does not involve any intervention staged by the researcher, or direct interaction with the individual or groups; individuals or groups targeted for observation have no reasonable expectation of privacy; and any dissemination of research results does not allow identification of specific individuals).
3. Quality assurance and quality improvement studies, program evaluation activities, performance reviews, and testing within normal educational requirements if there is no research question involved (used exclusively for assessment, management or improvement purposes).
4. Research based on review of published/publicly reported literature.
5. Research exclusively involving secondary use of anonymous information or anonymous human biological materials, so long as the process of data linkage or recording or dissemination of results does not generate identifiable information.
6. Research based solely on the researcher's personal reflections and self-observation (e.g. auto-ethnography).
7. Case reports.
8. Creative practice activities (where an artist makes or interprets a work or works of art).

For more information please visit the Health Research Ethics Authority (HREA) at https://rpresources.mun.ca/triage/is-your-project-exempt-from-review/

Appendix III: Environmental Scan Report

The Development of an e-Learning Resource on the Assessment, Treatment, and Management of Lymphedema: A Review of the Literature

Beverly-Anne Lanning

Memorial University

Lymphedema/chronic edema is a condition that has been broadly defined as edema that persists for more than three months (Keast et al., 2019; Moffatt et al., 2019). The swelling usually affects the limbs, but may affect the head, neck, trunk, or genital regions (Keast et al., 2019; Moffatt et al., 2019). The terms lymphedema and chronic edema are often used interchangeably, which has confused the use of these terms. Most current definitions now suggest that all chronic edema will cause lymphatic impairment. Therefore, all chronic edema is lymphedema (Keast et al. 2019; Moffatt et al., 2019). Lymphedema is a progressive condition that requires life-long management and treatment (Benbow, 2009; Grada & Phillips, 2017; Todd, 2018). Moffatt et al. (2003) and Morgan et al. (2005) suggested that front-line workers, such as community nurses, need training in lymphedema assessment and management. Continuing care nurses at Central Health are the primary providers of care to the many clients with lymphedema within the Central Health region. Therefore, these nurses need to have the knowledge and skills to safely and effectively treat and manage clients with lymphedema in the community setting.

The Lymphedema Management Program (LMP) at Central Health has provided services for clients with lower limb lymphedema since 2011. A division of Home and Community Nursing, the LMP has one nurse responsible for providing education to health care providers at Central Health on the assessment, treatment, and management of lymphedema. Central Health consists of a large geographical area, with continuing care nurses providing much of the care to clients with lymphedema in the community setting. All continuing care nurses at Central Health are required to complete a one-day workshop on the assessment, treatment, and management of lower limb lymphedema. Evaluations completed following this one-day workshop have suggested that continuing care nurses require additional learning resources to manage clients with lymphedema. Therefore, the purpose of this practicum project is to develop an e-learning

module on the assessment, treatment, and management of lower limb lymphedema for continuing care nurses at Central Health.

The literature review conducted for this practicum project revealed that much of the research on lymphedema had been conducted on upper extremity, cancer-related lymphedema, despite lower extremity lymphedema being more common (Grada & Phillips, 2017; Moffatt et al., 2019). Existing educational resources on lymphedema management have mainly been developed to address breast cancer-related lymphedema. The program at Central Health is primarily a lower extremity clinic and is not directed at cancer-related lymphedema, making much of the available resources not applicable to the majority of clients at Central Health. Finding existing educational resources that may be useful in developing an e-learning module on lower extremity lymphedema was the focus of conducting the environmental scan.

The purpose of this environmental scan was to reach out to known contacts, select health authorities, lymphedema organizations, and associations provincially, nationally, and internationally to seek out e-learning educational resources already developed for health care providers on assessment, treatment, and management of lower limb lymphedema. Any educational resources located may be used to inform the development of an e-learning module for continuing care nurses at Central Health.

Objectives of the Environmental Scan

The objectives of this environmental scan were as follows:

1. To ascertain if other health authorities, lymphedema organizations, and associations or personal contacts have or know of existing e-learning modules for health care providers on the assessment, treatment, and management of lower limb lymphedema.

2. To identify how other health authorities, lymphedema organizations, and associations use technology to present e-learning education on the assessment, treatment, and management of lower limb lymphedema.
3. To identify what content and measurement tools have been included in other e-learning modules developed for health care providers, who assess, treat, and manage lower limb lymphedema.

Methods

The environmental scan was conducted targeting two groups of sources. The sources, seven personal contacts and eleven website administrators, were contacted by email on July 1st, 2020. A copy of the email sent to the personal contacts and website administrators can be found in Appendices A and B, respectively. The email explained my practicum project and asked the sources if they knew of existing e-learning modules for health care providers on the assessment, treatment, and management of lower limb lymphedema. A request was also made to share or discuss what was available, which may assist in developing an e-learning resource for Central Health. Personal sources and website administrators were informed that any details shared would be confidential and only shared with my practicum supervisor, who is overseeing this project. Sources were informed that any request for further sharing of information or adaptation of content for the proposed e-learning module would be obtained in writing from the appropriate sources. Responses to the email were requested by July 10th, 2020.

Personal Contacts

The personal contacts represented well-established lymphedema programs and would know if any e-learning resources for health care providers were in existence in their region or possibly elsewhere. The personal contacts were known to me through attending conferences and

working on national initiatives under the Canadian Lymphedema Framework (CLF). The CLF is a national, non-profit organization that works collaboratively to advance lymphedema care nationally and internationally.

The personal contacts were affiliated with the following health care institutions or organizations:

1. Canadian Lymphedema Framework
2. Eastern Health, Newfoundland and Labrador
3. Faculty of Rehabilitative Medicine, University of Alberta
4. Horizon Health, Saint John, New Brunswick
5. International Lymphedema Framework, United Kingdom
6. McGill University Health Centre, Lymphedema Program, Quebec
7. Sinclair School of Nursing, University of Missouri Health, United States of America

Website Administrators

The website administrators, of health authorities, organizations, and associations websites, were contacted for links to online education for health care providers on the assessment, treatment, and management of lymphedema.

The administrators of the following websites were contacted:

1. Alberta Health Service (www.albertahealthservices.ca)
2. Alberta Lymphedema Association (www.albertalymphedema.com)
3. American Lymphedema Framework (www.alfp.org)
4. Australasian Lymphedema Association (www.lymphoedema.org.au)
5. British Columbia Lymphedema Association (www.bclymph.org)
6. Canadian Lymphedema Framework (www.canadalymph.ca)

7. International Lymphedema Framework (www.lympho.org)
8. Lymphedema Association of Ontario (www.lymphontario.ca)
9. Lymphedema Association of Quebec (www.en.infolympho.ca)
10. McGill University Health Centre (www.muhc.ca)
11. Sunnybrook Health Services (www.sunnybrook.ca)

Data Collection and Management

All correspondence received from my personal contacts and the website administrators were stored electronically in separate files on my designated laptop owned by Central Health. The laptop is password-protected, and information stored is housed on the secure Central Health network. Information was only shared with my practicum supervisor, who is an integral part of this practicum project.

The responses were analyzed for relevance to my practicum project, and any educational materials shared were reviewed for content and presentation style. Specifically, the content was analyzed for current evidence-based information and practice. Any new information was reviewed to consider whether it should be included in the proposed e-learning module for continuing care nurses at Central Health. I also noted how the e-learning modules were presented, including the use of illustrations, video links, and testing that may enhance learning.

Ethical Considerations

This practicum project did not require review by the Health Ethics Review Board as it was not a research project. The Health Research Ethics Authority Screening Tool was completed and can be found in Appendix C of this environmental scan report. Agreement to share information was voluntary and up to the persons contacted if they wished to reply to the email. All emails were kept confidential and only shared with my practicum supervisor as needed. All

sources contacted were informed that any plans for further sharing of information or adaptation of content would be obtained in writing from the appropriate sources if any material was to be used in the development of the e-learning module for this practicum project. Any information used would be referenced accordingly in the completed e-learning module.

Results

Personal contacts (2 of 7) and website administrators (3 of 11) responded to the email I sent requesting information on the existence of any e-learning modules for health care providers on the assessment, treatment, and management of lower limb lymphedema. The personal contacts who responded were affiliated with the CLF and McGill University Health Centre, Lymphedema Program. The website administrators were from the Alberta Lymphedema Association, Australasian Lymphedema Framework, and the Lymphedema Association of Quebec. None of the five sources who replied had e-learning modules specific to their programs, associations, or organizations. However, the sources were able to provide three links to e-learning modules from other organizations. The e-learning modules were produced by the British Columbia Provincial Nursing and Wound Care Committee (BCPSWCC), BMJ Learning, and CEUFast Nursing. Suggestions were also made to search four additional websites and to contact a researcher from Wales, United Kingdom to seek out possible e-learning modules/videos that may be in existence elsewhere.

The following links (3), websites (4), and researcher (1) suggested by the sources were:

1. BCPSWCC: Education Module https://www.clwk.ca/wp-content/uploads/2016/10/Compression-Therapy-Education-Module1.pdf
2. BMJ Learning: Module Chronic Edema/Lymphedema https://learning.bmj.com/learning/module-intro/.html?moduleId=10029385

3. CEUFast Nursing CE: Lymphedema Module https://ceufast.com/course/wound-series-part-4-lymphedema-and-chronic-wounds
4. Casley-Smith International Lymphatic Training (www.casleysmithinternational.org)
5. Dr. Vodder School International (www.vodderschool.com)
6. Norton School of Lymphatic Therapy (www.nortonschool.com)
7. Klose Training (www.Klosetraining.com)
8. Dr. Melanie Thomas, National Clinical Lead for Lymphoedema in Wales, United Kingdom

The three links (BCPSWCC Education Module, BMJ Learning, and CEUFast Nursing CE: Lymphedema Module) to e-learning modules were reviewed. None of these modules fully addressed the assessment, treatment, and management of lymphedema. The four websites, Casey-Smith International Lymphatic Training, Dr. Vodder School International, Norton School of Lymphatic Therapy, and Klose Training, were reviewed for e-learning modules/videos. The first three websites charged for their e-learning and were not reviewed further. The Klose Training website provided a series of four training videos entitled *Lymphedema 101* which were further reviewed. These four videos from Klose Training contained some of the desired content on assessment, treatment, and management of lymphedema, but were more for information purposes than for education of nurses in lymphedema care. A researcher, Dr. Melanie Thomas, Clinical Lead for Lymphoedema in Wales, United Kingdom was contacted by email. The same email was sent to Dr. Thomas as the other sources contacted in the initial scan. Dr. Thomas provided a link to six training videos produced by the United Kingdom, National Health Service Network (NHSN), Wales. The six training videos provided basic information about lymphedema

and care that could be useful to health care providers and patients, but not specific to nursing care. The hyper-links to all modules and videos reviewed can be found in Table 1.

Table 1

E-learning Links

Administrator/ Module	Learning Module or Website Videos	Link
BCPSWCC: Education Module	Learning Module	https://www.clwk.ca/wp-content/uploads/2016/10/Compression-Therapy-Education-Module1.pdf
BMJ Learning: Module Chronic Edema/Lymphedema	Learning Module	https://learning.bmj.com/learning/module-intro/.html?moduleId=10029385
CEUFast Nursing CE: Lymphedema Module	Learning Module	https://ceufast.com/course/wound-series-part-4-lymphedema-and-chronic-wounds
Klose Training: Lymphedema Videos	Website Videos	https://klosetraining.com/course/online/
United Kingdom, NHSN, Wales: Lymphedema Videos	Website Videos	http://www.medic.video/can-lymph-edu

The e-learning modules and videos were carefully reviewed for content (topics), presentation style, and applicability to my practicum project. The modules and videos were further reviewed for the specific topics and presentation styles that were suggested by the stakeholders during the consultation process. Following completion of the review it was determined that none of the e-learning modules or videos reviewed contained exactly what I had envisioned an e-learning module on lymphedema to include for continuing care nurses. The content and presentation style of each module or video reviewed was presented in Table 2.

Table 2

E-learning Content and Presentation Style of Modules and Videos

	BCPSWCC Education Module	BMJ Learning Chronic Edema Module	CEUFast Nursing CE Lymphedema Module	Klose Training Lymphedema Training Videos	United Kingdom NHSN Wales Lymphedema Videos
Pictures	X	X	X	X	X
Treatment & Management	X	X	X	X	X
Compression	X	X	X	X	X
Anatomy Physiology Pathophysiology		X	X	X	X
Assessment		X	X	X	X
Causes		X	X	X	X
Diagnosis		X	X	X	X
Signs and Symptoms		X	X	X	X
Cellulitis Link		X		X	X
Post-test	X	X	X		
Videos		X		X	X
Certificate of Completion		X	X		
Client-Centered				X	X
Interactive		X	X		
Obesity Link				X	X
Types		X		X	
Wound & Skin			X		X
Assessment Tools/Outcomes	X				
Doppler Assessment	X				
Venous/Arterial	X				
Pre-test		X			
Fee Charged for Certificate of Completion			X		

Note. Red **X** indicates the topic/presentation is included in a module. Green **X** indicates the topic/presentation is identified in a video.

Summary of Findings

All e-learning modules/videos reviewed had elements of what I had envisioned to include in an e-learning module on lymphedema. The modules/videos also contained some of the content and presentation styles suggested by the participants through the consultation process. Details of the type of content and presentation styles noted in the e-learning modules/videos can be found in Table 2. All e-learning modules/videos covered components of assessment, treatment, and management of lymphedema, with treatment using compression therapy, acknowledged in all five. Five e-learning modules/videos were illustrated with pictures of persons with lymphedema. This was considered important to the continuing care nurses during the consultation process. The anatomy, physiology, and pathophysiology of lymphedema were covered in four e-learning modules/videos, with animated videos to demonstrate the physiology of the lymphatic system included in three. The majority (4 of 5) of the modules/videos included content on assessment, causes, diagnosis, and signs and symptoms of lymphedema. Three modules had a post-test included, with two modules being interactive for testing. Only one of the interactive modules also included a pre-test. Two modules offered a certificate, with continuing education hours awarded upon completion. One of those modules required the user to pay a fee to obtain the certificate.

There was a lack of content on assessment tools and measurement outcomes in all modules/videos. Only one module covered Doppler assessment, but this was specific to venous and arterial disease and not to lymphedema assessment. The link between cellulitis and lymphedema was reviewed in one module and two videos, while wound care was covered briefly in one module and a video. There was limited information on lymphedema and obesity, which was only briefly covered in two videos viewed. The videos produced by Klose Training and the

NHSN, Wales were client-centered, with the NHSN, Wales videos appropriate for health care providers and clients who would be interested in basic lymphedema information. The videos provided information; however, knowledge was not tested.

Conclusion

The environmental scan included provincial, national, and international contacts to ensure a broad landscape of potential sources of information were reached. Findings included three e-learning module links and two links to sites with videos on the assessment, treatment, and management of lymphedema. The resources were helpful to see how others presented and used technology to provide education or information on lymphedema and related conditions. No resource met all components of the assessment, treatment, and management of lower limb lymphedema as was highlighted in Table 2. Resources from four lymphedema schools/training centers were available for purchase only and could not be reviewed.

The environmental scan results suggested there were no e-learning modules/videos available that adequately addressed all the learning needs identified for continuing care nurses at Central Health. This educational resource gap supported the need to develop a module and supported the choice of specific content to include in the e-learning module on the assessment, treatment, and management of lower limb lymphedema for the continuing care nurses at Central Health.

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Morgan, P. A., Moody, M., Franks, P. J., Moffatt, C. J., & Doherty, D. C. (2005). Assessing community nurses' level of knowledge of lymphoedema. *British Journal of Nursing, 14*(1), 8-13. https://doi.org/10.12968/bjon.2005.14.1.17365

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Appendix A

Sample of Email to Known Contacts

Dear (name of known contact),

I met you previously through my work with the Canadian Lymphedema Framework, Research Working Group and through attendance at national and international conferences on lymphedema. As part of an environmental scan, **I am writing you to ask if you know of the existence of any e-learning modules for health care providers on the assessment, treatment, and management of lower limb lymphedema.** If you are aware and able to share or know of a specific person or organization to contact, it would be greatly appreciated.

I am currently completing my practicum project for the Master of Nursing Program at Memorial University in Newfoundland and Labrador and have chosen the development of an e-learning module on the assessment, treatment, and management of lower limb lymphedema as part of my practicum experience. Any information shared at this point would only be with my practicum supervisor. If I am interested in using or adapting any material you share in the development of the e-learning module, I will contact you for the appropriate written permissions to use the content. Material you share will not be used without permission. Content used for the development of this e-learning module would be referenced accordingly in the completed e-learning module.

Please respond by **July 10th, 2020** so I can move forward with this important project. Thank you in advance for your time and any information you can share.

Sincerely,

Bev Lanning RN, BN, CLT-LANA

Regional Lymphedema Nurse

Home & Community Nursing

Central Health

3 Bell Place

Gander, NL

Canada

Appendix B

Sample Email to Website Sources

Hello,

My name is Bev Lanning and I work as the Regional Lymphedema Nurse for the Lymphedema Management Program at Central Health in Newfoundland and Labrador, Canada. As part of an environmental scan, **I am writing you to ask if you know of the existence of any e-learning modules for health care providers on the assessment, treatment, and management of lower limb lymphedema.** If you are aware and able to share or know of a specific person or organization to contact, it would be greatly appreciated.

I am currently completing my practicum project for the Master of Nursing Program at Memorial University in Newfoundland and Labrador, Canada and have chosen the development of an e-learning module on the assessment, treatment, and management of lower limb lymphedema as part of my practicum experience. Any information shared at this point would only be with my practicum supervisor. If I am interested in using or adapting any material you share in the development of the e-learning module, I will contact you for the appropriate written permissions to use the content. Material you share will not be used without permission. Content used for the development of this e-learning module would be referenced accordingly in the completed e-learning module.

Please respond by **July 10th, 2020** so I can move forward with this important project. Thank you in advance for your time and any information you can share.

Sincerely,

Bev Lanning RN, BN, CLT-LANA

Regional Lymphedema Nurse

Home & Community Nursing

Central Health

3 Bell Place

Gander, NL

Canada

Appendix C: Health Research Ethics Authority (HREA) Screening Tool

Student Name: Beverly-Anne Lanning

Title of Practicum Project: The Development of an e-Learning Resource on Lower Limb Lymphedema for Continuing Care Nurses

Date Checklist Completed: July 22nd, 2020

This project is exempt from Health Research Ethics Board approval because it matches item number 4 from the list below.

1. Research that relies exclusively on publicly available information when the information is legally accessible to the public and appropriately protected by law; or the information is publicly accessible and there is no reasonable expectation of privacy.
2. Research involving naturalistic observation in public places (where it does not involve any intervention staged by the researcher, or direct interaction with the individual or groups; individuals or groups targeted for observation have no reasonable expectation of privacy; and any dissemination of research results does not allow identification of specific individuals).
3. Quality assurance and quality improvement studies, program evaluation activities, performance reviews, and testing within normal educational requirements if there is no research question involved (used exclusively for assessment, management or improvement purposes).
4. Research based on review of published/publicly reported literature.
5. Research exclusively involving secondary use of anonymous information or anonymous human biological materials, so long as the process of data linkage or recording or dissemination of results does not generate identifiable information.
6. Research based solely on the researcher's personal reflections and self-observation (e.g. auto-ethnography).
7. Case reports.
8. Creative practice activities (where an artist makes or interprets a work or works of art).

