

The role of low intensity laser therapy in community nursing

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ABSTRACT

Objective

To review the effects of low intensity laser therapy (LILT) on healing and to explore its role in community nursing.

Setting

Primary care, outpatient clinic, community health centre

Primary argument

Low intensity laser therapy encompasses many positive attributes that make it a useful healing mechanism in community nursing.

Conclusions

Laser light is non-invasive, painless, free from side-effects, and can support vital bio-regulating processes, particularly in diabetic and neuropathic conditions. The use of LILT for treatment can bring about positive outcomes for patients, families, communities and governments.

INTRODUCTION

In 1965, Professor Endre Mester began to study the biomodulating effects of low intensity laser therapy (LILT) on human tissue at Semmelweis University in Budapest. His pioneering work resulted in over 100 published scientific papers and the establishment of the first laser therapy clinic in Budapest for the treatment of non-healing ulcers (Mester 1976). Laser biomodulation is being successfully utilised by doctors, allied health practitioners and nurses in many different clinical environments throughout the world. This modality is, however, still viewed with a considerable degree of scepticism, despite the fact that there are numerous publications in the scientific and medical literature which attest to the biomodulating effects of *non laser* visible red and near infra-red light on a range of cellular functions (Albrecht-Bruehler 1991, Chopp et al 1990, Kato 1981).

A lack of understanding about the importance of correct laser dosimetry and application protocols and poorly controlled studies and reporting have flawed the research literature in the past. Most of the studies supporting the effectiveness of LILT in the treatment of wound ulceration consist of unreliable or poor reports (Posten et al 2005). Though the results have been noteworthy, they usually failed to establish standard criteria for the particular laser, dosage, number, frequency, or duration of treatment (Sobanko and Alster 2008), involved small sample size or compromised clinical protocols (Flemming and Cullum 2008). The recognition of these past shortcomings has produced an ever increasing number of positive, high quality, well designed studies in this emerging field of laser phototherapy over the past decade. The question of whether LILT has a role in community nursing is best answered after reviewing the effects of LILT on certain critical factors that influence healing.

DISCUSSION

Laser light can be therapeutic

The word *laser* is an acronym for *light amplification by stimulated emission of radiation*. The term *radiation* raises concerns about the safety and risks of using laser to treat human tissue, but it is the *light* that is of therapeutic importance when applying laser to instigate biomodulation. There are two distinctly different methods of treating human tissue with laser light and this is primarily governed by the power output of the laser device itself.

Thermal laser activation

The first more commonly known method of laser application is high intensity laser therapy (HILT), the use of laser devices operating with high watt (W) powers to produce photothermal effects within living tissues. Thermally induced reactions range from protein denaturation, coagulation, vapourisation and carbonisation of tissue, and are used to perform various cosmetic, dermatological and surgical treatments. The degree of temperature change and tissue reaction is dependent on the watt power of the laser device and the amount of laser light energy *i.e joules* that is deposited per cm² over a specific period of time *i.e. energy density*. (Tuner and Hode 2002, Simmunovic 2000)

Non thermal laser biomodulation

The second method of laser application is termed low intensity laser therapy (LILT) and is also widely known as low level laser therapy. Laser devices operating with extremely low power outputs within the milliwatt range (mW) deliver wavelengths of light in the visible red and near infra red range of the electromagnetic spectrum. Light energy is transmitted through the skin surface at low dosages and at a very slow rate that is incapable of causing thermal tissue reactions. This free energy is transmitted well beyond the dermal layer of the skin into underlying tissues, because it has not been consumed as part of a photothermal reaction (Simmunovic 2000, Tuner and Hode 2002).

Indirect effect of lilt

Biomodulation using LILT instigates both direct and indirect effects. Direct effects occur primarily within seconds and minutes, whilst the LILT treatment is being applied. The indirect effects continue to modulate physiological and biological reactions in another area of the body by generating a nervous or neuroendocrine signal at the treatment site and this can continue for hours and days after the LILT treatment has ceased being applied (Karu 2002).

The ATP dependence of light-sensitive background signal channel currents and supports the scheme of a cellular phot signal transduction and amplification effect resulting in transfer of electrons within the redox pathway and increased production of cellular energy *i.e.* *adenosine triphosphate (ATP)* ultimately leading to cell division (Von Meyenburg and Hansen 1987).

