

Manual Lymphatic Drainage – an effective treatment for lymphoedemas

By Neil B Piller and Jan Douglass

In this article, Neil B Piller and Jan Douglass report on some studies that have indicated objectively how a specific type of lymphatic massage can help people at risk of and with lymphoedema. They emphasise, however, that massage is but one aspect of the comprehensive and holistic treatment of lymphoedema.

Lymphoedema is a multifaceted problem caused by surgery or radiotherapy associated with cancer treatment or associated with a congenital malformation of the lymphatic system. It is often of great complexity, requiring a team approach to its treatment and management. This complexity can mean that existing evidence does not always inform us totally of what is ideal for the current patient and further there is not always an opportunity to select what is ideal due to financial or health professional availability. While we should use existing quantitative/objective evidence for core actions such as Manual Lymphatic Drainage (MLD) the evidence can be hard to find because it is often published in inaccessible medical/scientific journals or is of poor quality or poor underlying science. Rarely does the information provide us with details relating to the qualitative/subjective side of lymphoedema and its co-morbidities. We are often left then with decisions of treatment based on limited or poor evidence. However at least in the area of the benefits of massage for lymphoedema that evidence base is expanding and is being made available to those who deliver it to the patient base.

Background

The superficial lymphatic system is divided into drainage areas called territories which are separated by watersheds. There is also a deep lymphatic system of the abdominal and thoracic areas. Most of the lymph from our body drains into the thoracic duct which empties into the blood near the left collarbone. The lymphatic system has two major roles, one as a drainage system, which along with the veins, is responsible for clearing fluids, metabolic wastes and toxins from the tissues and the other as a defense system. When fluids and their contents accumulate due to a lymph system which has been damaged or destroyed or is congenitally malformed, this is called *lymphoedema*. This failure occurs when the lymph load exceeds the lymph transport capacity. In lymphoedema cases it is because the lymph transport capacity has been reduced.

DIAGRAM 1 - LOAD and Transport

There may also be situations where the lymphatic system is normal and even while functioning at one hundred per cent fails to remove the awaiting lymph load. This occurs when there are high levels of materials leaking out of the blood vessels due to high blood pressure (Congestive Cardiac Failure, incompetent veins, Deep Vein Thrombosis) or situations where the blood vessel walls are weakened (inflammatory lesions of the vessel walls, hyper permeability, tissue trauma etc). When this occurs it is called *oedema*. The majority of the signs and symptoms of lymphoedema and oedema are similar.

When there is an increased load on a compromised lymphatic system then the problem is a very serious one and is often referred to as 'Saftey Valve Failure'.

In all these situations MLD can help improve tissue and cellular health by facilitating an improvement in the functioning of the lymphatic system. Again we must emphasise that MLD is but one component of a regimen aimed at helping to restore a gap between the transport capacity of the lymphatic system and the load of fluids and materials awaiting removal by it. While the MLD therapist can improve lymphatic drainage, there is also a range of other complementary techniques and strategies which should be explored. The patient must also take a significant part in this process by helping to reduce the load on their lymphatic system.

What is lymphoedema?

Lymphoedema is primarily an accumulation of protein rich fluids in the epifascial compartment. However, if it remains untreated, there will be a proliferation of adiposities, changes in the skin and blood and lymph vessel densities along with changes in cell types such as fibroblasts and macrophages. However it is the proliferation of the adiposities which leads to the middle 'fatty' stage of lymphoedema. If left untreated this will progress to the later fibrous stage in which fibroblasts deposit increasing amounts of collagen through out the tissues and in which there may also be a proliferation of epidermal cells leading to hyperkeratosis and pachydermia as end points.²

Every person progresses through these stages at different rates and some may remain in the early fluid rich phase. What determines how they progress is the balance between the lymph load and the lymph transport capacity. It seems that the greater the excess of load over transport, the more rapidly the lymphoedema progresses. Thus its clear that one of our great leverage points on lymphoedema progress is to impact on load or lymph transport.