For more information please visit the Health Research Ethics Authority (HREA) at https://rpresources.mun.ca/triage/is-your-project-exempt-from-review/

Appendix IV

e-Learning Resource Manual: The Assessment, Treatment and Management of Lower Limb Lymphedema

Developed by Beverly-Anne Lanning RN, BN, CLT-LANA

Education resource developed as a partial requirement for Master of Nursing degree Memorial University of Newfoundland and Labrador

December 2020

TABLE OF CONTENTS

Welcome to e-Learning!

Welcome to the e-learning resource on the assessment, treatment, and management of lower limb lymphedema. The following e-learning resource has been developed for the continuing care nurses (CCNs) at Central Health to facilitate your learning needs on the assessment, treatment, and management of lower limb lymphedema. These learning needs were identified through the various consultations with stakeholders. The resource is intended to supplement the mandatory one-day workshop already offered at Central Health to the CCNs on lymphedema care. It is an expectation that CCNs will complete the three e-learning modules before attending the in-person workshop. This resource will be available on the Learning Management System at Central Health and will be accessible to CCNs at any time should they wish to review. This resource will also be available to any health care professional at Central Health should they wish to learn more about lower limb lymphedema.

The resource consists of three e-learning modules. The first module is an overview of lymphedema. The second module focuses on assessment of lower limb lymphedema, with the third module focusing on the treatment and management of lower limb lymphedema. Each module will contain reflective exercises, case studies, interactive activities, video links, and a quiz to engage you the learner in acquiring the necessary information, education, and skills to care for your clients with lower limb lymphedema.

E-learning will provide you with flexibility in your learning and allow you to complete the modules as needed at your own pace before attending the workshop on lymphedema care. You are encouraged to view all video links and additional learning opportunities to further enhance your understanding of lymphedema

Any terms bolded in the modules can be found in the *Glossary* located in Appendix A at the end of this resource manual. Answer keys to the various case studies, interactive activities, and quizzes can be found for each module in Appendices B, C, and D respectively.

You are invited to take a pre-test before starting the modules to test your knowledge on the assessment, treatment, and management of lower limb lymphedema. The same test will be included at the end of the resource for you take again so that you can self-evaluate your own learning. The answers to this test can be found in Appendix E of this resource manual.

Please enjoy your learning!

Pre-test

Please complete the following pre-test before starting the e-learning modules. Once you have completed your e-learning there will be an opportunity to take the same test again. At the end of the post-test you will be directed to where you can find the answers to the test.

Answer true (**T**) or false (**F**) to the following statements. Place an 'X' in the appropriate box as illustrated.

	Statements	**T**	**F**
1.	Lymphedema is rarely seen in the community setting.		
2.	Lymphedema/chronic edema is broadly defined as swelling lasting more than three months.		
3.	The most common cause of lymphedema worldwide is morbid obesity.		

Choose the most appropriate answer to the following questions by placing an **X** in the correct box.

4. When is the best time to measure for compression stockings?

☐ a. Mid afternoon

☐ b. Before bed

☐ c. Early morning

☐ d. It does not matter when you measure.

5. Compression is contraindicated if the ankle brachial pressure index is:

☐ a. 0.6

☐ b. 1.0

☐ c. > 0.5

☐ d. < 0.5

6. What are some common lower limb characteristics of venous disease?

- [ ] a. varicose veins, itchy legs, hemosiderin staining
- [ ] b. varicose veins, claudication, restless legs
- [ ] c. restless legs, night pain, deep, punched-out ulcer
- [ ] d. hemosiderin staining, varicose veins, absent pulses

7. What are some common signs and symptoms of cellulitis?

- [ ] a. increasing redness to a limb
- [ ] b. fever
- [ ] c. increased warmth to a limb
- [ ] d. all the above

8. Treatments for lymphedema management may include:

- [ ] a. compression stockings
- [ ] b. exercise
- [ ] c. skin care
- [ ] d. all the above

9. As part of risk reduction management for lymphedema the client should:

- [ ] a. complete skin care nightly
- [ ] b. walk as tolerated daily to promote the calf muscle pump
- [ ] c. balance rest with activity
- [ ] d. all the above

10. When measuring for ready-made below the knee compression stockings, the nurse should:

- ☐ a. measure at the largest width of the ankle and calf
- ☐ b. measure in the evening when swelling is the greatest
- ☐ c. measure circumference of the narrowest part of the ankle and widest part of the calf
- ☐ d. all the above

MODULE 1:
OVERVIEW OF LYMPHEDEMA

Module 1: Overview of Lymphedema

The purpose of this module is to provide an overview of what lymphedema is and why lymphedema is a problem in the community setting. This section will review the **prevalence** and impact of lymphedema and why continuing care nurses (CCNs) need knowledge of lymphedema. A brief review of the anatomy, physiology, and pathophysiology of the lymphatic system will be provided, with information on causes and types of lymphedema included. Definitions of bolded terms can be found in the Glossary located in Appendix A of the e-learning resource manual.

This module is intended for use by the CCNs at Central Health but will be accessible through the Learning Management System to any health care professionals at Central Health who have an interest in learning about lymphedema.

This module contains evidenced based information, with reflection exercises, a case study, video links, an interactive activity and quiz to provide an enhanced learning experience for nurses. Embedded videos can be accessed by placing the mouse over the arrow at the center of the video and “clicking” your mouse. You can return to the module by pressing the escape button on your keyboard. Links to websites can be accessed by placing your cursor on the link and pressing the control button on your keyboard while clicking your mouse. You can return to the module by closing the “x” on the open tab on your tool bar

Learning Objectives

Upon completion of this module, you will be able to:

1. Define lymphedema/chronic edema in broad terms;
2. Discuss why lymphedema is a problem and why continuing care nurses need knowledge about lymphedema;
3. Discuss the prevalence and impact of lymphedema;
4. Describe the basic anatomy, physiology, and pathophysiology of the lymphatic system;
5. Apply the basic concepts of how the lymphatic system and cardiovascular system work together; and
6. Identify types and causes of lymphedema.

What is Lymphedema?

Lymphedema is a progressive condition that has been traditionally described as an accumulation of protein-rich fluid in the space between the cells, i.e., the **interstitial space** or **interstitium**.[1-3] More recently, lymphedema has been generally referred to as **chronic edema**. Chronic edema is an umbrella term, which broadly defines edema as any swelling lasting more than three months.[4,5] Keast et al.[4] and Moffatt et al.[5] have argued that any chronic edema will lead to lymphatic dysfunction, therefore, chronic edema is lymphedema. Throughout this e-learning resource the terms lymphedema and chronic edema may be used interchangeably, meaning they are one and the same.

Lymphedema often presents as swelling to a limb, but may affect the trunk, head, neck, or genital regions.[6-8] This excess fluid accumulates in the interstitial spaces of the tissues, which over time leads to impairment or failure of the lymphatic system.[9] Types and causes of lymphedema will be further discussed later in this module. This e-learning resource will focus on lower extremity lymphedema and the assessment, treatment, and management of this troubling condition.

How Common is Lymphedema?

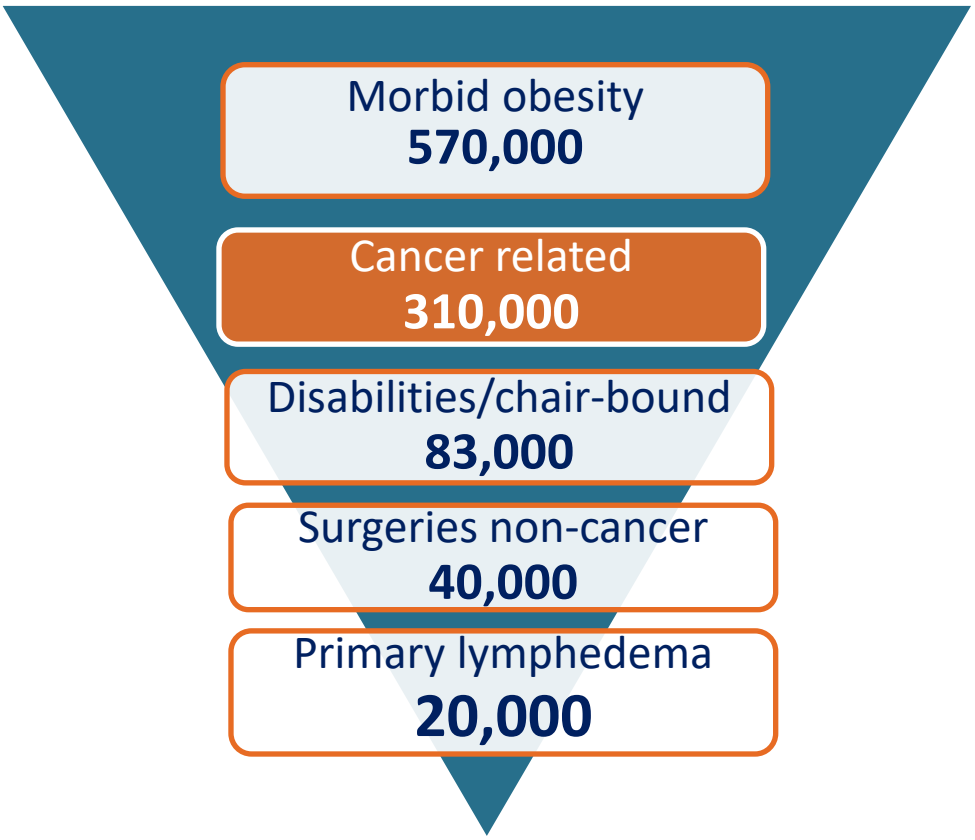
It is not known how many people worldwide are affected by lymphedema, but the limited evidence suggests that globally lymphedema is under-estimated, under-recognized, and a neglected public health issue.[4,5,10] The World Health Organization considers **lymphatic filariasis** to be the most common cause of lymphedema, with an estimated 120 million people affected worldwide.[2] While lymphatic filariasis is not common in North America, it may present a risk to those who travel to the countries of Africa or India where this mosquito-borne infection is endemic.[2]

In Canada, it is estimated that one million Canadians may be affected by lymphedema of various causes.[11] Considered a very conservative estimate by Keast and Towers,[11] these authors have reported that lymphedema in **morbidly obese** persons alone is estimated at 570,000 persons in Canada.

Figure 1.1 provides an estimate of the potential prevalence of lymphedema/chronic edema in Canada based on extrapolation of data from what is already known about lymphedema/chronic edema in specific conditions. Pausing for a moment to ponder this data helps to put into perspective the potential magnitude of this problem.

Figure 1.1

Lymphedema/Chronic Edema: Potential Prevalence in Canada 2018



Source. 2018 Canadian estimates of one million cases of lymphedema/chronic edema per 36 million population. Adapted from "Lymphedema/chronic edema: Potential prevalence in Canada 2018", by D. Keast and A. Towers, 2018. Copyright 2018 by the Canadian Lymphedema Framework. Used with permission.[12]

Why do Nurses Need to Know About Lymphedema?

The limited evidence available suggested that lymphedema is a problem. An extensive literature review conducted prior to creating this e-learning module suggested lymphedema is not just a problem in hospitalized patients, but exists in a variety of settings, which include community health. A study, conducted in the United Kingdom by Moffatt, et al.[13] surveyed three urban-based community services by completing a questionnaire-based interview on all patients (*N* = 2541) over a four week period to determine the number of people with chronic edema utilizing these three community services. The three services reported chronic edema in 51.6%, 59.2%, and 68.5% of their patients respectively. This was considered a growing public health concern within the community setting, which will require nurses in the community to have the skills and knowledge to treat and manage this population.

At Central Health, CCNs are seeing increasing numbers of clients with lymphedema/chronic edema in their lower limbs. These clients require considerable time and resources to manage their care. Given these increasing numbers, CCNs and other key stakeholders were consulted about the learning needs of community nurses. The results of these consultations supported that CCNs need knowledge and understanding in treating persons with lower limb lymphedema in the community setting. Having expertise in this area will better enable you to assist clients to self-manage their care.

Reflection

- Can you think of clients in the community with lower limb swelling?
- Have you considered this swelling to be lymphedema?
- Do you know the cause of their swelling?
- Does the swelling impact their care and life?
- Are there things you need to know in order to safely care for your clients with chronic swelling?

If you have answered yes to any of these questions, this e-learning module will provide valuable information and learning for you! As you progress through the modules, you should be able to develop the knowledge and skills to better manage your clients' care.

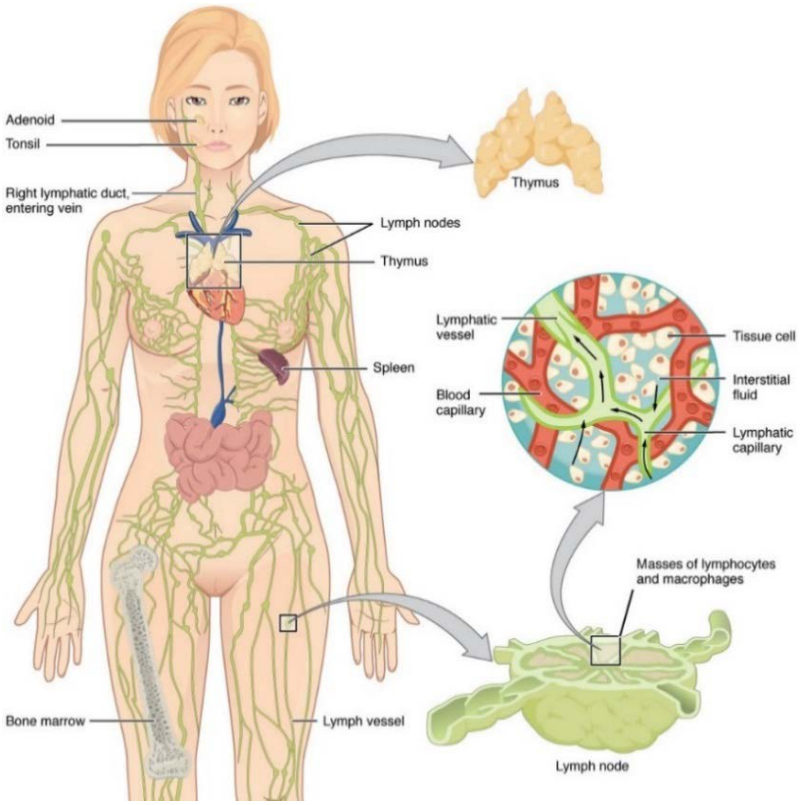
Anatomy and Physiology of the Lymphatic System

The lymphatic system is an intricate system of **lymphatic vessels** and **lymph nodes** that transport and filter fluid from the interstitial spaces back to the circulatory system.[2] Lymphatic organs, such as the lymph nodes, tonsils, thymus, and spleen, play an important role in immune surveillance and activating the immune response to foreign invaders such as bacteria, helping us to fight infection.[2]

Figure 1.2 is an illustration of the lymphatic system and associated lymphatic organs. Review the diagram to become familiar with where the lymphatic organs are in the body. The lymphatic vessels run throughout the body and are depicted in green. These lymphatic vessels run mostly parallel to the venous system.[2,14]

Figure 1.2

Anatomy of the Lymphatic System

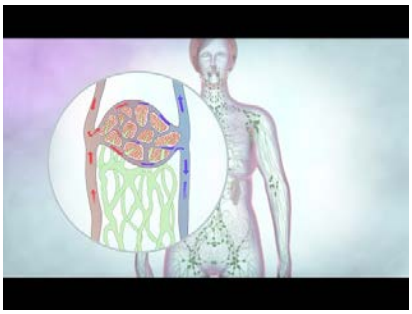


Source. From "Illustration from Anatomy & Physiology, Connexions Web site", OpenStax College, 2013, Wikimedia Commons, Creative Commons Attribution 3.0 Unported.[15]

The lymphatic vessels form a one-way system that carries protein, colloids, and cellular debris initially through the lymphatic capillaries to the larger precollector vessels, which drain into even larger collecting vessels.[14] These collector lymph vessels have lymph nodes situated along the larger vessels.[14] Rhythmic contractions from muscle movement, respiration, and arterial pulsation move the lymph fluid along until it reaches the larger thoracic and right lymphatic ducts. These ducts drain into the right and left subclavian veins.[3,16]

Our overall health depends on a healthy lymphatic system. Apart from a major role in regulating fluid homeostasis and an immune cell response, the lymphatic system also functions to remove cellular debris and plays a role in fat absorption from the gastric system.[3]

Watch the short, animated video on the lymphatic system. Click on the arrow at the center of the video to start. Press the escape button to return to the module.

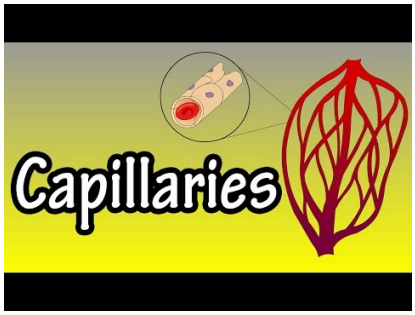


Source. From "The lymphatic drainage system", Cancer Research UK, 2020,[17] https://www.youtube.com/channel/UC01cT8kXmbVH6-mzwaa2qIQ

The lymphatic system functions separately from, but in very close proximity to, the circulatory system at the level of the arterial-venous capillary bed. The circulatory system is a closed system that is pumped by the heart. As blood is pumped throughout the body, oxygen and nutrients are carried through the arteries to the smaller arterioles and blood capillaries where hydrostatic forces promote the transfer of fluid containing the oxygen and nutrients to the interstitial space where the cells can be nourished.[16] Reabsorption of fluid occurs on the venous end of the capillary bed through osmotic forces.[16] While an in-depth understanding of this process is beyond the scope of this module, it is important that you have a basic understanding of the circulatory system and of filtration and reabsorption.

Watch the following short, animated videos to review the basics of the circulatory system and blood capillary network. Click on the arrow at the center of the video to start. Press the escape button to return to the module.

Source. From "Introduction to the circulatory system", by FuseSchool, 2019,[18] https://www.youtube.com/watch?v=73ei6YD0VnM.

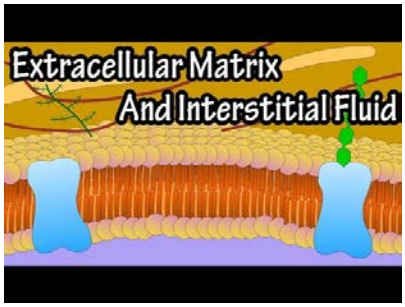


Source. From "Capillaries-What are Capillaries-Functions of Capillaries", by Whats Up Dude, 2016,[19] https://www.youtube.com/watch?v=mQc9mf6w0Tw

How does the Arterial-venous System Work with the Lymphatic System?

Understanding the normal functioning of the circulatory system and the lymphatic system is important when trying to visualize how these systems work together. In the short, animated videos presented above, it showed how the higher pressure in the arteriole vessels causes the blood capillaries to leak fluid into the interstitial spaces. This interstitial fluid contains the oxygen and nutrients needed for cell metabolism and nourishment.

Watch the following short video that explains the role of interstitial fluid and the extracellular matrix. Click on the arrow at the center of the video to start. Press the escape button to return to the module.