The alteration to one cellular homeostasis parameter will consequently lead to a parallel shift of different reactions which make it difficult to establish the causal relationship. For LILT to be effective, it is imperative that correct treatment protocols and dosimetry are adhered to. This requires the appropriate exposure intervals (*treatment sessions*), wavelength (*nm*), units of energy (*joules*) and pulse frequency (*hertz*) when treating various conditions involving different types of cells and tissues.

Studies examining the effects of LILT on wound healing using scanning electron microscopy clearly indicate enhanced metabolic changes following exposure to LILT, as compared to non irradiated wounds. LILT treated wounds exhibit an accelerated state of healing and a more organised tissue structure, with greater tensile strength and vascularity, and these effects are comparable in both humans and animals (Mester 1976).

Electrical stimulation

Cells also respond to electrical stimulation (ES) during wound healing via the galvanotaxic effects of direct or pulsed electrical currents. Furthermore the greatest amount of positive evidence in clinical trials has been produced using ES in comparison to ultrasound, hydrotherapy and ultra violet radiation. However, anytime an electrical current is used to assist healing, the wound bed must be debrided and adequately prepared to avoid uneven transmission of the current and precautions must be taken to avoid electrochemical burns. It is contraindicated in patients with metal implants or pacemakers, treating over the pericardium, larynx, carotid sinus, parasympathetic nerves and ganglia and phrenic nerve (Kloth 2002, Wolcott 2002). Such risks and side effects associated with electrical stimulation of wounded tissue can be avoided through the use of laser *light* to assist wound repair (Karu et al 1996, Simmunovic 2000)

Pharmacology recognises the Arndt- Schulz law

The stimulating function of an irritation is well recognised in pharmacology and physiology, and the oscillating nature of the response of cells and tissues to linearly increasing irritation has been described by Nasonov and Aleksandrov (1940). Pharmacology recognises the Arndt-Schulz Law of regularity and the enormous range of non specific agents that bring about complex specific reactions of stimulation and inhibition relating to the concept of the adaptation syndrome (Selye 1952). The Arndt-Schulz law states that:

- Weak stimuli promote physiological functions
- Medium stimuli accelerate them
- Strong stimuli inhibit them
- The strongest stimuli halt them

There is no universal explanation for the cellular and molecular mechanisms of the adaptation syndrome; and although the irritants may be of a specific nature, the reaction of cells and tissues are in fact nonspecific. The most common form of exchange by cells is at the level of energy metabolism, irrespective of the type

of cell and its specialisation (Kondrashova 1970). Moreover, the cyclic changes in the metabolic activity of mitochondria occur as the action of the physical factor increases; this factor could be either pharmacological or energetic in nature triggering nonspecific responses by cells and tissues to these external irritations. Low levels of laser light (Karu 1988), microwaves (Frohlich 1988) and pulsed electromagnetic fields (Basset 1993) of low intensity can and do exert a stimulating effect on cells and tissues.

When a pharmacological agent interacts with a cell receptor, a chain reaction of events known as the response-recovery cycle takes place. This chain of events is a complicated series of biochemical reactions with agonists and receptors. A common step involved in this stimulus-response recovery cycle is a change in the redox state and intracellular PH of the cell (Kondrashova 1970).

Lilt photochemistry and photobiology

Photochemistry and photobiology utilises a very narrow region of the electromagnetic spectrum UV (200-400nm), visible light (400-700nm) and near infra red (700-1400nm). LILT involves the use of wavelengths ranging from 600nm–1000nm. Radiant laser energy in specific units *i.e. photons*, are absorbed by light absorbing molecules *i.e. photoacceptors*, which are *not* connected with a light response, but take part in a metabolic reaction within the cell (Brown 1992, Hartmann 1983).

In order for a photoacceptor molecule to take part in photobiomodulation during LILT, it must be part of a key structure involved in the regulation of a metabolic pathway *e.g. redox chain*. Proven photoacceptors of wavelengths used in LILT are NADH-dehydrogenase, a flavinic component of the redox chain and Cytochrome c oxidase (cyt c), which is the terminal enzyme of the respiratory chain of all eukaryotic cells. This enzyme plays a central role in mediating the transfer of electrons from cyt c to molecular oxygen (Karu and Afanasyeva 1995).