PICTURE OF LO ARM AND LEG

DIAGRAM OF MAJOR CHANGES IN LIMB – SHOWING SUPERIFICAL NATURE OF LYMPHOEDEMA

Who gets lymphoedema?

Fortunately not everyone who has surgery and/or radiotherapy will develop lymphoedema. While estimates vary, there is generally a relationship with the extent of surgery and with radiotherapy to the axilla/chest wall and the incidence of lymphoedema and its severity.³ This relationship is clouded by other confounders such as seroma duration and wound infection, condition of the skin, body mass and other parameters. While the range quoted for the incidence of lymphoedema varies considerably depending on the minimal criteria used for the presence of lymphoedema it would seem that with minimal intervention (i.e. sentinel node biopsy and no radiotherapy) that about five per cent of patients develop lymphoedema while with a high level (total clearance) and radiotherapy about thirty per cent of patients develop lymphoedema. The incidence is generally reported to be higher for the legs since they are always in a dependent position.

Lymphoedema does not always develop immediately and a range of average onset times from twenty months to three years is often quoted. The positive aspect of this is that if we can review those in the moderate and high risk categories we may be able to detect early signs of the appearance of lymphoedema and reduce the risk of the clinically manifest (overt lymphoedema) from forming. In fact this is done in South Australia with the free Lions Lymphoedema Screening days held in metropolitan, regional and rural areas.

Any person who has had cancer (or other) therapy involving lymph node removal or radiotherapy has a risk of developing lymphoedema. This risk factor does not reduce over their lifetime regardless of the length of time since surgery (in fact age is probably a risk factor in itself).

The manual lymph techniques described in the outline below ideally could be used on all post cancer clients to help prevent the occurrence of lymphoedema in moderate and high risk patients and of course to help those already with lymphoedema.

Symptoms of lymphoedema

Before the lymphoedema becomes clinically manifest, the patient may indicate some symptoms which are generally associated with an increased risk of the development of clinically discernible lymphoedema. These symptoms are heaviness and tension in the limb, aching, and bursting pains. Other symptoms which are not associated with the lymphoedema but are associated with prior surgery and or radiotherapy (if they have had it) are loss of muscular strength, reduced range of movement, pins and needles etc.

The characteristics of an effective lymphatic massage

The lymphatic system is very delicate and the main the part of the system we wish to have an influence on is close to the surface. The pressure of the lymph in even the larger lymph vessel is usually very low. Lymph vessels contract of their own accord at about six to ten times per minute.

Lymphatic massage should concentrate on more than the affected area. This is crucial since lymph from all parts of the body (except the right chest and head and arm) drains into or near the junction of the left subclavian/jugular veins of the left shoulder. The right chest (and internal organs/structures), arm and head drain into the right lymphatic duct at the join of the right sub-clavian/jugular.

All proximal lymphatic drainage pathways must be cleared before any attempt to move lymph into them from a more distal area.

Lymphatic massage should be gentle (except perhaps where there are areas of significant fibrotic induration) as overly heavy massage has been shown to damage the delicate collagenous filaments attaching to the endothelial cells of the initial lymphatics, this making further uptake of fluids and their contents into the lymphatics more difficult. The most important aspect of lymphatic drainage is to encourage uptake of these fluids into the initial lymphatics and along the lymph collectors by variation in tissue pressures.

Once the fluids have been moved into the initial lymphatics and beyond the first valve set into the pre collectors (which have muscle elements in their walls), there is a range of neurogenic and myogenic controls which will mean the collectors will start to pump more strongly and rapidly when the load on them is increased. Of course, the collectors have to be of a reasonable functional status and be able to carry the now higher lymph load. If there are high levels of fibrotic tissues around them then this may be difficult.

LINK to WEB MOVIE (B/W PICTURE of INITIAL LYMPHATIC AND COLLECTOR in text)

The early signs of lymphoedema

Lymphatic massage may be of significant benefit in patients who are in the latent phase of lymphoedema. These patients have not developed clinically manifest lymphoedema. They may in fact never develop it but since they already have either some of the early symptoms of lymphoedema or some mild local areas of fluid accumulation the application of massage may have some significant longer term benefit in terms of removing this excess fluid and reducing or removing some of the above mentioned symptoms.