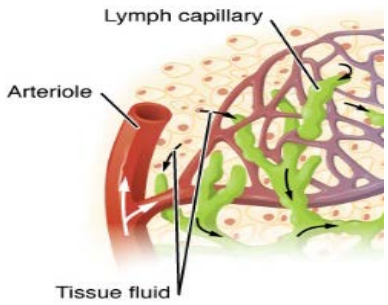


Source. From "Extracellular Matrix and Interstitial Fluid", by Whats Up Dude, 2018,[20] https://www.youtube.com/watch?v=EqnDH1yes2I

Located in the interstitium, the lymphatic capillaries are larger than blood capillaries and function to transport the waste products of cellular metabolism, large proteins, and all excess interstitial fluid back to the venous system through ducts that empty into the subclavian vein.[16] Figure 1.3 illustrates the arteriole end of the circulatory system and shows how the lymphatic capillaries are placed throughout the interstitium. Note the very close proximity to the arterial-venous capillary bed and cells.

Figure 1.3

Arteriole Side of the Arterial-venous Capillary Bed with a Lymphatic Capillary

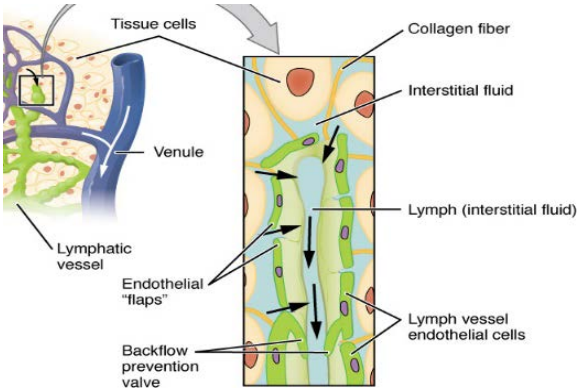


Source. Adapted from "Illustration from Anatomy & Physiology, Connexions Web site", OpenStax College, 2013, Wikimedia Commons, Creative Commons Attribution 3.0 Unported.[21]

As pressure rises in the interstitial spaces, excess fluid moves into the initial lymphatic capillaries through single cell, endothelial flaps.[3] Figure 1.4 shows a single lymphatic capillary with endothelial flaps.

Figure 1.4

Single Lymphatic Capillary with Endothelial Flaps

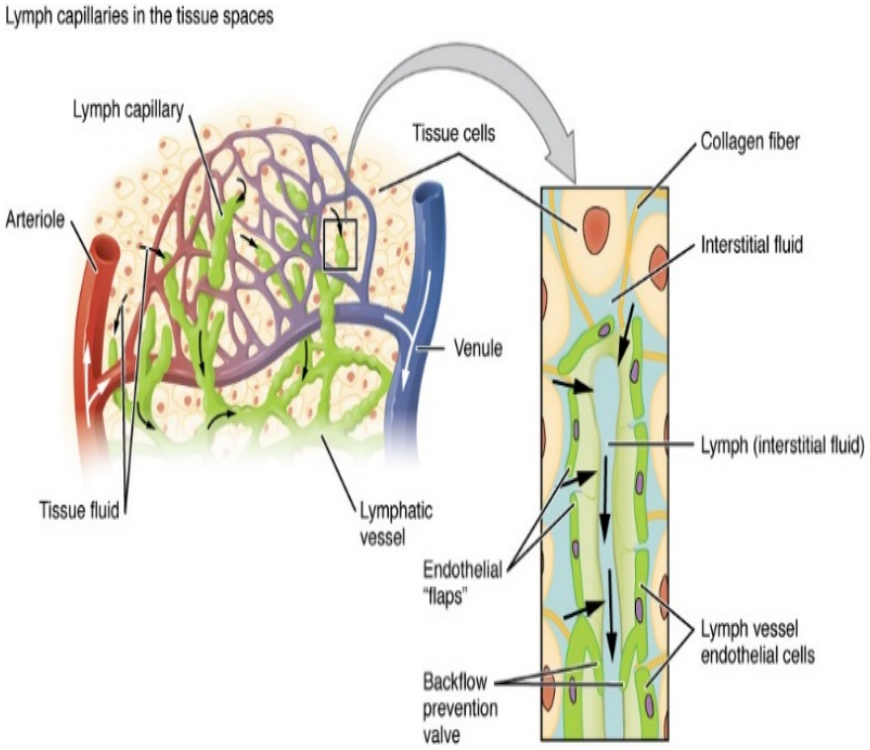


Source. Adapted from "Illustration from Anatomy & Physiology, Connexions Web site", OpenStax College, 2013, Wikimedia Commons, Creative Commons Attribution 3.0 Unported.[21]

The endothelial flaps are tethered by anchoring filaments made of collagen fiber, which act to pull the flaps open creating a gap to allow fluid to enter the lymphatic capillary. Once the fluid enters the initial lymphatics it is known as lymph fluid.[3] The lymph fluid moves in a one-way direction aided by unidirectional valves that prevent back-flow of the lymph fluid.[3] A complete illustration of the arterial-venous capillaries, with initial lymphatic capillaries is shown in Figure 1.5.

Figure 1.5

Arterial-venous Capillary Bed with Lymph Capillaries



Source. From "Illustration from Anatomy & Physiology, Connexions Web site", OpenStax College, 2013, Wikimedia Commons, Creative Commons Attribution 3.0 Unported.[21]

Pathophysiology of the Lymphatic System

In a normal functioning lymphatic system, if the transport capacity of the lymphatic system exceeds the volume of interstitial fluid to be transported (lymphatic load) no edema will result.[16] The lymphatic system may be challenged to transport fluid when insufficiencies occur. The most common insufficiency is called a **dynamic insufficiency** or **high-volume insufficiency**.[16] This

occurs when the lymphatic load of protein and water in the interstitial space exceeds the ability of the lymphatics to transport, resulting in edema in the tissues.[16]

A second type of insufficiency results if there is a mechanical failure and is known as **mechanical insufficiency**. This can happen if there are blockages to the lymphatic system or damage to the lymphatic system such as from tumor compression, trauma, and radiation injury.[16] This inability to the remove water and proteins form the interstitial space will result in a high-protein edema or lymphedema.[16]

Finally, there may be a **combined insufficiency**. If the transport capacity is reduced from a mechanical insufficiency, such as a trauma, and an excess of fluid is produced due to a dynamic insufficiency as seen in congestive heart failure, there will be an overload of fluids to the system, resulting in damage to the tissues and lymphatic structures causing lymphedema.[16]

Once edema becomes chronic, lasting more than three months,[5] progressive changes affect the tissue compartments in the regions affected by the edema.[22] Proteins and lipids accumulate in the interstitial fluid causing inflammation, fibrosis, and fat deposition.[22] This remodeling of the tissues causes a thicker collagen matrix (fibrosis), adipose tissue hypertrophy, and a hardening of the tissues resulting in the non-pitting edema seen in advancing lymphedema.[22]

Additional Learning

Would you like to learn more about lymphedema and the anatomy and physiology of the lymphatic system? Additional learning videos can be found on the Klose Training website (www.klosetraining.com). Suggest viewing: Lymphedema 101, Parts 1 & 2 by clicking on the link https://klosetraining.com/resources/klose-videos/

Types and Causes of Lymphedema

Lymphedema has been classified into two types, primary and secondary.[1,2] **Primary lymphedema** is due to malformations in the lymphatic system which have a hereditary or genetic cause.[1,2,23] **Secondary lymphedema** is caused by damage or obstruction to the lymphatic system which leads to swelling in the affected area.[1,2] This acquired form of lymphedema is often multifactorial and may be more challenging to treat. Table 1.1 lists some of the characteristics and causes of primary and secondary lymphedema. This list is not exhaustive but will give you an appreciation of the many factors that can contribute to chronic swelling.

Table 1.1

Primary versus Secondary Lymphedema

Primary Lymphedema	Secondary Lymphedema
Interesting facts: • Thought to be rare[7] • Occurs more often in females[1,2] • Usually affects the lower extremities, but can affect the arms and genitalia[1,2] Causal factors: • genetic malformations in the lymphatic system[1,2,23] • Genetic malformation may be known, but often reason for malformation is unclear[2,23] • There are more than 20 gene mutations identified that present with lymphatic abnormalities[2] • Sometimes there is a familial link, but also may occur sporadically[2,24] Primary lymphedema is often categorized based on age of onset: • Congenital lymphedema seen at birth or shortly after.[2,24] The most common birth presentation is Milroy disease.[2] • Lymphedema praecox presents during adolescence usually around puberty. It is the most common form of primary lymphedema.[2,23] • Lymphedema presenting later in life, after the age of 35 is known as lymphedema tarda[1,23,24]	Interesting facts: • More common than primary lymphedema[2] • Affects millions worldwide[2] • Acquired form of lymphedema[2,3] • Often multifactorial cause and can be challenging to treat[4] Causal factors and risks for developing secondary lymphedema are: • Cancer[4,9] • Cardiovascular disease[4,9] • Chronic venous insufficiency[4,9] • Diabetes[4,9] • Drugs[2,5,9] • Hypertension[4,9] • Immobility[5] • Infection[4,9] • Lipedema[5] • Obesity[4,9] • Parasitic infection, filariasis[2,14] • Trauma[4,9] • Radiation[4,9] • Organ failure[2] • Vascular malformations[5]

The initial diagnosis of lymphedema is usually made in the clinical setting. The diagnosis should involve a detailed history plus a physical exam. Further diagnostic tests can be carried out, but often these tests are not readily available. Therefore, for many the diagnosis is based on the history and clinical exam. Assessment will be covered in detail in Module 2. Figure 1.6 shows a

14 year old male who developed a sudden onset of left leg swelling. There was no history of injury and all diagnostic tests were negative for any pathological cause. A diagnosis of primary lymphedema praecox (sporadic) was made. This was based largely on the history and physical exam and ruling out other possible causes such as malignancy through the various diagnostic tests performed. Note the asymmetrical appearance between the legs, with loss of normal contour in the left leg.

Figure 1.6

Primary Lymphedema Praecox

Source. From "14 year old boy with primary lymphedema praecox", by Lanning (2011), personal photo collection.[25]

Figure 1.7 shows a person with lower extremity secondary lymphedema. The history of this person is not known. From the picture, the swelling appears to involve both lower legs, with skin changes consistent with venous disease noted. The hyperpigmentation of the skin over the lower legs and feet may elude to possible cause. Taking a complete medical history would be important to identify other possible causes and risk factors. Remember, secondary lymphedema is often multifactorial. The most common risk factors that can lead to progression of lower limb lymphedema are obesity, recurrent cellulitis/infection, and wounds.[13] Assessment will be covered in detail in Module 2.

Figure 1.7

Secondary Lymphedema Legs

Source. From "Lymphedema, 67year old female patient", by Bobjgalindo, 2010, Wikimedia Commons, Creative Commons Attribution-Share Alike 4.0 International.[26]

Reflection

Think about your clients with complex medical issues.

- Do these clients have swelling in their lower limbs?
- Is it clear what may be causing the swelling or is the swelling likely multifactorial?
- Has anyone ever addressed the swelling?
- Is the chronic swelling of secondary cause, or could the swelling have a possible primary etiology?
- Have you discussed family history of swelling when taking a history?

Case Study 1.1

Read the following case and answer the questions below. The answers to this case study can be found in Appendix B of the e-learning resource manual under the Case Study 1.1: Answer Key.

Lisa is 42 years old with a history of swelling in her left leg since her teens. She denies swelling in her right leg. Doctors have told her the swelling is due to being overweight and there is nothing that can be done. Lisa does not believe this is the full cause of her swelling as when she has lost weight in the past there has not been a difference noted in her leg swelling. Lisa reported she has an aunt and a sister with a history of only one leg swelling.

Based on the limited information:

- Would you consider this swelling to be of primary or secondary cause?
- Explain the reasoning for your decision.

Figure 1.8 is an example of what Lisa's leg looked like.

Figure 1.8

Lymphedema Left Leg

Source. From "Lower limb lymphedema", by Medical Doctors, 2015, Wikimedia Commons, Creative Commons Attribution-Share Alike 4.0 International.[27]

Interactive Activity Exercise: 1.1

Place in the appropriate order the normal movement of fluid from the circulatory system to the lymphatic system. Click on and drag the answer box on the left and place it in the correct sequence in the answer box on the right. The answers to this activity can be found in Appendix B of the e-learning resource manual under Interactive Activity Exercise 1.1: Answer Key.

Lymph fluid moves through the lymphatics until it enters the venous system through ducts at the subclavian.	
High pressure in the arterioles cause fluid containing protein to leak into the interstitial spaces.	
Excess fluid, proteins, and cellular waste products are picked up by the lymphatic capillaries.	
Protein and oxygen nourish the cells in the interstitial space.	

Quiz Activity 1.1

Answer true (**T**) or false (**F**) to the following statements. Place an 'X' in the appropriate box as illustrated. The answers to this activity can be found in Appendix B of the e-learning resource manual under Quiz Activity 1.1: Answer Key.

	Statements	T	F
1.	Lymphedema is rarely seen in the community setting.		X
2.	Lymphedema/chronic edema is broadly defined as swelling lasting more than three months.		
3.	Secondary lymphedema has a genetic cause.		
4.	Low pressure in the arterioles causes fluid to leak into the interstitial spaces.		
5.	Rhythmic contractions from skeletal muscle, respiration, and arterial pulsations aid in lymph transport.		
6.	Lymphatic organs such as the thymus, spleen, and liver make up the lymphatic system.		
7.	Lymphatic fluid is propelled though the lymphatics in a one-way direction.		
8.	Mechanical failure of the lymphatics is caused by dynamic insufficiency or high-volume overload.		
9.	Lymphatic capillaries pick up all excess fluid from the interstitium.		
10.	Secondary lymphedema can have many risk factors and have more than one cause.		
11.	Lymphedema is classified into two types, primary and secondary.		
12.	The most common cause of lymphedema worldwide is morbid obesity.		
13.	The lymphatic system plays a limited role in fluid homeostasis.		
14.	Fat absorption from the gastric system is a function of the lymphatic system.		
15.	Once interstitial fluid enters the lymph capillaries, it is known as serous fluid.		

Conclusion

Congratulations on completing Module 1! This module aimed to provide an overview of lymphedema and why lymphedema is a problem in the community setting. In completing this module, you should be able to define lymphedema broadly and be able to discuss briefly what is known about the prevalence of lymphedema in Canada and worldwide. Video links provided a visual to supplement the text when learning about the anatomy and physiology of the lymphatic and circulatory system. You should be able to describe the basic anatomy and physiology of the lymphatic system and be able to apply the basics concepts of how the lymphatic and circulatory systems work together. Finally, you should be able to identify the types and causes of lymphedema. Additional links to learning have been provided and you are encouraged to review these videos at your leisure.

You now have the basics to proceed with Module 2 and then Module 3 where you will learn how to assess your clients with lymphedema, as well as gain the knowledge and skills for the treatment and management of lymphedema. Enjoy your learning experience and continued professional development!

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MODULE 2:
ASSESSMENT OF LYMPHEDEMA

Module 2: Assessment of Lymphedema

The purpose of this module is to provide an overview of the basic assessment of lower limb lymphedema and to provide continuing care nurses (CCNs) with information and knowledge to assist them in safely caring for their clients with lymphedema in the community setting. This module will review the stages of lymphedema, skin changes, common risk factors associated with lymphedema, and the simple clinic tests and measurement tools used to evaluate lymphedema, quality of life, and the safety of treatment. This module will also provide information on which to base a decision about when further medical referral might be necessary.

This module is intended for use by the CCNs at Central Health but will be accessible through the Learning Management System to any health care professional at Central Health who has an interest in learning about lymphedema.

This module contains evidenced based information, with reflection exercises, a case study, video links, an interactive activity, and a quiz to provide an enhanced learning experience for nurses. Embedded videos can be accessed by placing the mouse over the arrow at the center of the video and “clicking” your mouse. You can return to the module by pressing the escape button on your keyboard. Links to websites can be accessed by placing your cursor on the link and pressing the control button on your keyboard while clicking your mouse. You can return to the module by closing the “x” on the open tab on your tool bar

Learning Objectives

Upon completion of this module, you will be able to:

1. Identify the stages of lymphedema and what to look for in each stage;
2. Describe a basic skin assessment and note the common skin characteristics associated with the different stages of lymphedema;
3. Discuss how obesity, cellulitis, and wounds contribute to lymphedema and its associated changes and consequences;
4. Identify assessment considerations and possible contraindications to compression;
5. Identify the lower limb characteristics seen in venous and arterial disease, and the need for further vascular assessment in those with symptoms of arterial disease;
6. Explain how and why a Doppler assessment is conducted, and calculate and interpret the results of an ankle brachial pressure index;
7. Describe what history should be taken and what physical assessment should be completed when assessing a person for lymphedema;
8. Conduct a basic lower limb physical assessment and document results;
9. Describe a quality of life tool specific for clients with lymphedema; and
10. Complete a basic measurement of the lower limb to monitor limb circumference and to measure for readymade compression stockings.

Assessing Clients with Lymphedema

Ideally the assessment of a person with lymphedema should include a detailed baseline assessment by a health care professional trained in lymphedema management.[1,2] Recognizing that this is not always possible, it is important for continuing care nurses to have a basic understanding of lymphedema assessment and to be able to apply these assessment skills in practice. Having a knowledge of the stages of lymphedema, awareness of skin changes, risk factors for lymphedema, simple clinic tests, and measurement tools used to evaluate lymphedema will provide the nurse with the assessment skills to safely manage and treat lymphedema in the community. As you complete the module you should be able to obtain a basic history and conduct an assessment to safely manage care. A lower limb assessment checklist will be provided to help you decide if your client is safe for compression or if they need further referral for care. The checklist will also provide you with a written record for documentation on your client's file.

Did you Know!

At Central Health there is one regional nurse/lymphedema therapist providing consultation and care for persons with lymphedema. The Regional Lymphedema Nurse completes a holistic assessment that considers the physical and emotional well-being of all clients referred. Click on the pdf. file below for a copy of the New Client Lymphedema Assessment.

Assessment Form
Lymphedema Progra

Stages of Lymphedema

Lymphedema is a progressive, chronic condition[3-5] that progresses through stages.[2,6] Having a knowledge of the progression and common skin/tissue characteristics seen in the various stages can help the nurse determine what stage of lymphedema a client is in. Knowing the stage can also help the nurse realistically develop a care plan with the client. For example, a client who has advanced stage lymphedema should not expect the nurse to be able to resolve the client's edema completely. While reductions in edema can be attained, it would be reasonable to expect this client to require life-long management of their lymphedema. Table 2.1 highlights the stages of lymphedema and the characteristics found.[2,6]

Table 2.1

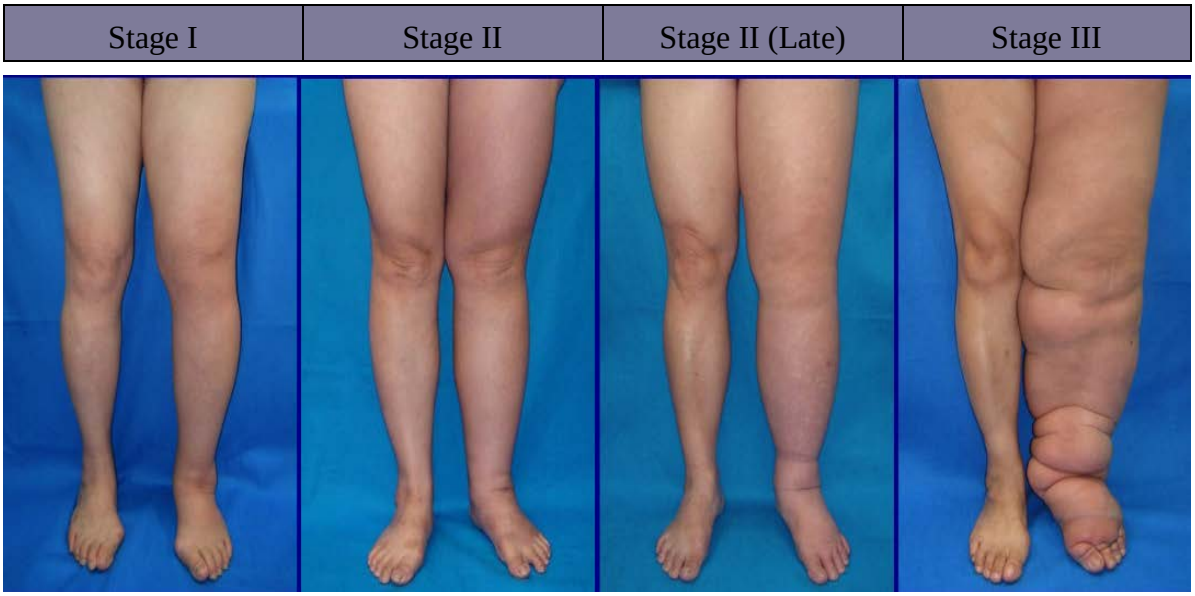
Stages of Lymphedema

Stage	Description
Stage 0 (Latent)	There has been an injury to the lymphatic system, but lymphedema may not be noted.[2,6] Examples include: • Removal of lymph nodes[2,6] • Radiation to lymph nodes[2] • Surgery that disrupts lymph nodes[2,6]
Stage I	Considered spontaneously reversible.[2,6] Characteristics: • Skin is soft[2] • Skin is pitting (skin indents when pressed)[2,6] • Edema resolves completely with rest and elevation[2,6]
Stage II	Considered spontaneously irreversible.[2,6] Characteristics: • Difficult to pit skin or skin is non-pitting[2,6] • Skin/tissue has a spongy consistency[6] • Skin feels thickened with fibrotic changes noted[2,6] • Edema may decrease, but does not resolve completely with rest and elevation[2] • Stemmer sign may be positive[2] • Client may be prone to frequent infections/cellulitis[2]
Stage III	Characteristics: • Limbs lose natural contours and are often very large.[2,6] • Significant skin changes may be noted (cobblestone appearance, dryness, cracking, and leaking may be present).[1,2] Skin/tissue has a hard/thickened feel.[2,6] • Deep skin folds may be present[2] • Papillomas may be present[2,6] • Stemmer sign positive[2,6] • Infections/cellulitis common[2,6]

There may be slight variations to the staging used,[6] but understanding that lymphedema progresses over time with some distinct characteristics can be helpful when assessing new clients referred for care. Stages of lymphedema are shown in Figure 2.1. Stage 0 is not represented in the picture.

Figure 2.1

Stages of Lymphedema



Source. Adapted from "Lymphedema staging lower limbs", by DocHealer, 2017, Wikimedia Commons, Creative Commons Attribution-Share Alike 4.0 International[7]

Stage I and early Stage II lymphedema is characterized by pitting edema often noted over the dorsum of feet, medial and lateral ankles, and the anterior tibial regions. You can test for pitting by applying pressure with your finger over the feet, ankles, and tibial regions to see if the pressure causes a depression in the skin. With pitting edema, the indentation in the skin may last several seconds if fluid in the tissues is easily displaced. As lymphedema progresses into later Stage II, the edema becomes more difficult to pit as the fibrotic changes thicken the skin.[2,8] Once edema becomes non-pitting it is considered irreversible.[8] Edema is typically non-pitting in Stage III and can be challenging to treat. Figure 2.2 shows a picture of lower leg pitting edema over the tibial regions.

Figure 2.2

Pitting Edema

Source. From "Pitting edema during and after the application of pressure to the skin", by James Heilman, 2010, Wikimedia Commons, Creative Commons-Share Alike 3.0 Unported[9]

As lymphedema progresses and specifically if it involves the feet, swelling may be noticeable in the toes. The inability to tent the skin at the base of the second toe is referred to as a positive **Stemmer sign** and is considered diagnostic of lymphedema in the lower extremity.[2,6,10] The absence of a positive Stemmer sign, however, does not mean lymphedema is not present.[2] Figure 2.3 depicts the Stemmer sign test.

Figure 2.3

Stemmer Sign Test

Source. From "Stemmer's Sign", by Canadian Lymphedema Framework Photo Library, 2020. Copyright 2020 by the Canadian Lymphedema Framework. Used with permission.[11]

Skin Changes

As lymphedema progresses skin changes are noted. In stage II the skin begins to feel thickened and will no longer pit easily. This is due to fibrotic changes within the subcutaneous tissues.[10] As edema increases the skin can become **hyperkeratotic** and hyperpigmented,[6,10] often appearing dry and a reddish/brown colour. This reddish-brown discolouration is known as **hemosiderin staining**.[8]

In late Stage II and Stage III lymphedema the skin changes continue to progress, which often leads to breakdown in the skin barrier. The leakage of fluid from the skin is known as **lymphorrhea,** which may cause maceration of the surrounding skin and predispose the person to infection/cellulitis.[6] Wart-like skin lesions known as **papillomas** often develop. These lesions are benign hypertrophied papillae and endothelial tissue that protrude from the skin.[2] Figure 2.4 shows a late Stage III lymphedema with skin breakdown, leakage of fluid, hyperpigmentation, hyperkeratosis, and papillomatous lesions on the skin.

Figure 2.4

Skin Changes in Late Stage Lymphedema

Source. From “Skin Changes”, by Canadian Lymphedema Framework Photo Library, 2020. Copyright 2020 by the Canadian Lymphedema Framework. Used with permission.[12]

Reflection

Think about your clients with lymphedema.

- What will you look for?
- Think about your client's signs, symptoms, and the characteristics of different stages of lymphedema to help you to draw conclusions about your client's care.
- Can you determine what stage lymphedema your client is presenting with?
- What was your justification for the conclusion drawn?

Continuing care nurses are experiencing increased requests to manage lymphedema in the community. While continuing care nurses are not expected to carry out an in-depth clinical exam for lymphedema, it is important that nurses assess their clients with lymphedema each time they are seen to monitor for changes such as disease progression or improvements in skin health and edema reduction. In the case study below the nurse noted some important initial observations that can provide insight into the client's stage of lymphedema.

Case Study 2.1

Read the following case and answer the questions below. The answers to this case study can be found in Appendix C of the e-learning resource manual under the Case Study 2.1: Answer Key.

John is a 48 year old male who has experienced swelling to his lower legs for approximately 12 years. John believes the swelling is increasing. The swelling is persistent, decreasing somewhat overnight with rest and elevation, but never fully resolving. John has noticed increasing skin dryness and a thickened feel to his skin. On exam, the skin does not pit easily. He has noted swelling to his toes.

Based on the limited information:

- What stage lymphedema would you suspect John is experiencing?
- Is there a simple test you can perform in the clinic to support a diagnosis of lymphedema?

How Obesity, Cellulitis, and Wounds are Risk Factors for Lymphedema

The presence of co-morbid issues in persons with lymphedema has been well documented.[13-15] Obesity, recurrent cellulitis, and wounds are three health concerns that may contribute to poorer health outcomes when coexisting with lower limb lymphedema.[16] These three risk factors will be explored separately in this section.

Obesity and Lymphedema

Morbid obesity is referred to as a **body mass index** (BMI) of greater than 40kg/m².[17] Obesity and morbid obesity are conditions seen in persons with lymphedema.[13,15,16] Increased intrabdominal pressure from a large abdomen can cause **lymphostasis** and leakage of protein-rich fluid into the interstitial space, which causes inflammation in the tissues, leading to increased fibroblast production.[18] This results in fibrosis of the tissues and changes to the skin barrier function, which leads to a susceptibility to skin infections such as cellulitis.[17,18] The increased deposition of fat also can obstruct lymphatics and further impair drainage.[18]

A significant consequence of lymphedema with morbid obesity is the known effects on health-related quality of life. It is reported that obesity is associated with lower quality of life and this is further intensified in the presence of chronic lower limb edema.[19]

Did you Know!

Patient stories can have a powerful impact on how health care providers view their patients. You are encouraged to view the video “Stephanie’s Story-Living with Lymphedema” to gain some insight into the impact of lymphedema and obesity. Click on the arrow at the center of the picture to begin the video. At the end of the video, press the escape button to return to the module.

Source. From “Stephanie’s Story-Living with Lymphedema”, by Klose Training, https://www.youtube.com/watch?v=bOSdboTewUA

Cellulitis and Lymphedema

Chronic lymphedema will lead to skin changes caused by the fibrosis or thickening of the skin.[8,10] The fibrosis leads to hyperkeratosis, fissures, and ulcerations of the skin.[8] Once the skin barrier has been disrupted, leakage of high protein fluid known as lymphorrhea may predispose the person with lymphedema to recurrent skin infections (fungal and bacterial) such as **cellulitis** or **erysipelas**.[8,10] These recurrent infections further damage the superficial lymphatics and make the lymphedema worsen.[8,10] Cellulitis/erysipelas may present suddenly and typically include symptoms of increased swelling, redness, warmth, and pain to the affected area.[20] If untreated the infection can quickly become systemic, with the person experiencing fever, chills, rigor, headache, and vomiting.[20] This is a medical emergency as sepsis may be life threatening.

It is extremely important that persons with lymphedema understand the risk of infection and are aware to seek prompt medical assessment should these symptoms develop. Figure 2.5 shows inflammation and cellulitis to the lower legs. Note the swelling, increased redness, and evidence of blistering to the lower legs and feet.

Figure 2.5

Cellulitis

Source. From “Cellulitis: Severe bilateral inflammation and swelling of legs”, by Charlie Goldberg, M.D., 2020. Copyright 2020 by MedPics/Clinical Images. Image provided courtesy of MedPics.[21]

Wounds and Lymphedema

The presence of a wound in a limb affected by lymphedema adds complexity to the person's care. A study by Moffatt et al.[16] reported that 73.6% of their participants with chronic edema also had a concurrent wound, with more than 40% of these persons requiring wound care twice weekly by a community nurse. Another 13.7% required a daily visit. This has significant implications for health care resources, both in cost and nursing time required to treat.

It is understood that for a wound to heal, edema must be addressed. However, assessing the etiology of the wound is paramount in order to ensure a safe treatment plan is initiated. Wounds in the presence of edema may be strictly from uncontrolled swelling that causes the skin to blister and break, resulting in superficial ulcerations to the affected area.[22] The wounds also may be a result of venous disease, arterial disease, or a combination of both.[22] It is important to know if a person's wound is a result of arterial disease as this will change a treatment plan and how any associated edema may be treated.

Assessment Considerations: Is Your Client Safe for Compression Therapy?

Clients with lymphedema may be referred to the continuing care nurse for compression therapy. The most common referrals are for edema reduction, management of edema, and wound care using compression therapy. The treatments for lymphedema including compression therapy will be covered in detail in Module 3. As part of the assessment of clients with lymphedema it is important to be aware of the possible contraindications to compression therapy. Applying compression without an assessment may lead to an adverse health outcome for your client.

Acute infection, acute congestive heart failure, and arterial disease all need to be considered before treating lymphedema.[6] Acute, untreated infection, congestive heart failure, and severe arterial disease are all contraindications for compression therapy[2,6] and need to be further evaluated by a physician and stabilized before initiating compression therapy. If there is a concern for either when taking a client's history, further consultation with the client's medical practitioner is required, with documentation in the client record of a decision plan.

Remember, as a nurse you are accountable for all treatments provided! When in doubt, always seek consultation with the client's primary care physician or nurse practitioner.

Table 2.2 outlines the key signs and symptoms of acute infection, acute congestive heart failure, and arterial disease that should not be ignored when assessing clients with lymphedema. This list may not be exhaustive but is a starting point for assessing clients potentially at risk.

Table 2.2

Assessment Concerns, Signs and Symptoms

Concern	Signs & Symptoms
Acute infection/cellulitis of leg **Note: A localized infection can quickly become systemic in persons with lymphedema leading to sepsis. This is a medical emergency! Consult promptly with a physician or nurse practitioner.**	• Sudden increase in swelling to limb[2,20,23] • Increasing redness to a limb[2,20,23] • Increased warmth to a limb compared to the unaffected limb[2,20,23] • Blistering[20] • Increased pain to a limb,[2,20,23] • Enlarged, palpable, painful lymph nodes in groin[20] • Fever[2,20,23], > 37.5 Celsius • Chills[2,20], rigors[23] • Nausea, vomiting[20,23] • Elevated heart rate, > 90/minute
Acute congestive heart failure (untreated) **Note: Heart failure must be treated and stable before initiating compression therapy. Compression should be used in close consultation with a physician.**	• Increased shortness of breath, with client short of breath at rest[24,25] • Audible chest sounds, wheezes, crackles[24] • Inability to lay supine due to shortness of breath[24,25]
Arterial disease **Note: Compression therapy is contraindicated in persons with an ABPI of < 0.5. Further vascular assessment is required.**	• Dependent rubor[26,27] • Cyanosis/ischemia of the legs, feet, or toes[26,27] • Limb pallor[26,27] • Non-healing wounds[27] • Calf pain when walking (claudication)[26-28] • Night pain, rest pain[26-28] • Altered pain perception[26,27] • Absence of pulses (posterior tibial, dorsalis pedis, popliteal, femoral)[26,27] • Delayed capillary refill,[26,27] > 3 seconds • ABPI ≥ 0.5 to < 0.9,[26-28] (mild/moderate arterial disease) • ABPI < 0.5 (severe arterial disease)[26,28]

Note. ABPI = ankle brachial pressure index; > is greater than; ≥ is greater than or equal to; < is less than.

Assessing Arterial and Venous Disease

Assessment of chronic edema requires the clinician to be aware of possible underlying conditions such as arterial and venous disease that may impact treatment decisions around the safe use of compression therapy. As previously noted in Table 2.2, compression therapy is contraindicated in persons with an ankle brachial pressure index (ABPI) of < 0.5.[26,28] More details of ABPI assessment are provided later in this module. Continuing care nurses may be required to treat lower limb skin ulcers that develop in the presence of edema. It is important for nurses to recognize some of the characteristics associated with peripheral vascular disease. Table 2.3 outlines some of the lower limb characteristics associated with venous and arterial ulcer disease. This list is not exhaustive, but provides a basic assessment starting point.

Table 2.3

Lower Limb Characteristics Associated with Venous and Arterial Ulcer/Disease

Venous Ulcer Disease	Arterial Ulcer Disease
• Ulcer usually develops in the gaiter area of the lower leg or around the malleolar regions (medial most common)[22,27] • Ulcers are often superficial with maceration due to increased drainage[22] • Wound with yellow slough mixed with a pink wound bed is common[22,27] • Erythema,[22] stasis dermatitis/eczema,[22] and repeated cellulitis[22] • Skin changes[22] (atrophe blanche, hemosiderin staining, and lipodermatosclerosis) • Varicose veins[22,29] • Edema[22,29] • Itchy legs[29] • Restless legs[29] • Palpable pulses[22,26]	• Ulcer usually develops over the lateral ankle, dorsum of foot, or toes[22] • Often deep, with a punched-out appearance[22,26,27] • Non-healing ulcer[26,27] • Wound bed may be covered with eschar, or appear unhealthy, pale coloured, or necrotic[26,27] • Ulcer may be painful, worse at night[22,26] • Skin may be shiny, taut with little hair growth[26] • Dependent rubor or elevation pallor to lower leg[27] • Minimal edema and drainage • Calf pain when walking/claudication[26-28] • Night pain, rest pain[26,28] • Abnormal ABPI or absence of pulses[26-28] • Delayed capillary refill > 3seconds[26,27]

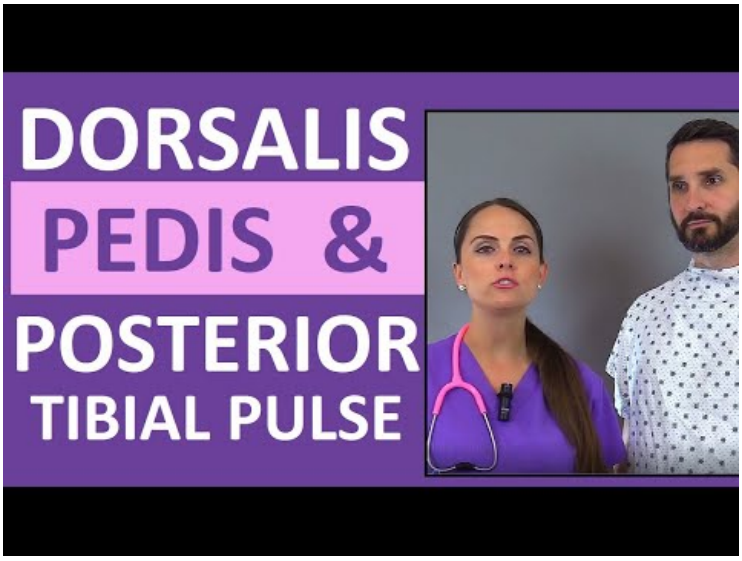
Note. ABPI = ankle brachial pressure index; > is greater than.

When taking a history on clients with suspected peripheral vascular disease, it is important to ask about their history of smoking, diabetes, elevated cholesterol, and weight.[26,27] The presence of these risk factors may increase the risk of peripheral vascular disease.[26,27] To complicate assessment further the client may have a mixture of venous and arterial disease. Having mixed disease may mean treatment plans have to be adjusted in order to provide safe care. This further supports why nurses must be able to complete a lower limb assessment on their clients before initiating treatments such as applying compression. If in doubt, discuss with the primary care provider and request a further vascular assessment such as an ABPI assessment.

How to Palpate the Dorsalis Pedis and Posterior Tibial Pulses

It is important to know how to palpate the dorsalis pedis and posterior tibial pulses when assessing your client's lower limbs. Difficulty finding these pulses or noting weak or bounding pulses may provide clues to your client's vascular status. While palpating pulses is a very basic test to do in the clinic, it may help you decide if further vascular assessment may be warranted.

Please watch the short video on the palpation of the dorsalis pedis and posterior tibialis pulses by clicking on the arrow at the center of the picture. At the end of the video press the escape button to return to the module.



Source. From "Dorsalis pedis and posterior tibial pulse point nursing assessment", by RegisteredNurseRN.com, 2019,[30] https://www.youtube.com/watch?v=xvlaQDMbz-4

Doppler Ankle Brachial Pressure Index Assessment

A Doppler assessment is required if there are concerns for arterial vascular disease. Compression should never be applied if there is a concern for severe arterial disease.[2,6] Compression pressure may be reduced and should be closely monitored in persons with known mild to moderate disease. Continuing care nurses are not expected to be able to assess for arterial disease beyond taking a history and feeling or auscultating for pulses. If a client requires further vascular assessment an ABPI can be performed by the Regional Lymphedema Nurse or Enterostomal Nurse. If there is a need for further vascular studies, the client should be referred to their physician or primary care provider for referral to the appropriate vascular assessment clinic.

Ankle brachial pressure index is completed using a Doppler and blood pressure cuff with the client supine. Systolic blood pressures are obtained in the arms and legs. The systolic pressures of the legs are auscultated at the dorsalis pedis and posterior tibialis arteries of the dorsal aspect of the foot and the medial aspect of the ankle. The highest systolic pressures of each leg are divided by the highest systolic pressure of the arms to obtain the ABPI.[26] This is completed for each leg. The lowest reading is considered the overall ABPI. Table 2.4 shows the ABPI values and the suspected arterial disease severity. This is the range used by the Lymphedema Management Program at Central Health and is consistent with values reported in the article by Furlong (2015).[28] These values may differ slightly between authors.