Assessing the effect - objective tools

One of the most important facts we have to acknowledge is the importance of basing our actions on evidence. Our knowledge of the lymphatic system and of the strategies we as health professionals and our clients as patients must use to help it work better is still not as clear or as deep as that of our knowledge of the blood system or of the other systems of our body. We are often faced with evidence from a range of clinical trials and from case study reports, which is often hard to translate to our current client.

Every person (especially those with lymphoedema) is an individual and needs treatment which is targeted, sequenced and staged to optimally deal with and acknowledge their unique problem. We also have to balance the art of massage with the science and the need to base our actions on evidence but at the same time provide a reasonable level of objective information to the client and to others in our professions, so we can all learn from each other and improve our practice.

Below is a brief description of some tools which are useful in the assessment of the status of lymphoedema (and oedemas) and of how well our treatments might be working.

Fluid level – bio-impedance

We have the ability to measure the extent of the extra-cellular fluid levels and to learn whether they are within or outside of normal range by using bio-impedance,⁴ which is an accurate and increasingly accepted means of measuring segmental (limb) fluids and changes in extra-cellular fluids for the early diagnosis of lymphoedema.⁵ We can measure even a 5ml change in the extracellular fluids of a limb, and the changes detected have clinical relevance.⁶ Since bio-impedance is able to indicate an absolute measure it may be useful as a prognostic tool to detect the early (latent) stages of lymphoedema,⁷ with the potential then allow targeted treatment to hopefully prevent the development of full blown secondary lymphoedema. Importantly bioimpedance can also show how effective your massage is in moving accumulated fluids

There are various types of equipment ranging from the top level stand on IN-Body (BioSpace – Korea) machines to the hand held Lymphometer (Impedimed, Queensland). However you can still detect free fluid accumulation by a simple tissue indent test on each of the lymphatic territories. (*refer to territory diagram*). In this test the thumb is gently (but firmly and continuously) pushed in the tissue for about ten to 15 seconds and the nature (depth and ease of intent) of the indent mark recorded.

Lymphatic Territory Induration - Tonometry

Changes in the resistance of the tissues to compression, which is a good indicator of the build up of fibrous elements in the superficial tissues can be measured by tonometry.⁸ Tonometers are able to discriminate within 1mm of depth of compression. Tonometers are made in Australia at Flinders Medical Centre's Biomedical engineering department.

If you do not have a tonometer then it's possible to do a pinch and roll test on the various lymphatic territories (*see lymph territories diagram for sites*). This technique involves gently picking up a fold of skin and rolling it between the thumb and fingers and feeling and noting the thickness of the fold, and the texture of the tissue. It's an acquired art but it can help you see if your treatment is halting or has stopped the progress of lymphoedema and more excitingly, if it's reversing it!

Circumference and volume measurement

The measurement of limb circumferences using tapes has long been used but there are limitations to this technique.⁹ One of the crucial issues is the actual way in which the limb is measured, and the nature of the calculations used to translate circumference into volumes (if that is required). If we want to be accurate in our measurement, the position and alignment of the tape, the way it's overlapped and the pressure we exert on it, will all influence the circumference measure.

While we are technically capable of a 1mm discrimination of circumference, due to the reasons indicated above the accuracy often sadly comes down to measuring and discriminating at the 1cm level. On top of all of this is the often forgotten acknowledgement and logging of the impact of arm dominance and of acknowledging the changes in the normal limb in volume calculations of the effect of treatment on the affected limb. Notwithstanding these problems, we can reduce our error and improve our measurement accuracy. It can be difficult, but it is essential for us to be accurate in the reporting of our findings of the objective changes which occur in lymphoedematous limbs and of the effect of treatment on them.