Table 2.4

Ankle Brachial Pressure Index Value with Suspected Arterial Disease Severity

ABPI Value	Arterial Disease Severity
< 0.5	Severe arterial disease
0.5 to 0.8	Moderate arterial disease
> 0.8 to 1.3	Mild to no arterial disease (normal range)
> 1.3	May indicate calcification in arteries, reading considered unreliable

Note. < is less than; > is greater than.

Additional Leaning

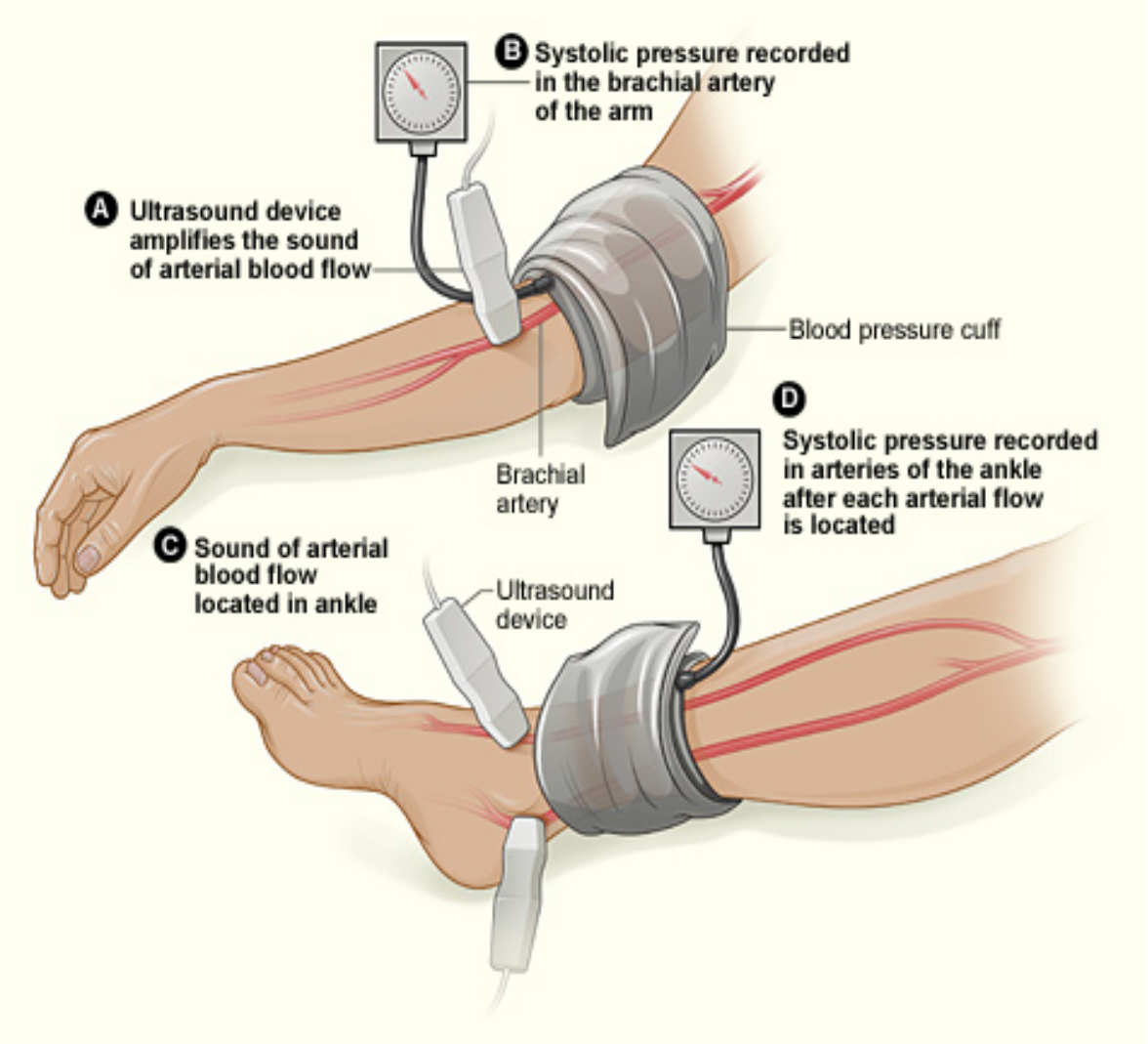
Click on the pdf. file below for a helpful worksheet on completing an ankle brachial pressure index assessment.[31]

abi_worksheet.pdf

Figure 2.6 represents the placement of blood pressure cuffs and Doppler when calculating an ABPI.

Figure 2.6

Ankle Brachial Pressure Index Test



Source. From "Illustration of ankle brachial index test", by Jmarchn, 2014, Wikimedia Commons, Creative Commons Attribution-Share Alike 3.0 unported.[32]

Additional Leaning

Would you like to learn more about vascular assessment tests that can easily be performed in a clinic setting? Go to the Klose Training website (www.klosetraining.com) by clicking on the following link https://klosetraining.com/klose-training-graduates/graduates/ed-videos/ and further clicking the "Vascular Tests" icon.

Conducting a Lower Limb Assessment: Putting it Altogether!

Throughout this module you have learned about the many assessment skills needed to conduct a lower limb assessment on a person with lymphedema. These assessment skills are very important when deciding if it is safe for you to initiate compression therapy with your client. The box below has a pdf. file that provides you with a *Lower Limb Assessment Checklist* and *Lower Limb Assessment Checklist: Referral Guide*. Please consider using this checklist to assist in your assessment of clients with lymphedema before applying compression therapy. The checklist can be completed and kept as part of your paper file on your client.

Lower Limb Assessment Checklist and Referral Guide

Please review and use the pdf. below to assist you in conducting a lower limb assessment and making decisions around the application of compression. When in doubt, always refer! The Lower Limb Assessment Checklist: Referral Guide should be printed in colour so that it is easy to see the highlighted items that may be of potential concern.

Lower Limb
Assessment Checklis

Interactive Activity: ABPI Exercise 2.1

John's ABPI was performed using a hand-held Doppler. The following systolic pressures were recorded for John's ABPI test and are shown in Table 2.5.

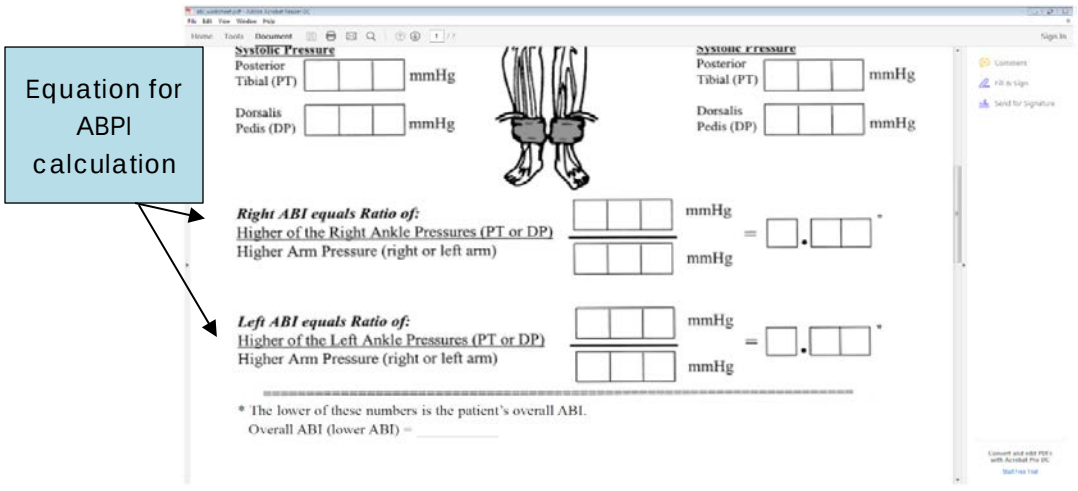
Table 2.5

Systolic Pressure values for John

Limb	Systolic Pressure mmHg
Right arm	134 mmHg
Left arm	126 mmHg
Right posterior tibial	148 mmHg
Right dorsalis pedis	140 mmHg
Left posterior tibial	142 mmHg
Left dorsalis pedis	146mmHg

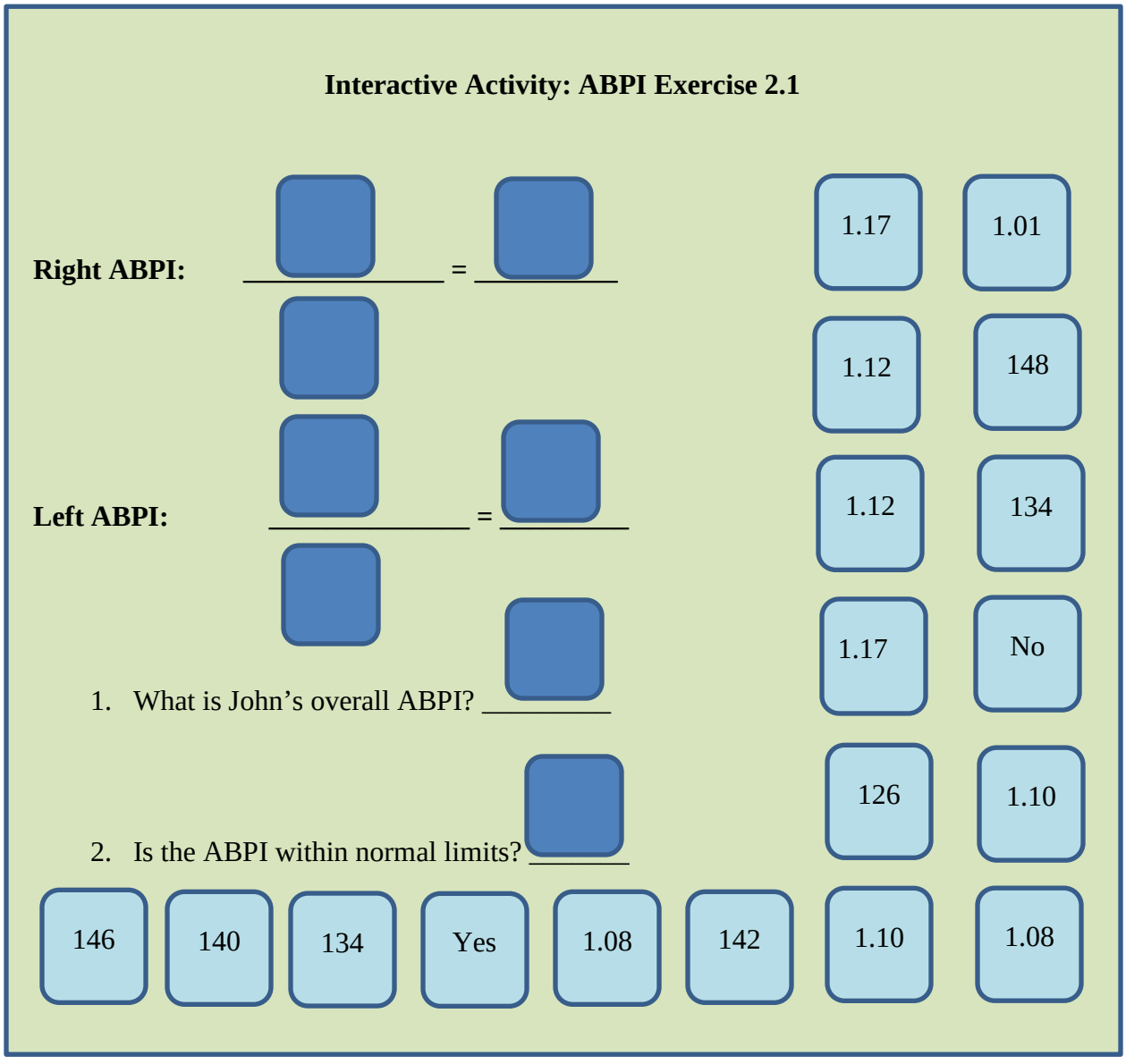
Note: Remember the formula for calculating the ABPI is to take the highest systolic pressures of each leg and divide by the highest systolic pressure of the arms.[26] The lowest reading is considered the overall ABPI. Refer to Module 2, page 156 if you need to review.

Please refer to the screenshot below for a sample equation to calculate the ABPI.



Source. From "ABPI Worksheet," by Todd-roat, n.d., Todd-roat.squarespace.com[31]

Using the information provided in Table 2.5 to calculate the ABPI for John. Click and drag the correct answer boxes to the appropriate location to obtain John's right and left ABPI and answer the two questions about James's ABPI. Please note there are more answer boxes provided than needed**.** The correct answers can be found in Appendix C of the e-learning resource.



Health-related Quality of Life in Persons with Lymphedema

Studies have shown that health-related quality of life (HRQOL) is decreased in persons with lymphedema.[3,4,15,19] There are many HRQOL tools available, which may be applicable to a wide variety of conditions.[3] Recently, there has been an effort by the International Lymphedema Framework to assess quality of life using a disease-specific tool to measure HRQOL in persons with lymphedema.[19] Research reviewed reported a HRQOL tool specific to lymphedema aimed

to provide a baseline when assessing patients, and aided health care providers in developing a more patient-centered plan of care.[19] The HRQOL tool which has been consistently used in recent

studies conducted by the International Lymphedema Framework, is known as LYMQOL. This validated quality of life assessment tool is specific to upper or lower limb lymphedema. The tool, which covers four domains, consists of a questionnaire that is completed by the client. The four domains of symptoms, body image, appearance, function, and mood each are scored between 1 (not at all) and 4 (a lot). In each domain a total score is calculated by adding the scores of each item and dividing the score by the number of items answered.[13,19] The higher the score the poorer the quality of life of the client. For example, a score of 1 would mean that lymphedema does not affect the client's quality of life at all and it is the best possible score. A score of 4 indicates lymphedema is negatively impacting their quality of life. Overall quality of life is measured using a scale ranging from 0 (poor) to 10 (excellent). For this rating, the higher the score, the better the quality of life.[13]

Central Health has not adopted a disease specific quality of life tool for assessing lymphedema. The current assessment form used by the Regional Lymphedema Nurse (see page 144) uses a Likert scale to assess broadly what the client perceives their quality of life to be on a scale 1(poor) to 10 (excellent). This question can provide a basis for further discussion with the client if they express their quality of life as low. Ideally, having a HRQOL assessment tool that is disease specific and validated would allow for a more holistic assessment of your client. Identifying clients who may be experiencing a low quality of life allows for early intervention and support for these clients. In the *Additional Learning* box below, there is a link to the LYMQOL questionnaire should you wish to review and use it.

Reflection

Think about your clients with lymphedema.

- Do any of your clients experience poor quality of life due to health issues?
- Is lymphedema a contributing factor to their poor quality of life?

Additional Learning

- For more information on LYMQOL and a copy of the lower limb questionnaire, please click on the following link https://oro.open.ac.uk/32567/1/JoL_Quality_of_Life_Measures.pdf

- Would you like to learn more about the impact of lymphedema? A learning video can be found on the Klose Training website (www.klosetraining.com). View: Lymphedema 101, Part 4 by clicking on the following link https://klosetraining.com/resources/klose-videos/

Lower Limb Circumferential Measurement

Measuring limb volume is one of the most common measurements used in lymphedema assessment to determine outcomes of edema reduction. This can be done using a variety of methods. The challenge in lymphedema assessment practice is that there is no clear standard for limb volume measurement in use.[33] The simplest, practical, and most common method for limb volume calculation is tape measurement.[34] This can be done quickly in a clinic setting, with little cost.

At Central Health, calculation of limb volume measurement is typically completed by the Regional Lymphedema Nurse to monitor limb volume and edema reduction. At present, community health nurses at Central Health are not expected to calculate limb volumes on their clients.

It is important that continuing care nurses know how to take basic lower limb circumferential measurements. These measurements can be used to determine sizing for compression stockings or to monitor reductions in leg circumferences following use of compression. It is important to note that tape measurement has a potential for bias and inaccuracies. Therefore, it is recommended that measurements be performed consistently by one practitioner to obtain the least amount of variability when using tape measurement as an outcome measure.

When taking measurements, nurses should take care not to put tension on the tape. Measurements should be completed in centimeters. The circumference tape measurements used at Central Health are performed at the base of the toes, the smallest part of the ankle, and at 10cm intervals (starting 10cm proximal to the lateral malleolus) up to 60cm, proximal to the lateral malleolus. If measuring for stockings, it is best to measure first thing in the morning when limbs are likely smaller.

Please review the Central Health Leg Measurement Form located in a pdf. file in the box below. This form can be printed and used to document your leg measurements. On the back of the form is space to add assessment notes. Remember any written notes on page 2 of this form should be included in your electronic health record documentation. Currently the measurement chart is not available in the electronic health record. The form should be added to your client's paper file.

Central Health: Leg Measurement Form

Please click on the pdf. file below to access the Leg Measurement Form used at Central Health.

FRM-CSW007 Leg Assessment.pdf

Quiz Activity 2.1

James is a 50 year old male who has experienced chronic lower limb swelling for more than 20 years. He was referred to the continuing care nurse for management of a leg ulcer to the medial aspect of his right leg. James has a fever, and his right leg is red and warm to touch. The lower legs are non-pitting and have lost normal leg contours. The skin has hyperkeratosis and papillomatous lesions to the shin areas. James reported he has diabetes, hypertension, depression and a history of repeated cellulitis. He works as a cook in a local restaurant, often standing for eight hours a shift. He admits to smoking one pack of cigarettes per day. James weighs 138.6kg (305lbs) and he is 182.8cm (6 feet) tall. James has a body mass index of 41.4. The physician has requested compression to be started.

Choose the most appropriate answer to the following questions by placing an **X** in the correct box. The correct answers to the questions can be found in Appendix C.

1. The most appropriate next step would be to:

- [ ] a. Apply compression as directed by the physician.
- [ ] b. Complete the wound care only.
- [ ] c. Complete wound care and call physician to discuss concerns and further care.
- [ ] d. Call the Regional Lymphedema Nurse to assess.

2. James has the following risk factors for lymphedema

- [ ] a. Morbid obesity, fever, smoking.
- [ ] b. Morbid obesity, smoking, depression.
- [ ] c. Morbid obesity, recurrent skin infection, skin ulceration.
- [ ] d. Fever, diabetes, hyperkeratosis.

3. What stage lymphedema is James most likely experiencing?

- [ ] a. Stage II
- [ ] b. Stage III
- [ ] c. Stage 0
- [ ] d. Stage I

4. James has risk factors for what type of vascular disease?

- [ ] a. Venous disease
- [ ] b. Arterial disease
- [ ] c. Arterial and venous disease
- [ ] d. James does not have risk factors.

5. The health-related quality of life tool LYMQOL is:

- [ ] a. specific to lymphedema
- [ ] b. a validated tool
- [ ] c. used to aid health care providers in developing more patient-centered care
- [ ] d. all the above

6. When is the best time to measure for compression stockings?

- [ ] a. Mid afternoon
- [ ] b. Before bed
- [ ] c. Early morning
- [ ] d. It does not matter when you measure.

7. James is at risk for what life-threatening condition?

- [ ] a. Sepsis
- [ ] b. Cancer
- [ ] c. Cellulitis
- [ ] d. Venous disease

Conclusion

Congratulations on completing Module 2! This module aimed to provide an overview of the assessment of lower limb lymphedema and to provide you with the information and knowledge you will need to safely care for your clients with lower limb lymphedema in the community setting. You should be able to conduct a basic lymphedema assessment and be able to interpret the results. As a continuing care nurse, you should be able to describe the common skin characteristics seen in lymphedema and how obesity, recurrent cellulitis, and wounds are risk factors for lymphedema.

As part of your assessment skills you must be able to identify characteristics seen in venous and arterial disease in order to know when further consultation is required for your clients. While you are not expected to perform ABPIs it is important that you know how to calculate and discuss an ABPI assessment. This would include knowing the normal range for ABPIs and at what ABPI reading compression would be contraindicated. You should be able to conduct and document a basic lower limb assessment using the checklist provided and know how to interpret the results and know when to seek further guidance and refer.

As nurses, you should recognize that HRQOL may be affected in persons with lymphedema. While Central Health does not require you to assess HRQOL using a validated tool, you should be aware that the LYMQOL tool specific to lower limb lymphedema is available should you wish to use it. Finally, continuing care nurses should be able to complete basic circumferential measurements to the lower limb. This will help you to monitor circumferential changes when treating your clients with compression and allow you to measure for ready-made compression stockings.

Now that you can conduct a basic assessment of your clients with lymphedema, the next step is to use your skills to help inform your client’s treatment plan. Proceed to Module 3 to learn more about the treatment and management of lower limb lymphedema.

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MODULE 3:

TREATMENT AND MANAGEMENT OF LYMPHEDEMA

Module 3: Treatment and Management of Lymphedema

The purpose of this module is to provide an overview of the treatment and management of lower limb lymphedema and to provide continuing care nurses (CCNs) with the information and knowledge to assist them in safely caring for their clients with lower limb lymphedema in the community. This module will review the current treatments and risk reduction practices, as well provide information on the various types of compression garments available to manage lymphedema. Definitions of bolded terms can be found in the Glossary located in Appendix A of the e-learning resource manual.

This module is intended for use by the CCNs at Central Health but will be accessible through the Learning Management System to any health care professional at Central Health who has an interest in learning about the treatment and management of lymphedema.

This module contains evidenced based information, with reflection exercises, a case study, video links, an interactive activity, and a quiz to provide an enhanced learning experience for nurses. Embedded videos can be accessed by placing the mouse over the arrow at the center of the video and “clicking” your mouse. You can return to the module by pressing the escape button on your keyboard. Links to websites can be accessed by placing your cursor on the link and pressing the control button on your keyboard while clicking your mouse. You can return to the module by closing the “x” on the open tab on your tool bar.

Learning Objectives

Upon completion of this module, you will be able to:

1. Names the five basic components of lymphedema management;
2. Describe the current treatments for managing lymphedema;
3. Describe the various types of compression available to treat and manage lymphedema;
4. Apply simple measurement techniques to measure accurately for ready-made, below the knee or thigh high compression for a normal-contoured leg;
5. Describe how to correctly don and doff compression stockings; and
6. Describe how to care for compression stockings.

Treatments for Lymphedema

Lymphedema is a life-long, progressive condition that has been widely suggested to be under-recognized, under-treated, and a neglected public health issue.[1,2,3] There are many factors that contribute to lymphedema, but for most chronic swelling the treatments and management remain similar. In Module 2, assessment was covered in detail. It is important that nurses have the necessary skills to assess their clients in order to ensure safe and effective treatment is carried out. It is also paramount that the nurse can engage the client actively in their care so that the eventual outcome will be self-care by the client.

There has been limited strong evidence to support the various treatments for lymphedema.[4] Most treatments aim to control or decrease the swelling by improving lymphatic drainage and improving venous return.[5,6] The widely accepted standard for treating lymphedema is known as complete decongestive therapy (CDT).[7,8] Complete decongestive therapy involves a combination of skin care, manual lymphatic drainage (MLD), compression bandaging, and exercise.[7,8] This therapy is typically provided by a certified lymphedema therapist. At Central Health, CDT is provided by the Regional Lymphedema Nurse who is also a certified lymphedema therapist.

The four cornerstones of CDT along with promoting self-care make up the five basic components of lymphedema management. The continuing care nurse may be requested to assist in the care of clients with lymphedema. Components of CDT can be provided by continuing care nurses, with the most common components being skin care and compression bandaging.

It is suggested that a multidisciplinary approach, with a comprehensive plan, is required to successfully manage clients with complex lymphedema.[4] Newer research has indicated that a more proactive approach should be taken to address chronic edema early before it becomes a complex problem.[6] This has implications for continuing care nurses as they often see these clients in the community. Having skills to treat lymphedema in the community may decrease the progression of lymphedema and provide clients with valuable self-management skills in order to manage this life-long condition.

Managing lymphedema often requires identifying and reducing risk factors and changing lifestyles. While treatment plans include the basic components of lymphedema management, such as skin care, MLD, compression bandaging, and promoting exercise, additional practices, such as elevation, weight management, and diet also play an integral role.[4,5] These will all be covered in more detail throughout this module.

Five Basic Components of Lymphedema Management

Skin Care

Basic skin care is one of the cornerstones of lymphedema care.[4,8] The promotion of meticulous skin care aims to reduce the incidence of **cellulitis**, **lymphangitis**, and **erysipelas**.[4,8] Breaks in the skin barrier can predispose a person with lymphedema to a cellulitis as the protein-rich fluid is a perfect medium for pathogens to grow.[8] It is recommended that persons with lymphedema moisturize dry skin nightly with a fragrance-free hydrant of neutral or slightly acidic pH.[8]

Manual Lymphatic Drainage

Manual lymphatic drainage is a type of light-touch massage that is performed by a certified lymphedema therapist or qualified registered massage therapist.[4,8] Manual lymphatic drainage is a component of CDT and is generally initiated during the initial or intensive treatment phase by the certified lymphedema therapist.[4,8] The aim of MLD is to facilitate movement of lymph through the lymphatics away from the edematous areas towards proximal areas where lymphatics are functioning normally.[4,8] During the maintenance phase of lymphedema management clients may be taught simple self-MLD practice. This instruction would be provided by the Regional Lymphedema Nurse.

Compression Bandaging

Compression bandaging is a component of CDT and often a necessary part of the life-long management of lymphedema. Continuing care nurses may be required to apply compression bandages to assist with the management of chronic edema and in the healing of wounds. The most common form of compression bandaging used at Central Health is a cohesive system known as 3M™ Coban™ 2 layer compression system. The application of this system is the focus of a one-day workshop that is mandatory for all continuing care nurses at Central Health.

Compression acts to decrease production and build up of the interstitial fluid in the limb and to promote venous return.[4] When combined with exercise and activation of the calf muscle pump, venous return is further enhanced.[4]

Please watch the following video on the basic application of 3M™ Coban™ 2 layer bandaging to the lower leg. Click on the arrow at the center of the video to start. Press the escape button to return to the module. Note there are two different pressure bandages that can be used. 3M™ Coban™ 2 Lite aims to deliver approximately 20-30mmHg, while 3M™ Coban™ 2 Regular delivers approximately 30-40mmHg pressure.

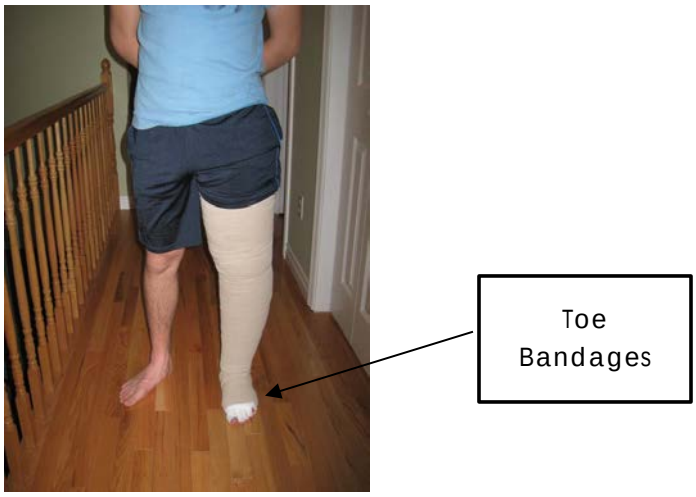
Source. From "Basic application of 3M™ Coban™ 2 Layer Compression System", 3M Health Care, 2011,[9] https://www.youtube.com/watch?v=5iGA9tCyFyA

A more traditional form of bandaging uses multiple short-stretch bandages of varying widths to create a multi-layered bandage.[8] Stockinette and cast padding are used under these bandages to protect the skin. The bandages are applied with tension from distal to proximal on the limb. As layers of bandaging are added, the compression level increases creating a firm bandage. Bandaging can be taught to the client to self-apply at home. This skill would be taught by the Regional Lymphedema Nurse and would not be an expectation of continuing care nurses.

Figure 3.1 shows short-stretch bandaging to the left leg. Note the toe bandages in the picture. Toe bandaging is a skill that is taught by the Regional Lymphedema Nurse during the one-day workshop at Central Health.

Figure 3.1

Short-stretch Bandaging to Leg



Source. From "Short-stretch bandaging left leg", by Lanning (2011), personal photo collection.[10]

Exercise

Exercise is considered a fundamental component in decreasing and managing lower limb lymphedema.[4] The calf muscle pump is reported to play an important role in assisting with venous return of blood from the legs.[11] Decreased use of the calf muscle pump or failure of the calf muscle pump as seen with immobility and paralysis may cause an excess of interstitial fluid build-up in the lower limbs resulting in increased edema. Therefore, exercise should be considered in some form in all clients as part of their treatment plan. Remember to always balance rest with activity.

Simple dorsiflexion of the foot at the ankle and encouraging a seated client to tap their feet are easy exercises to encourage. Walking as tolerated is an effective exercise to maintain the calf muscle pump and encourage return of excess fluid to the venous system. More vigorous exercise should be discussed with the client's family physician or nurse practitioner. A physiotherapist consult should be a consideration to ensure an appropriate exercise plan is initiated.

Please watch the short video showing simple leg exercises to share with your clients. Clients with balance issues should ensure they have a stable surface to hold on to when doing standing exercises. Click on the arrow at the center of the video to start. Press the escape button to return to the module.

Source. From "Leg exercises for lymphoedema", Cancer Research UK, 2019,[12] https://www.youtube.com/watch?v=2PKkdyBRu1k

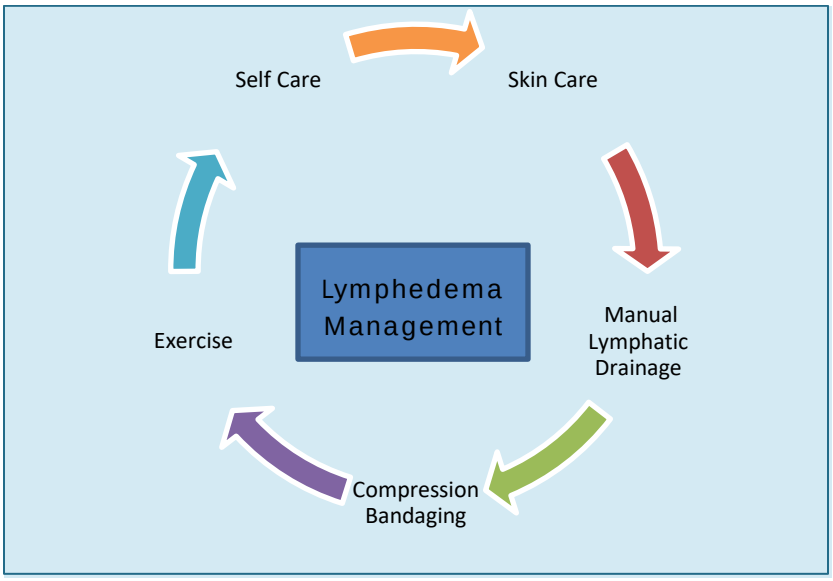
Self-care

Encouraging clients to self-manage care is a component that must be introduced early in the treatment plan of clients with lymphedema. Involving the client in their care right from the start encourages the client to become an active participant in their care and leads to a more client-centered approach to care.

Figure 3.2 illustrates the five basic components involved in managing lymphedema. It is not one component but the integration of multiple components working together that aims to achieve the desired results of edema reduction and maintenance.

Figure 3.2

Five Basic Components of Lymphedema Management



Reflection

Think about your clients with lymphedema.

- Have you discussed with your clients how skin care, exercise, maintaining an optimal weight, and wearing compression garments may help them manage their lymphedema?
- Have you considered how these practices work together to reduce swelling?
- Have you involved the right people in your client's care?
- Is your client in need of multidisciplinary care?

Other Treatments and Therapies for Lymphedema Management

Compression Stockings

Following reduction of edema or for maintenance therapy, persons with lymphedema are often advised to wear compression stockings. Compression stockings come in ready-made or made-to-measure garments. For persons with abnormal contoured legs, wide ankle girth, or advanced stage lymphedema, it is usually advised that they obtain custom stockings. If custom stockings are required, it is important that clients are measured by a certified fitter to ensure they get an appropriate fit. Wearing ill-fitted stockings will cause discomfort or possibly harm and is one of the reasons a person may not tolerate stockings or discontinue wear. Stockings come in various pressure levels. Typically, a prescription is required for pressures above 20-30mmHg. Insurance companies may require a diagnosis to be written on the prescription, as well as the pressure level (mmHg) in order to provide reimbursement. Many insurance companies will not cover compression stockings under 20mmHg pressure. Clients should discuss with their physician or nurse practitioner re wearing compression and obtaining the necessary prescription. The Regional Lymphedema Nurse can provide guidance/consultation if required.

Figure 3.3 is an example of custom flat knit stockings. Note the seam in the back, which denotes they were knit flat and not on a circular knit system. These stockings are heavier and less likely to constrict at the ankles than a circular knit stocking. Flat knit stockings are the preferred type of stocking for well-established lymphedema especially if there is loss of normal contour to the limb. These stockings come in a variety of prints and colours.

Figure 3.3

Custom Flat Knit Compression Stockings

Source. From “Compression stockings for compression therapy”, by Users from Hamburg, 2019, Wikimedia Commons, Creative Commons-Share Alike International.[13]

Remember!

Clients who have suspected arterial vascular disease should not wear high compression (> 30mmHg). If their ankle brachial pressure index is < 0.5, compression is contraindicated.[14]

Adjustable Compression Systems

Compression garments are available in the form of an adjustable, Velcro-on system, which allows the person to adjust the tension on the straps to provide varying pressure levels of compression. These garments come in standard sizes, as well as made-to-measure. A certified fitter should measure for these garments to ensure the best fit.

Figure 3.4 shows a thigh high adjustable compression system capable of reaching pressures of 60mmHg depending on tensions applied to the straps. This system is more appropriate as a nighttime garment.

Figure 3.4

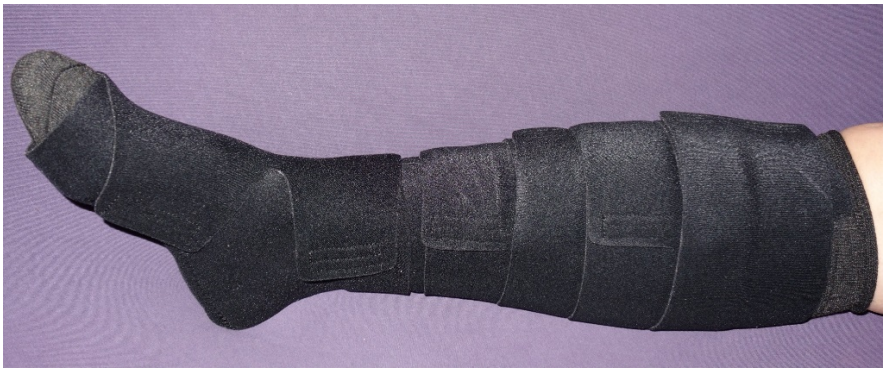
Adjustable Compression System (Nighttime Garment)

Source. From "Nighttime adjustable compression" by Lanning (2011), personal photo collection.[15]

Figure 3.5 shows another type of adjustable compression. The Velcro closure straps simulate bandaging and can be adjusted up to 60mmHg pressure. This below the knee system is low-profile and can be worn with regular footwear. This type of adjustable system is meant to be worn in the day and removed at night.

Figure 3.5

Adjustable Compression (Daytime Garment)



Source. From "Adjustable Velcro bandage for compression therapy of leg, foot and ankle", by Users from Hamburg, 2016, Wikimedia Commons, Creative Commons Attribution-Share Alike 4.0 International.[16]

Elevation

Elevation is commonly recommended for decreasing swelling to the affected limb.[4,17] Elevation is thought to decrease venous pressure and improve venous return,[4] thereby decreasing edema from the distal extremity. Elevation is most successful in the early stages of lymphedema and is why in Stage I and early stage II lymphedema the client will report the swelling decreases overnight with rest and elevation in bed.

It is important to assess whether arterial vascular disease is playing a role in your client's presentation (see Module 2). Elevation is not an appropriate treatment for persons with severe arterial disease as it may decrease the blood supply to the distal limb causing further ischemia.

Pneumatic Compression Pumps

Pneumatic compression pumps are used to reduce edema in limbs. These pumps, which use compressed air, can be single or multi-chambered. The pump works by inflating a sleeve sequentially from the distal to proximal aspects of a limb, mechanically forcing the edema towards the proximal limb.[8] The compression level is adjustable to control the force applied to the limb. Compression pumps should only be applied by qualified practitioners or following receipt of training in their use. Any person with lymphedema who obtains a pump for home use must be trained in how to safely use it. This would not be an expectation of continuing care

nurses. The Regional Lymphedema Nurse and some physiotherapists are trained in the use of pneumatic compression for lymphedema. A person with lymphedema should receive a medical assessment before using or purchasing pneumatic compression. If used correctly in the appropriate client, pneumatic compression can be a valuable part of a lymphedema treatment plan. These compression systems are very expensive. Some insurance companies cover a portion of the costs, but for many this type of treatment is not a viable option.

Please watch the short video demonstrating the use of a pneumatic compression system. Click on the arrow at the center of the video to start. Press the escape button to return to the module.

Source. From "Lympha Press sequential compression device", Compression Management Services, 2010,[18] https://commons.wikimedia.org/wiki/File:Adaptive_Klettbandage_mit_Fu%C3%9Fteil.jpg

Did you Know!

Use of pneumatic compression may reduce the water content in the limb leaving increased protein in the tissues, which results in more water leaving the blood capillaries, further exacerbating edema.[8] There is also a risk of increasing edema to the genital area if fluid is pumped forcefully through the lymph nodes at the groin, increasing congestion in the pelvic, suprapubic, and genital region.[8] Genital edema is difficult to treat, further complicating a client's care and possibly their quality of life.

Always use pneumatic compression with caution!

Aqua Lymphatic Therapy

Aqua lymphatic therapy is reported to promote edema reduction.[19] This therapy, which involves exercise in a pool, is based on the premise that water provides a natural resistance and pressure to the submerged limbs. As the depth increases the limb is exposed to higher pressures which, when combined with exercise, is thought to enhance and influence the direction of lymphatic flow.[19] Assuming your client does not have a wound, exercise in water may be a beneficial treatment for managing lymphedema.

Weight Management and Diet

Obesity and morbid obesity are conditions seen in persons with lymphedema.[1,20,21] There is no specific diet for the treatment of lymphedema.[8] It is accepted to follow a healthy diet such as Canada's Food Guide that promotes maintenance of an optimal weight. Typically, persons with lymphedema are recommended to follow a low-fat, low salt diet that promotes water for hydration.[8] In persons where obesity is likely a factor in their chronic edema, a dietitian consult should be considered and offered.