The determination and setting of unified Australasian measurements is a priority of the Australasian Lymphology Association, which was initiated in 2000, and is a step in the right direction.¹⁰ Flinders Medical Centre's Lymphoedema Clinic has produced a CD rom program about lymphoedema and its measurement. In the health professional version of this program there is the facility to enter the limb circumference measurement data from an unlimited number of patients and to trace their progress in terms of limb circumference and volume (www.flinders.sa.gov.au/lymphoedema).

Other strategies for limb circumference measurement and volume determination are immersion plethysmography in which the limb is either totally or progressively put into a cylinder of water¹¹ and optoelectronic perometry.¹² The later has been subject to some validation studies and is relatively free of errors.¹³ There is nothing wrong at all with tape measurement as long as it's done to a standard and you are consistent.

Subjective

In addition to their swollen limb a large proportion of the patients will have their quality of life ¹⁴ and activities of daily living affected through the size or mobility of the limb or through how the limb feels. For some, it's this impact for which they are seeking help. The impact of our treatments or interventions on these factors also should be considered alongside of their impact on the size of the limb. Often, even while the limb size may change little as a consequence of treatment, the greatest improvement may be in how the limb feels and thus on the patient's quality of life. ¹⁵

Manual Lymphatic Drainage

Having now established some background about the lymphatic system, lymphoedema and how to measure it, let's now focus on the nature of MLD and its benefits for those at risk of and with lymphoedema (or oedema). Since there is often a significant period of time between the event which has damaged the lymphatic system and the appearance of clinically manifest lymphoedema we have a great opportunity to have a significant impact on the risk of it appearing. Also, even if a person already has lymphoedema we can have a significant impact on its progress.

History and development of Manual Lymphatic Drainage

The term Manual Lymph Drainage (MLD) was first used by Dr. Emil Vodder and his wife Estrid when they presented their work to a Paris symposium in 1936. Since then many other methods of lymph drainage have also come to be known as MLD and while most of them employ similar principles to the original Dr. Vodder method, there is considerable variation in technique. MLD as described by Vodder involves very specific hand movements which must be precisely taught and cultivated through practical application. The movements apply only very light pressure and stretch the skin in a circular, distal to proximal fashion. It's recommended that no more than 35mmHg be applied to the subcutaneous tissues as higher pressures may compress the lymphatic vessels and thereby possibly hinder lymph transport. Higher pressures may be used to drain deeper tissues or release fluid from and soften fibrotic areas.

The very profound effects the Vodders had been achieving in the intact lymph system then could be applied to the treatment of lymphoedema. The resulting program of Combined Decongestive Therapy which evolved from that union is used throughout the world today. The Vodder school is unique in Australia in its willingness to accept suitably qualified massage therapists into its training program.

Preventing lymphoedema

The effects of MLD for established lymphoedema is becoming well documented.¹⁶ What is less well known is how MLD might help an apparently unaffected limb to remain lymphoedema free, a benefit less easy to demonstrate and measure objectively. We can reasonably assume that the known and measured effects of MLD, applied to an unaffected limb at risk, would have the same effects in the connective tissue and lymphatic uptake. For these clients the benefit is one of support, mimicking and reinforcing the natural coping mechanisms of the body in dealing with a reduced lymph transport.

Opening anastomoses

Small valveless vessels often connect lymph collector vessels in one area to lymph vessels draining towards groups of lymph nodes other than those removed by surgery. This connection between the collectors allows lymph to flow from an area of higher load into an area of lower load thus sharing the lymph load across territories and other lymph nodes. In normal tissues these anastomoses would be dormant and their presence almost impossible to detect, until fluctuations of pressure within collector vessels differs enough to force movement through them. Movement may be in either direction. Dormant vessels may spontaneously open after damage to the lymph vessels system or lymph nodes. This automatic redirecting of lymph load probably accounts for the absence of established lymphoedema in many post cancer patients. Anastomoses may connect across whole watersheds and much of the aim in a preventative treatment plan would be to encourage and support fluid movement through these anastomoses.