Case Study 3.1

April is a 42 year old female who has bilateral lower limb lymphedema, with leaking from various superficial wounds to the anterior tibial regions of her legs. She does not have an acute infection but remains on antibiotics due to her increased risk for cellulitis. Her physician has requested Coban™ 2 bandaging below the knee, bilateral. April had recent vascular studies and her ankle brachial pressure index (ABPI) is 0.94. She works at a local retail store but is off work due to her leaking legs. April's weight is 147.7kg (325lbs) and she is 152.4cm (60 inches) tall. Her body mass index is 63.5kg/m². She is eating a bag of chips and drinking a pop while in the waiting room.

Based on this limited information, what kind of treatment plan and discussion would you consider for April? Suggestions for an appropriate treatment plan can be found in Appendix D of the resource manual.

Practice Tips for Measuring and Wearing Compression Stockings

There are a few basic practice tips continuing care nurses should be aware of when using compression stockings as a treatment for their clients with lower limb lymphedema. For example, not all clients will need to see the Regional Lymphedema Nurse to be treated for their chronic swelling. If a client has mild swelling, with no contraindications for compression, they likely would benefit from at least mild (15-20mmHg) compression stockings. A discussion with the family physician or nurse practitioner would be appropriate to obtain a prescription for ready-made stockings. Ready-made stockings are only suitable for those who have a normal contoured leg. Knowing how to measure, don and doff, and care for these stockings will allow the

continuing care nurse to provide early care and help to prevent their client's swelling from progressing. This is a big step in preventative care.

How to Measure for Ready-made Stockings

Ready-made stockings are available with and without a prescription. Generally, compression levels below 20mmHg do not require a prescription. A common compression level available for purchase in many retail stores such as pharmacies is 15-20mmHg, below the knee or thigh high stockings. These stockings still require some basic measurements, with the smallest ankle circumference, widest calf, and widest part of the thigh being the usual circumference measurements requested. Some brands of stockings also come in petite, average, and tall lengths, which may require measurements for length to correctly size.

Please watch the video below to learn how to take basic measurements for ready-made compression stockings. Note in the video the nurse measures in inches. Accepted practice in Canada is to measure in centimeters (1 inch = 2.54 cm). Click on the arrow at the center of the video to start. Press the escape button to return to the module.

Source. From "Measuring for compression stockings", by Terri Morrison, 2011,[22] https://www.youtube.com/watch?v=P70Drkz7uEg

How to don and doff stockings

Learning to don and doff compression stockings can be challenging for some, which may lead a person to discontinue wear. Stockings should be donned early in the morning and removed before bed. There are techniques to donning stockings that make it easier for clients to self-don.

It is important to teach clients how to don their stockings correctly to improve compliance in wear. The following video shows step-by-step how to don below the knee compression stockings. Click the arrow at the center of the video to start. Press the escape button to return to the module.

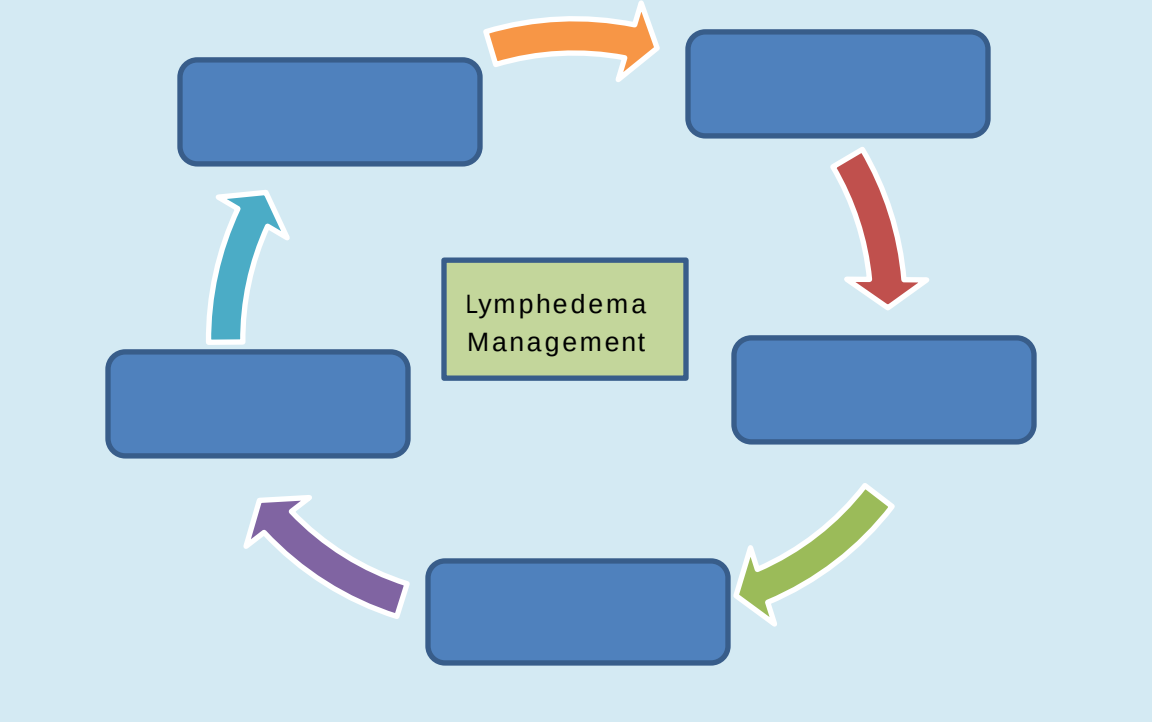
Source. From " How to get the most out of compression stockings", by UW Health, 2013,[23] https://www.youtube.com/watch?v=rdEL-bV4Xnc

How to Care for Compression Stockings

Compression stockings should be rinsed out after each wear with a mild detergent and rolled in a towel or laid flat to dry. Some stockings can be washed on the delicate cycle in a washer and dried on the low setting in a dryer. Clients should check the washing instructions for their brand of stockings to ensure the appropriate care is followed. If washing in the washer, it is recommended to use a mesh garment bag to avoid stockings being tangled around the agitator or other clothing. Washing by hand is thought to prolong the life of stockings. A single pair of stockings if washed and worn daily will wear out in three to four months. Therefore, it is important to replace stockings when showing signs of wear or if they start to go on too easily as the compression level may decrease, leading to poorly managed edema.

Interactive Activity 3.1

Click on and drag the correct answer boxes labelled with the five basic components of lymphedema management to the most appropriate place to drop on the diagram. Please note there are more answer boxes provided than needed to complete the diagram. The correct answers can be found in Appendix D at the end of the resource manual.



Answer Boxes

Vibration Therapy

Self-Care

Acupuncture

Low Protein Diet

Skin Care

Manual Lymphatic Drainage

Compression Bandaging

Diuretics

Exercise

Quiz Activity 3.1

Choose the most appropriate answer to the following questions by placing an **X** in the correct box. The correct answers to the quiz activity can be found in Appendix D of the resource manual.

1. Treatments for lymphedema management may include:

- [ ] a. compression stockings
- [ ] b. exercise
- [ ] c. skin care
- [ ] d. all the above

2. Ready-made compression stockings are available:

- [ ] a. with and without a prescription
- [ ] b. for wear with ABPI of < 0.5
- [ ] c. for abnormal contoured legs
- [ ] d. and recommended to be worn for 24 hours a day

3. Persons with lymphedema may be at increased risk for cellulitis due to:

- [ ] a. breakdown of the skin barrier
- [ ] b. excess protein-rich fluid in the interstitial spaces
- [ ] c. poor skin care
- [ ] d. all the above

4. The five basic components of lymphedema management consist of:

- [ ] a. wound care, rest, elevation, and antibiotics
- [ ] b. elevation of limb, foot and ankle exercise, pneumatic compression, and skin care
- [ ] c. skin care, manual lymphatic drainage, compression, exercise, and self-care
- [ ] d. skin care, swimming, massage therapy, and compression

5. Pneumatic compression to the leg may increase the risk of:

- [ ] a. genital edema
- [ ] b. fluid congestion in the pelvic and suprapubic region
- [ ] c. high protein in the tissues, causing more edema
- [ ] d. all the above

6. Manual lymphatic drainage:

- [ ] a. is a form of deep tissue massage
- [ ] b. encourages the movement of lymphatic fluid proximal, away from edematous regions
- [ ] c. can be performed by all registered massage therapists
- [ ] d. encourages the movement of lymphatic fluid to the distal aspect of the limb

7. As part of risk reduction management for lymphedema the client should:

- [ ] a. complete skin care nightly
- [ ] b. walk as tolerated daily to promote the calf muscle pump
- [ ] c. balance rest with activity
- [ ] d. all the above

8. When measuring for ready-made below the knee compression stockings, the nurse should:

- [ ] a. measure at the largest width of the ankle and calf
- [ ] b. measure in the evening when swelling is the greatest
- [ ] c. measure circumference of the narrowest part of the ankle and widest part of the calf
- [ ] d. all the above

9. When donning stockings the client should:

- [ ] a. apply moisturizer to skin to assist with donning
- [ ] b. don stockings after exercising
- [ ] c. don stockings first thing in the morning
- [ ] d. don stockings before going out

10. When teaching a client about care of their compression stockings, it is important that they know to:

- [ ] a. wash stockings after each wear in a mild detergent
- [ ] b. wash stockings in hot water
- [ ] c. wash stockings every second night
- [ ] d. dry stockings on high heat in dryer to kill bacteria

Conclusion

Congratulations on completing Module 3! This was the final module in the e-Learning Resource on the assessment, treatment, and management of lower limb lymphedema. This module provided an overview of the treatment and management of lower limb lymphedema.

You should now know the five basic components for lymphedema management and be able to describe risk reduction practice such as skin care, exercise, diet, and the use of compression for managing lymphedema and preventing lymphedema from worsening.

This module provided information on the various types of compression available for treating and managing lymphedema and you should be able to recognize some of the common types available. While the development of new compression systems is ever evolving, continuing care nurses should be able to measure for ready-made compression stockings for the normal-contoured leg. This will allow for the early treatment and management of non-complex clients, with the aim to prevent the progression of lymphedema and possible risks that may be associated with later stage lymphedema. Finally, you should be able to provide basic teaching to your clients on how to correctly don and doff their compression stockings, as well as how to care for care for their stockings.

Having this information and knowledge provides you with the basics to safely manage your clients with lymphedema in the community setting. This module and e-learning resource will build upon your existing knowledge and experience and will supplement the one-day workshop on lymphedema provided to CCNs at Central Health.

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Post-test

Please complete the following post-test once you have completed the e-learning modules. At the end of the test you will be directed to where you can find the answer key for the test.

Answer true (**T**) or false (**F**) to the following statements. Place an 'X' in the appropriate box as illustrated.

	Statements	**T**	**F**
1.	Lymphedema is rarely seen in the community setting.		
2.	Lymphedema/chronic edema is broadly defined as swelling lasting more than three months.		
3.	The most common cause of lymphedema worldwide is morbid obesity.		

Choose the most appropriate answer to the following questions by placing an **X** in the correct box.

4. When is the best time to measure for compression stockings?

☐ a. Mid afternoon

☐ b. Before bed

☐ c. Early morning

☐ d. It does not matter when you measure.

5. Compression is contraindicated if the ankle brachial pressure index is:

☐ a. 0.6

☐ b. 1.0

☐ c. > 0.5

☐ d. < 0.5

6. What are some common lower limb characteristics of venous disease?

- [ ] a. varicose veins, itchy legs, hemosiderin staining
- [ ] b. varicose veins, claudication, restless legs
- [ ] c. restless legs, night pain, deep, punched-out ulcer
- [ ] d. hemosiderin staining, varicose veins, absent pulses

7. What are some common signs and symptoms of cellulitis?

- [ ] a. increasing redness to a limb
- [ ] b. fever
- [ ] c. increased warmth to a limb
- [ ] d. all the above

8. Treatments for lymphedema management may include:

- [ ] a. compression stockings
- [ ] b. exercise
- [ ] c. skin care
- [ ] d. all the above

9. As part of risk reduction management for lymphedema the client should:

- [ ] a. complete skin care nightly
- [ ] b. walk as tolerated daily to promote the calf muscle pump
- [ ] c. balance rest with activity
- [ ] d. all the above

10. When measuring for ready-made below the knee compression stockings, the nurse should:

- ☐ a. measure at the largest width of the ankle and calf
- ☐ b. measure in the evening when swelling is the greatest
- ☐ c. measure circumference of the narrowest part of the ankle and widest part of the calf
- ☐ d. all the above

Congratulations on completing your pre and post-test! Please refer to Appendix E for the answer key. You will be able to compare your results to self-evaluate your learning.

Appendix A: Glossary

Body Mass Index (BMI)

A measure of body fat that is calculated based on height and weight. The formula is BMI = kg/m². A BMI of 25 or more is considered overweight. A healthy BMI is 18.5 to 24.9.[1]

Cellulitis

An acute infection of the skin that is characterized by pain, redness, and swelling to the area affected. Untreated cellulitis can quickly become systemic causing fever, chills, and nausea. It is common in lymphedema due to the accumulation of high-protein fluid in the tissues. This high-protein medium is a perfect setting for bacterial growth.[2]

Chronic edema

Defined as any swelling that lasts more than three months.[3,4] This term is considered an umbrella term and is used interchangeably with the term lymphedema. All chronic edema will result in lymphatic damage causing lymphedema.[4]

Combined insufficiency

Occurs when there is an increase in lymphatic load such as from congestive heart failure, and a mechanical failure to the lymphatic system due to injury or blockages. The combination of these insufficiencies may lead to chronic inflammation in the tissues causing severe tissue damage.[2]

Dynamic insufficiency

Also known as high volume insufficiency occurs when the lymphatic load in the interstitial spaces exceeds the ability of the lymphatic system to transport the load.[2]

Erysipelas

This acute infection of the skin typically causes redness, swelling, lymphadenopathy, blistering, pain, and fever and must be treated aggressively with antibiotics. This rapidly spreading infection can quickly become systemic resulting in sepsis.[2]

Hemosiderin staining

A reddish-brown discolouration of the skin caused by red blood cells leaking from the veins and breaking down under the skin.[5] The iron deposits from red blood cells stain the skin a reddish-brown colour.[5]

High volume insufficiency

Also known as dynamic insufficiency (see **Dynamic insufficiency**).[2]

Hyperkeratotic

An overgrowth of the top layer of skin which produces a waxy, scale-like appearance to the skin.[2]

Interstitial space

The fluid filled space between the tissue cells of the body. This space is also referred to as the interstitium.[5,6,7]

Interstitium

Same as interstitial space (see **Interstitial space)**.[5,6,7]

Lymphangitis

An inflammation of the lymphatic vessels often resulting from an infection. Red streaks may be visible on the skin. Infections causing lymphangitis may quickly become systemic resulting in fever, chills, headache, and nausea. Sepsis may occur rapidly. Therefore, signs and symptoms of lymphangitis should never be ignored. Treatment is typically with intravenous antibiotics.[2]

Lymphatic filariasis

A parasitic mosquito-borne infection caused by the nematode worm *Wuchereria bancrofti.* It is the most common cause of lymphedema worldwide.[2,5]

Lymphatic vessels

A series of small vessels that carry lymphatic fluid in a one-way direction from the interstitial spaces back to the venous system.[2,5]

Lymphedema

Characterized by the accumulation of protein-rich fluid in the interstitial spaces. This chronic, progressive condition produces a swelling usually in a limb, but may affect the head, neck, chest, and genital region.[5,6,7] The term lymphedema is used interchangeably with the term chronic edema and means one and the same.[3,4]

Lymph node

These kidney bean shaped structures are located throughout the lymphatic system and serve to filter the lymph fluid and help the body to fight infection. They are mainly situated in the head and neck, chest, axilla, groins, and intestinal regions.[2,5]

Lymphorrhea

The leakage of high-protein fluid through the skin.[2,8]

Lymphostasis

Sluggish or stagnant flow of lymph.[9]

Mechanical insufficiency

Also known as low volume insufficiency occurs when the transport capacity of the lymphatic system is impaired due to a mechanical failure such as by injury or blockages to the lymphatic system.[2]

Morbid obesity

Having a body mass index of 40 or greater.[10]

Papillomas

Protruding wart-like lesions from the skin that are covered with epithelial tissue.[2,8] These lesions are common in Stage III lymphedema where the fibrotic skin changes also include these benign lesions.[2,8]

Prevalence

Prevalence represents the total number of cases of a specific disease/condition present in a population at a specific point in time.[4]

Primary lymphedema

A developmental abnormality of the lymphatic system caused by a congenital or hereditary factor.[2,5] Swelling occurs in the tissues distal to where the abnormalities exists.[2]

Secondary lymphedema

Occurs as a result of injury or insult to the lymphatic system. This leads to swelling in the affected area.[2,5]

Stemmer sign

A positive Stemmer sign is considered diagnostic of lymphedema.[2,5,8] It can be checked by pinching the skin at the base of the second toe.[2,5,8] An inability to tent or lift the skin is considered a positive Stemmer sign.[2,5,8] A negative Stemmer sign, however, does not mean lymphedema does not exist.[2,5]

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Appendix B: Module 1 Answer Keys

Case Study 1.1: Answer Key

Case Study 1.1: Answer Key

The limited history provided suggests that primary lymphedema should be a consideration and further investigated.

- Adolescence age of onset
- Familial history of only one leg swelling. Is there a genetic cause?
- Pattern of occurrence in females within a family. Does this have a genetic basis?

Interactive Activity Exercise 1.1: Answer Key

High pressure in the arterioles cause fluid containing protein to leak into the interstitial spaces. See page 128.

Protein and oxygen nourish the cells in the interstitial space. See pages 127-128.

Excess fluid, proteins, and cellular waste products are picked up by the lymphatic capillaries. See page 128.

Lymph fluid moves through the lymphatics until it enters the venous system through ducts at the subclavian. See page 128.

Quiz Activity 1.1: Answer Key

	Statements	T	F
1.	Lymphedema is rarely seen in the community setting. See page 124.		X
2.	Lymphedema/chronic edema is broadly defined as swelling lasting more than three months. See page 123.	X	
3.	Secondary lymphedema has a genetic cause. See page 131.		X
4.	Low pressure in the arterioles causes fluid to leak into the interstitial spaces. See page 128.		X
5.	Rhythmic contractions from skeletal muscle, respiration, and arterial pulsations aid in lymph transport. See page 126.	X	
6.	Lymphatic organs such as the thymus, spleen, and liver make up the lymphatic system. See page 125.		X
7.	Lymphatic fluid is propelled though the lymphatics in a one-way direction. See page 130.	X	
8.	Mechanical failure of the lymphatics is cause by dynamic insufficiency or high-volume overload. See page 131.		X
9.	Lymphatic capillaries pick up all excess fluid from the interstitium. See page 128.	X	
10.	Secondary lymphedema can have many risk factors and have more than one cause. See page 131 and 132.	X	
11.	Lymphedema is classified into two types, primary and secondary. See page 131 and 132.	X	
12.	The most common cause of lymphedema worldwide is morbid obesity. See page 123.		X
13.	The lymphatic system plays a limited role in fluid homeostasis. See page 126.		X
14.	Fat absorption from the gastric system is a function of the lymphatic system. See page 126.	X	
15.	Once interstitial fluid enters the lymph capillaries, it is known as serous fluid. See page 130.		X

Appendix C: Module 2 Answer Keys

Case Study 2.1: Answer Key

John is a 48 year old male who has experienced swelling to his lower legs for approximately 12 years. John believes the swelling is increasing. The swelling is persistent, decreasing somewhat overnight with rest and elevation, but never fully resolving. John has noticed increasing skin dryness and a thickened feel to his skin. On exam, the skin does not pit easily. He has noted swelling to his toes.

Based on the limited information:

- What stage lymphedema would you suspect John is experiencing?
- Is there a simple test you can perform in the clinic to support a diagnosis of lymphedema?

Case Study 2.1: Answer Key

The brief history provided suggests John's lymphedema is Stage II. See Module 2, page 145.

- Edema is chronic and longstanding (12 years)
- Edema is persistent and does not resolve with rest and elevation
- Increasing dryness and thickened feel to skin suggests fibrotic skin changes
- Skin does not pit easily
- Swelling is noted to toes. The Stemmer sign is an easy test to perform in a clinic

Interactive Activity ABPI Exercise 2.1: Answer Key

John's ABPI was performed using a hand-held Doppler. The following systolic pressures were recorded for John's ABPI test.

Systolic Pressure values for John (see Table 2.5, page 159)

Limb	Systolic Pressure mmHg
Right arm	134 mmHg
Left arm	126 mmHg
Right posterior tibial	148 mmHg
Right dorsalis pedis	140 mmHg
Left posterior tibial	142 mmHg
Left dorsalis pedis	146mmHg

Note:

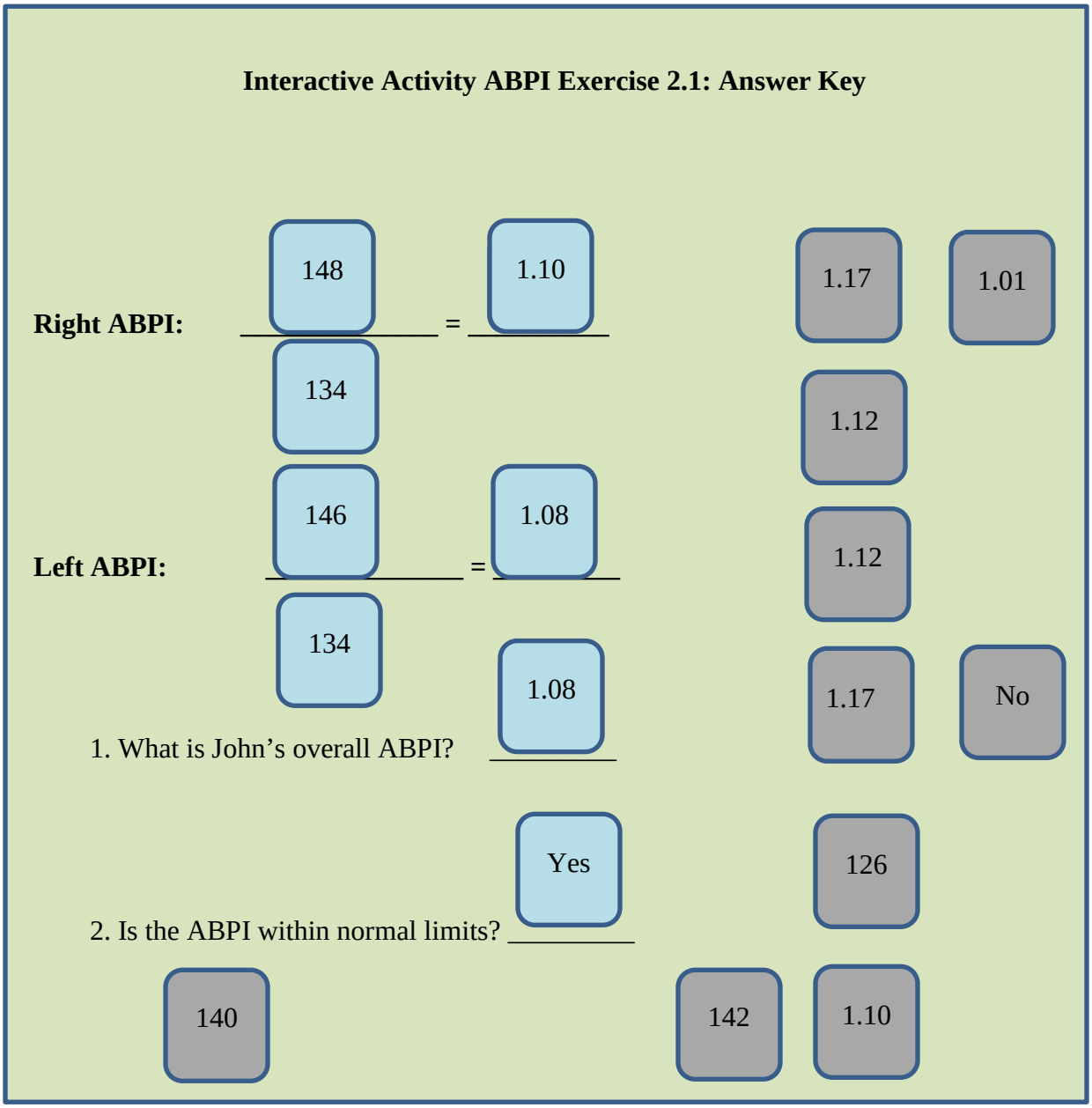
Remember the formula for calculating the ABPI is to take the highest systolic pressures of each leg and divide by the highest systolic pressure of the arms.[26] The lowest reading is considered the overall ABPI.

The table below shows the ABPI range used by the Lymphedema Management Program at Central Health. Values may differ slightly between sources

Ankle Brachial Pressure Index Value with Suspected Arterial Disease Severity (see Table 2.4, page 156)

ABPI Value	Arterial Disease Severity
< 0.5	Severe arterial disease
0.5 to 0.8	Moderate arterial disease
> 0.8 to 1.3	Mild to no arterial disease (normal range)
> 1.3	May indicate calcification in arteries, reading considered unreliable

Using the information provided in the above table to calculate the ABPI for John. Click and drag the correct answer boxes to the appropriate location to obtain John's right and left ABPI and answer the two questions. **Please note there are more answer boxes provided than needed.** The correct answer boxes remain shaded in light blue. The incorrect answer boxes are shaded in grey.



Quiz Activity 2.1: Answer Key

James is a 50 year old male who has experienced chronic lower limb swelling for more than 20 years. He was referred to the continuing care nurse for management of a leg ulcer to the medial aspect of his right leg. James has a fever, and his right leg is red and warm to touch. The lower legs are non-pitting and have lost normal leg contours. The skin has hyperkeratosis and papillomatous lesions to the shin areas. James reported he has diabetes, hypertension, depression and a history of repeated cellulitis. He works as a cook in a local restaurant, often standing for eight hours a shift. He admits to smoking one pack of cigarettes per day. James weighs 138.6kg (305lbs) and he is 182.8cm (6 feet) tall. James has a body mass index of 41.4. The physician has requested compression to be started.

Choose the most appropriate answer to the following questions by placing an **X** in the correct box.

1. The most appropriate next step would be to:

- [ ] a. Apply compression as directed by the physician.
- [ ] b. Complete the wound care only.
- [x] c. Complete wound care and call physician to discuss concerns and further care.
- [ ] d. Call the Regional Lymphedema Nurse to assess.

James is showing signs and symptoms of an infection (fever, leg redness, and warm to touch). The most appropriate answer would be to complete wound care and contact physician with concerns and guidance for further care. See Module 2, page 153.

2. James has the following risk factors for lymphedema

- [ ] a. Morbid obesity, fever, smoking.
- [ ] b. Morbid obesity, smoking, depression.
- [x] c. Morbid obesity, recurrent skin infection, skin ulceration.
- [ ] d. Fever, diabetes, hyperkeratosis.

Morbid obesity, recurrent skin infections, and wounds are all risk factors for lymphedema. See Module 2, pages 150-152.

3. What stage lymphedema is James most likely experiencing?

- [ ] a. Stage II
- [x] b. Stage III
- [ ] c. Stage 0
- [ ] d. Stage I

James most likely has Stage III lymphedema. The lower legs are non-pitting and have lost normal leg contours. The skin has hyperkeratosis and papillomatous lesions to the shin areas. See Module 2, pages 145-146.

4. James has risk factors for what type of vascular disease?

- [ ] a. Venous disease
- [ ] b. Arterial disease
- [x] c. Arterial and venous disease
- [ ] d. James does not have risk factors.

James has risk factors for both arterial and venous disease. Risk factors for arterial disease noted in history are; diabetes, hypertension, and smoking. Risk factors for venous disease include his obesity and his occupation. James stands long hours when working, which likely increases risk for venous disease. He has an ulcer on the medial aspect of his leg, which is a common region for venous ulcers. See Module 2, pages 153-156.

5. The health-related quality of life tool LYMQOL is:

- [ ] a. specific to lymphedema
- [ ] b. a validated tool
- [ ] c. used to aid health care providers in developing more patient-centered care
- [x] d. all the above

LYMQOL is a validated health-related quality of life tool specific for lymphedema. It can assist health care providers in developing a more patient-centered plan of care. See Module 2, pages 160-161.

6. When is the best time to measure for compression stockings?

- [ ] a. Mid afternoon
- [ ] b. Before bed
- [x] c. Early morning
- [ ] d. It does not matter when you measure.

Swelling to legs typically will reduce somewhat with rest and elevation. The best time to measure for stockings is when the limb is at the smallest circumference, which is usually in the morning after resting throughout the night. See Module 2, page 162.

7. James is at risk for what life-threatening condition?

- [x] a. Sepsis
- [ ] b. Cancer
- [ ] c. Cellulitis
- [ ] d. Venous disease

James has an open wound on his leg and is having symptoms (leg is red and warm to touch) of a cellulitis. The confirmation of a fever is a concern for a more systemic infection. A localized infection can quickly become systemic in persons with lymphedema leading to sepsis, which is a life-threatening condition. Prompt medical assessment is needed. See Module 2, page 153.

Appendix D: Module 3 Answer Keys

Case Study 3.1: Recommendations

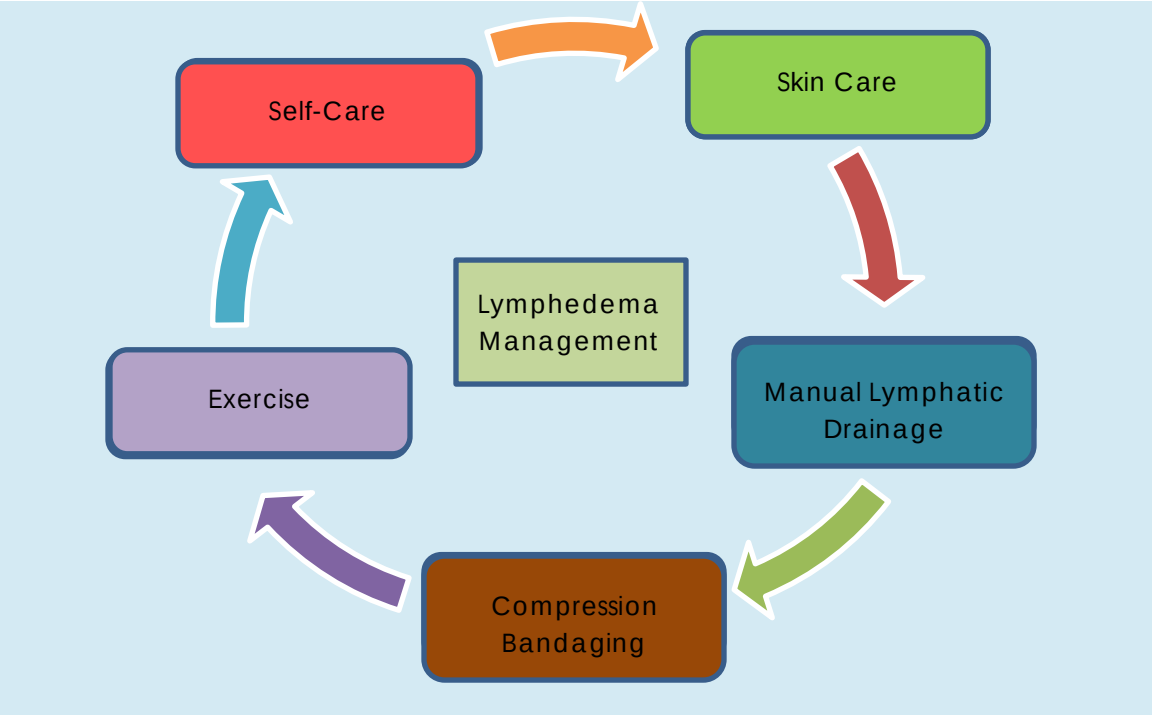
The nurse should recommend/discuss:

- Meticulous skin care. April is at increased risk for infection due to the breakdown in her skin barrier (weeping legs).
- April works on her feet (retail industry), but currently is off work. It would be important to encourage April to rest on her bed with legs elevated when possible. Foot and ankle exercise should be encouraged, as well as walking as tolerated to promote the calf muscle pump. Suggest balancing rest with activity.
- April's ABPI is 0.94, which is within normal limits and considered safe for compression. Coban™ 2 Regular (30-40mmHg) would be appropriate compression to use. The nurse has a medical order to apply.
- Stockings would not be appropriate at this time as April's legs are leaking. Once leakage stops, April should be fitted for compression stockings. Given her weight, she will likely require custom fitting. April will need to obtain a prescription for her compression garments.
- April is morbidly obese. The nurse should discuss a dietitian consult re weight reduction and healthy eating. The nurse can discuss salt and sugar reduction. April was eating chips and drinking pop on arrival to clinic. This is an opportunity to discuss April's diet and how her weight may be contributing to her leg swelling. April may also benefit from a physiotherapy consult if she requires assistance with her exercise plan.

Note: These recommendations/suggestions may need to be adjusted and expanded upon as the nurse gets to know April better. It is important to involve April in her care right from the first visit to ensure she is working towards her goal of self-care. Treatment plans often require modifications and frequent revisions. Work with the client in their care!

Interactive Activity 3.1: Answer Key

Click on and drag the correct answer boxes labelled with the five basic components of lymphedema management to the most appropriate place to drop on the diagram. Please note there are more answer boxes provided than needed to complete the diagram.



Answer Boxes (the remaining answer boxes are not basic components in lymphedema management)

Vibration Therapy

Acupuncture

Low Protein Diet

Diuretics

Quiz Activity 3.1: Answer Key

Choose the most appropriate answer to the following questions by placing an **X** in the correct box.

1. Treatments for lymphedema management may include:

- [ ] a. compression stockings
- [ ] b. exercise
- [ ] c. skin care
- [x] d. all the above

Compression stockings, exercise, and skin care are all treatments for lymphedema. See pages 172-181 for a more conclusive list.

2. Ready-made compression stockings are available:

- [x] a. with and without a prescription
- [ ] b. for wear with ABPI of < 0.5
- [ ] c. for abnormal contoured legs
- [ ] d. and recommended to be worn for 24 hours a day

See page 182.

3. Persons with lymphedema may be at increased risk for cellulitis due to:

- [ ] a. breakdown of the skin barrier
- [ ] b. excess protein-rich fluid in the interstitial spaces
- [ ] c. poor skin care
- [x] d. all the above

See page 173.

4. The five basic components of lymphedema management consist of:

- [ ] a. wound care, rest, elevation of limb, and antibiotics
- [ ] b. elevation of limb, foot and ankle exercise, pneumatic compression, and skin care
- [x] c. skin care, manual lymphatic drainage, compression, exercise, self-care
- [ ] d. skin care, swimming, massage therapy, and compression

See pages 173-176.

5. Pneumatic compression to the leg may increase the risk of:

- [ ] a. genital edema
- [ ] b. fluid congestion in the pelvic and suprapubic region
- [ ] c. high protein in the tissues, causing more edema
- [x] d. all the above

See pages 179-180.

6. Manual lymphatic drainage:

- [ ] a. is a form of deep tissue massage
- [x] b. encourages the movement of lymphatic fluid proximal, away from edematous regions
- [ ] c. can be performed by all registered massage therapists
- [ ] d. encourages the movement of lymphatic fluid to the distal aspect of the limb

See page 173.

7. As part of risk reduction management for lymphedema the client should:

- [ ] a. complete skin care nightly
- [ ] b. walk as tolerated daily to promote the calf muscle pump
- [ ] c. balance rest with activity
- [x] d. all the above

See pages 173 and 175.

8. When measuring for ready-made below the knee compression stockings, the nurse should:

- [ ] a. measure at the largest width of the ankle and calf
- [ ] b. measure in the evening when swelling is the greatest
- [x] c. measure circumference of the narrowest part of the ankle and widest part of the calf
- [ ] d. all the above

See page 182.

9. When donning stockings the client should:

- [ ] a. apply moisturizer to skin to assist with donning
- [ ] b. don stockings after exercising
- [x] c. don stockings first thing in the morning
- [ ] d. don stockings before going out

See page 182.

10. When teaching a client about care of their compression stockings it is important that they know to:

- [x] a. wash stockings after each wear in a mild detergent
- [ ] b. wash stockings in hot water
- [ ] c. wash stockings every second night
- [ ] d. dry stockings on high heat in dryer to kill bacteria

See pages 182-183.

Appendix E: Pre-test/Post-test Answer Key

Please complete the following pre-test before starting the e-learning modules. Once you have completed your e-learning there will be an opportunity to take the same test again.

Answer true (**T**) or false (**F**) to the following statements. Place an 'X' in the appropriate box as illustrated.

	Statements	T	F
1.	Lymphedema is rarely seen in the community setting. See Module 1, page 124.		X
2.	Lymphedema/chronic edema is broadly defined as swelling lasting more than three months. See Module 1, page 123.	X	
3.	The most common cause of lymphedema worldwide is morbid obesity. See Module 1, page 123.		X

Choose the most appropriate answer to the following questions by placing an **X** in the correct box.

4. When is the best time to measure for compression stockings?

- [ ] a. Mid afternoon
- [ ] b. Before bed
- [x] c. Early morning
- [ ] d. It does not matter when you measure.

See Module 2, page 162.

5. Compression is contraindicated if the ankle brachial pressure index is:

- [ ] a. 0.6
- [ ] b. 1.0
- [ ] c. > 0.5
- [x] d. < 0.5

See Module 2, see pages 153-154.

6. What are some common lower limb characteristics of venous disease?

- [x] a. varicose veins, itchy legs, hemosiderin staining
- [ ] b. varicose veins, claudication, restless legs
- [ ] c. restless legs, night pain, deep, punched-out ulcer
- [ ] d. hemosiderin staining, varicose veins, absent pulses

See Module 2, page 154.

7. What are some common signs and symptoms of cellulitis?

- [ ] a. increasing redness to a limb
- [ ] b. fever
- [ ] c. increased warmth to a limb
- [x] d. all the above

See Module 2, page 153.

8. Treatments for lymphedema management may include:

- [ ] a. compression stockings
- [ ] b. exercise
- [ ] c. skin care
- [x] d. all the above

Compression stockings, exercise, and skin care are all treatments for lymphedema. See Module 3, pages 172-181 for a more conclusive list.

9. As part of risk reduction management for lymphedema the client should:

- [ ] a. complete skin care nightly
- [ ] b. walk as tolerated daily to promote the calf muscle pump
- [ ] c. balance rest with activity
- [x] d. all the above

See Module 3, pages 173 and 175.

10. When measuring for ready-made below the knee compression stockings, the nurse should:

- [ ] a. measure at the largest width of the ankle and calf
- [ ] b. measure in the evening when swelling is the greatest
- [x] c. measure circumference of the narrowest part of the ankle and widest part of the calf
- [ ] d. all the above

See Module 3, page 182.