Increased uptake by initial lymph vessels

Before any symptoms of lymphoedema are felt there is probably already some accumulation of fluids and proteins in the subcutaneous tissues of affected territories. This can be measured by bio-impedance as described above. The protein contributes to further accumulation of fluid by increasing tissue osmotic pressure. MLD works to reduce the lymphoedema by removing proteins (note: diuretics are unable to do this and thus are of little use in lymphoedema since the protein concentration is usually high) from the tissues into the initial lymph capillaries. Fluid also moves into the lymph vessels. Osmotic pressure in the tissues is decreased and the lowered level of filtrate reduces lymph load in the affected territory. Thus MLD has a double sided effect in the microcirculation, reducing total filtrate entering the tissues from blood capillaries and increasing total removal of fluid and proteins by the initial lymph capillaries .

Increased dilation of lymph vessels

The smooth muscle in the lymph collectors, innervated by sympathetic fibres, vasoconstricts the lymph collectors. When sympathetic tonus is high lymph flow may be inhibited. MLD is known to decrease sympathetic activity. The resulting dilation of lymph vessels increases their filling capacity. Expanding lymphangions fire a stretch receptor reflex which empties each angion through the valve into the next lymphangion. Thus the pumping activity of collector vessels is maximally enhanced by the application of MLD. These effects may last for several days. It's also important to note that the major lymph collectors pulsate at between six to ten beats per minute and that usually they are only carrying about ten per cent of their maximum load. Helping more fluids to enter these collectors from the initial lymph capillaries will increase lymph transport from the affected area.

Web LINK to MOVIE ON LYMPH COLLECTORS (Still BW picture to appear text)

Other neural effects

Just as important are the effects of MLD on stress reduction for the whole body. The gentle rhythmic quality characteristic of the Vodder method reduces sympathetic tone and thus increases lymph activity throughout the body, not just in the treatment area, allows for proper immune system functioning, improves digestion, sleep and other stress related symptoms.¹⁷ Reduction in pain signals, probably achieved through inhibition at the dorsal root ganglion, are reinforced at the tissue level by the removal of excess inflammatory mediators.

Stimulation of the growth of new lymph capillaries

Some research shows this occurs more rapidly and prolifically when MLD is applied during wound healing. Unfortunately this poses a dilemma for treatment in cancer patients as MLD is contraindicated during the active treatment phases. Much can still be done though once the patient is in remission. In addition to facilitating the growth of new vessels MLD can reduce adhesion from surgery or radiation, reduce pain and improve healing time from radiation burns as well as stimulate the return of nerve sensation to numb areas, reduce cording in the axilla, restore ROM at joints and improve skin integrity. It has also been shown that appropriate frictional massage and low level laser therapy¹⁸ can facilitate reduced fibrous induration, improved wound healing and thus improve lymph transport by increasing new lymph capillary growth.

MLD treatment protocols

As previously described, the proximal areas of the lymph vessels system must be cleared prior to clearance of any affected or target areas. During lymphoedema treatment, or any treatment where there has been an obstruction to lymph flow, (even without presenting oedema), the therapist must develop a strategy for moving fluid out of the affected area and into an area where lymph pathways are known to be still functioning. This receiving area and any proximal vessels must be cleared before any drainage is attempted in the oedematous area. Diaphragmatic breathing may also be employed especially in the clearance of oedema from the lower watersheds.¹⁹

WEB Link to MOVIE of MLD (still BW picture to appear in text)

Manual Lymphatic Drainage and established lymphoedema

An intensive phase of treatment designed to reduce limb size and soften fibrotic induration may be undertaken once or twice a year. Intensive reduction treatment for a large established oedema involves frequent treatments once or twice a day for up to five weeks depending on responsiveness of the oedema. A regime of padded compression bandaging is applied after each MLD session and retained until the next session. An exercise program and skin care routine are prescribed. Limb volumes are measured regularly and when the limb is considered to be at its best possible size compression garments are measured and fitted. As this group of patients is the most common group that therapists are likely to come across, Robert Harris and one of the authors have been working to provide objective evidence for MLD in cases of secondary arm and leg lymphoedema and primary leg lymphoedemas.

Even though this research is only in its early stages, using the range of objective and subjective measures which have been described above, it's becoming clear what a patient and a therapist can expect from MLD. One of the important initial details is to discover what a single MLD session can offer. (We refer you to the full details in the literature Harris and Piller 2003.)

However it's clear that one 45 minute session can significantly soften hardened tissues, help the removal of abnormally accumulated extracellular fluids and result in reductions in the total volume of the affected limb. Interestingly when it comes to the effect of an MLD session on the legs, even a normal, apparently unaffected leg will show some signs of improvement, apparently through the improved clearance of lymph through the abdominal areas to the ductus and then to the blood. This frequent finding indicates the need for a holistic approach to any lymphatic problem and certainly the benefit of the MLD approach when it comes to attempting to remediate the problem. One of the most important aspects of the initial small group case studies (and from other studies since conducted) has been the great change in how the limb feels. That is, the patient's reported reductions in pain, heaviness, and tension in the affected limb. While these studies represent an advance in our knowledge about the benefits of MLD, we still have a long way to go in our collection of evidence for our actions for this treatment.

Our next stages, which are underway, are to assess the effect of a four week program of MLD and then as Johanssen²⁰ has done in a similar trial, to add other components of lymphoedema treatment such as bandaging, exercise to assess the overall total effect on the limb. Armed with this information we can inform the client of what they can expect at any stage of treatment and we can be comfortable in knowing what we can do and whether what we are doing is on par with the current evidence.

Maintenance programs

Regular weekly to monthly MLD sessions maintain open drainage pathways and correct posture. Garments should be worn daily or as required and the exercise and skin care routines followed. While all of these strategies are well documented on a case by case basis and there is no doubt that it does work with great effectiveness, as yet there are few well controlled large scale studies with the exception of Johansson,²¹ to confirm this effect. Current large scale blinded studies at Flinders Medical Center will add significant weight to this existing data.

Preventative treatment

Prevention models maintenance. A good quality compression garment is fitted and used during high risk events such as air travel. If this is not acceptable to a patient then a series of gentle rhythmic exercises involving variation in tissue pressure combined with variations in intra thoracic pressure are an acceptable substitute. Regular MLD sessions, exercise and skin care routines are recommended.

Role of other complimentary therapies

The differences in application of lymphatic drainage massage, from long stroking effleurage with or without oil or perhaps with soft brushes or textured cloths, through to the very precise rhythmic, pumping movements of the Dr. Vodder method will produce different effects in the tissues. The effectiveness of individual techniques should ideally be measured objectively in relation to the intention of each treatment. Long gentle strokes with a soft bristled brush towards intact lymph nodes may be suitable and beneficial for a healthy individual seeking decongestion of tissues for aesthetic purposes such as in the treatment of cellulite, but would be less effective in the treatment of lymphoedema and probably inappropriate where skin breakdown or irritation is present.

Massage therapists not trained in the specific treatment of lymphoedema should not attempt to prevent or reduce post cancer lymphoedemas mainly due to the risk of pushing accumulated fluids and their contents in retrograde directions into other parts of the lymphatic system. They can work safely in unaffected watersheds and do play an important team role in maintaining postural alignment, regaining full ROM of joints and restoring proper skeletal muscle function and balance after surgery. A remedial therapist with an understanding of lymphoedema could be involved in rehabilitation of the biomechanical activities of the limb and the postural integration of the body as a whole. While all compressive, friction or deeply penetrating techniques would be contraindicated in the affected watershed, the considered application of such techniques to structures in the other watersheds of the body will benefit the body as a whole including the affected, yet untreated, area.

An aromatherapist may additionally assist with skin care and infection control, an important aspect of lymphoedema prevention in view of its effect on reducing lymph load. A holistic massage therapist may address stress and emotional issues and naturopaths could be involved in good nutrition and weight management as this is known to be a factor in the development of lymph and other oedemas.

Basing our treatment on what is in the literature

The question arises, has Evidence Based Medicine (EBM) got a role to play in lymphoedema treatment? It probably has but with the acknowledgement that EBM generally deals with group response and then generally with the quantitative aspects of it. Lymphoedema is multi-faceted, each patient is strongly unique in the presentation and often in the combination of symptoms and associated sequelae, each patient responds to an intervention differently and each has different treatment and management preferences either forced on them by finances or the availability of treating staff. Often then there is a gulf between what might be able to be done optimally and what can be done in reality.

However we should acknowledge the existing evidence (both quantitative/objective and qualitative/subjective) and we must play a role in its further refinement and dissemination. There are three very important questions we should ask ourselves. What is the evidence (and its level) for our current core treatments, what level/detail of evidence will facilitate a change in your practice and what other things are likely to encourage a change in our treatments or other approaches to lymphoedema?

We all seek to offer the best treatments for our clients, but how do you evaluate and select the best treatment? Importantly, how do you measure the effect of your treatments and how easily can you relate and compare your results with others? One of the essential standards is that there should be a common measurement base (Piller, 2000). If there is a standard then ideally it should be used if you want to be able to compare what you are doing with that of others or explore how your own different techniques are working. Patients, however, will always be individuals and each will need to be reacted to differently but there will be a certain core which will be the same.

You can elevate yourself and the profession in the eyes of others by undertaking a basic form of measurement of the effectiveness of your treatment strategies, but the crucial part is to publish it and allow others to see if they can do better. That is how we can improve what we offer our clients and how we all can be confident that we are doing our absolute best.

Neil B Piller is Team Leader Lymphoedema Assessment Clinic and Jan Douglass is Clinical Research Assistant and MLD Therapist, Lymphoedema Assessment Clinic, Department of Surgery, School of Medicine, Flinders University and Medical Center, Bedford Park, South Australia.

End notes

- 1 Foeldi et al 2003
- 2 Piller and O'Connor, 2001, Piller, 2002, Foeldi, et al 2003
- 3 Weissleder and Schuchhardt, 2001
- 4 Cornish, 1994
- 5 Cornish, et al 2001
- 6 Harris and Piller, 2003, Cornish et al 2001
- 7 Cornish et al, 2001
- 8 Olszewski, 1992, Bates et al (1994)
- 9 Casley-Smith, 1994
- 10 Piller, 2000
- 11 Swedborg, 1977
- 12 Stanton et al 1997, 2000
- 13 Stanton et al 1997, 2000
- 14 Passik and McDonald 1998 Holzner et al, 2001
- 15 Weiss and Spray, 2002, Pereira de Godoy et al 2002
- 16 Hutzchnreuter et al 1991, Johansson 2002, Kasseroller, 1998, Wittlinger 1998
- 17 Wittlinger and Wittlinger 1998, Kasseroller 1998
- 18 Piller, 1998, Cariati et al 2003
- 19 Wittlinger and Wittlinger 1998, Kasseroller 1998
- 20 Johanssen , 2002
- 21 Johanssen , 2002

References

- Caban, ME: Trends in the evaluation of lymphoedema *Lymphology* 35 (2002) 28-38
- Carati C., Anderson SN., Gannon BJ., Piller NB: Treatment for post mastectomy lymphoedema with low level laser therapy. A double blind placebo controlled trial. *Cancer* 2003;98(6):1114-1122
- Casley-Smith, JR : Measuring and representing peripheral oedema and its alterations *Lymphology* 27 (1994) 56-70
- Clodius L., Deak I., Piller NB: A new instrument for the evaluation of tissue resistance in lymphoedema *Lymphology*;9 (1976) 1-5
- Cornish BH., Chapman M., Hirst C., Mirolo B., Bunce IH., Ward LC., Thomas BJ: Early Diagnosis of Lymphoedema using multiple frequency bio-impedance. *Lymphology* 34(1): (2001) 2-11
- Cornish, BH Ward, LC, Thomas BJ: Alteration to the extra- to intra-cellular fluid balance measured by multiple frequency bioelectrical impedance analysis. *Nutrition Research*. 14, (1994) 717-727
- Foeldi, M Foeldi, E and Kubic S (eds) *Textbook of Lymphology*, Urban and Fisher Munich (2003)
- Harris, R and Piller NB Evaluierung der Behandlungs- effektivitat – objective Messungen zur Wirkung der Manuellen Lymphdrainage *LymphForsch* 6(2) (2002) 93-96
- Harris, R and Piller NB Three case studies indicating the effectiveness of manual lymphatic drainage on patients with primary and secondary lymphoedema using objective measuring tools *J Bodywork and Movement Therapies* 7(4) (2003) 213-221
- Hutzchenreuter, P, Wittlinger H and Wittlinger, G, Kurz I Post mastectomy lymphoedema treated with Manual Lymph Drainage and Compression therapy. *Europ. J Lymphologie* 4, (1993) 14
- Holzner B, Kemmler G, Kopp M, et al: Quality of life in breast cancer patients - not enough attention for long-term survivors?. *Psychosomatics* 42: (2001) 117-123,
- Johansson, K., Albertsson, M., Ingvar, C., & Ekdahl, C: Effects of compression bandaging with or without manual lymph drainage treatment in patients with postoperative arm lymphoedema. *Lymphology*, 32(3) (1999) 103-110.

Johansson, K., Lie, E., Ekdahl, C., & Lindfeldt, J: A randomized study comparing manual lymph drainage with sequential pneumatic compression for treatment of postoperative arm lymphoedema. *Lymphology*, 31(2) (1998) 56-64.

Johansson, K Lymphoedema and Breast Cancer A Physiotherapeutic Approach. Doctoral Thesis. Lund University Lund ISBN 91 628 5117 9 (2002)

Kasseroller R Compendium of Dr Vodder's Manual Lymph Drainage. Haug. Heidelberg, (1998)

Liu N., Olszewski W; Use of Tonometry to assess lower extremity lymphoedema. *Lymphology* 25 (1992) 155-158

Logan, V: Incidence and prevalence of lymphoedema: a literature review. *Journal of Clinical Nursing*, 4(4) (1995) 213-219.

Moseley A & Piller N; The assessment and care of the patient with secondary limb lymphoedema. *Australian Nursing Journal*; 10(2): (2002) Clinical Update 1-4.

Passik, S. D. & McDonald, M. V: Psychosocial aspects of upper extremity lymphoedema in women treated for breast carcinoma *Cancer*, 83, (12) Suppl 2 (1998) 2817-2820.

Piller, Nb and Thelander, A, Treatment of chronic post mastectomy lymphoedema with low level laser – a 2.5 year followup. *Lymphology* 31(2) (1998) 74-86

Piller, NB. Recognition, Treatment and Management of a Lymphoedema Leg. Flinders University Press, ISBN 09578226 1 8 (2002)

Piller, NB. Recognition, Treatment and Management of Primary Lymphoedemas. Flinders University Press, ISBN 0606399128 (2003)

Piller, NB Recognition, Treatment and Management of a Lymphoedema arm Flinders University Press, ISBN 09578226 0 X (2002)

Piller, NB: Setting a national standard for measurement of lymphoedematous limbs Australian Lymphology Association Newsletter 1(2) (2000) 7-12

Piller, NB, Harris, R: Objective measurement of the effectiveness of a single session of Manual Lymphatic Drainage of primary and secondary lymphoedema of the leg. *Lymphology*, 35 (suppl.) (2002) 289-292.

Piller, NB and O'Connor, M. The Lymphoedema Handbook. Causes, Effects and Management, Hill of Content, Melbourne (2001)

Stanton, AWB, Badger, C, and Sitzia, J: Non invasive assessment of the lymphoedematous limb. *Lymphology* 33(3), (2000) 122-135.

Weissleder H and Schuchardt, C (eds) Lymphoedema, Diagnosis and Therapy. Viavitel Koln (2001)

Wittlinger H and Wittlinger G (1998) Introduction to Dr Vodder's Manual Lymph Drainage 6 Aufl., Haug

Verlag Heidelberg, vol 1

Educational Resource

Piller, NB. The Vital Essence – Understanding Lymphatics and Lymphoedema. CD Rom
www.flinders.sa.gov.au/lymphoedema (2002)