Absorption of light during LILT instigates pumping of protons vectorially from the mitochondrial matrix to the cytosol. This redox chemistry is converted into an electrochemical potential across the inner membrane of the mitochondria to drive the production of adenosine triphosphate (ATP). Chemical reactions that regulate cellular metabolism can be significantly altered by very small changes in ATP levels (Brown 1992). Direct measurement of ionic currents through the plasma membrane of *non excitable* glial cells, *excitable* neurons and cardiomyocyte cells after absorption of He-Ne laser, demonstrated an activation of background channels. These channels are associated with ATP dependant K^+ - channels or Ca^{2+} - dependant K^+ - channels (Karu et al 1996). LILT induces photosignal transduction and amplification chain effect from the cellular membrane to the nucleus, resulting in deoxyribonucleic acid (DNA) synthesis and increased cell proliferation (Karu 1988). However, controlling cell proliferation via the cellular signalling pathways also involves changes in intracellular concentrations of H^+ , K^+ , Na^+ , Ca^{2+} . and cAMP, a cyclic molecule which is active in the regulation of gene expression in bacteria and eukaryotic cells (Hesketh et al 1985; Kaplan 1978; Rozengurt 1986).

Laser photobiomodulation can be stimulative or inhibitive

Studies indicate that when the overall redox potential is optimal, LILT effects can be insignificant or even absent. Stronger responses are shown to occur when the intracellular PH is low and the redox potential is shifted towards a more oxidised direction (Karu 1987; Karu 2002; Pouyssegur et al 1985).

Procollagen synthesis showed an average increase of 4-fold using 633nm wavelength emitted by a Helium Neon (He Ne) laser with a peak response of 36-fold in cultures that previously had very low procollagen production. Cultures that were already producing procollagen did not show any significant increase (Lam et al 1985). Increased synthesis of collagen was also found to be reliant on ascorbate levels indicating a connection to redox activity (Labbe et al 1990).

Fibroblast cells react to all incoming information such as metabolites, hormones, neurotransmitters and PH changes thereby assisting in maintaining homeostasis via local feedback information from the extracellular matrix (Nietfeld et al 1994).

Furthermore, more than one cell function can be influenced by LILT in many different types of cells and an alteration of one cellular homeostasis parameter will ultimately lead to a parallel shift in others. The catalytic effect of activating an enzyme can initiate thousands of chemical reactions, making it nearly impossible to determine the exact cause of the effect on the cell.

Biological systems are energetically open; taking in nutrients i.e. dissipative energy from the environment and releasing waste products of lower energy. Energetically open systems oscillate and demonstrate feedback mechanisms that are characteristic of non linear behaviour, which exhibit no starting conditions (Adolph 1982, Szent-Gyorgyi 1941).

Opportunity for prediction of outcomes on the basis of initial and final states is not possible, because the whole biological system reacts with flexibility to non physiological changes and thereby permits adaptation processes to naturally occur (Klima et al 1987). At the molecular movement level, oscillating rhythms give way to higher oscillations that can be measured, such as heartbeat in seconds, intestinal peristalsis in minutes, sleep-wake cycle in hours, healing and regeneration in days and growth in years. Each molecule, cell, tissue and organ has an ideal resonant frequency that assists in the co-ordination of the whole biological system. In non linear systems the natural oscillations (*i.e. frequencies*) are never fixed, allowing small frequency variations to modulate information transfer. If a nonlinear system receives a suitable energy, the energy is distributed throughout that system and can create short lived fields of oscillation that can adjust or change spontaneously to re-instate biological coherence in other parts (Heine 2000).

Pain control mechanisms of lilt

The studies on pain control using LILT have demonstrated an analgesic stimulus response in all levels of the nervous system. Release of endogenous opiates α - and β endorphins binds to opiate receptors of the nociceptive system and in particular the substantia grisea centralis. Binding endorphins block the entry of the opiate receptors to the incoming nociceptive transmission substances and thereby cause narcotic analgesia (Walker 1998). Furthermore, nociceptive information may be modulated by the gate control theory, through deceleration of transmission rates of A- and B-fibres in the gray matter of the posterior horns in the cells of the spinal ganglia (Ohshiro 1991). Acceleration of C-fibres assist in controlling and modulating descending inhibitory systems, especially in the reticulospinal tract (Melzack 1996).

Lilt induced immune response

Experimental data relating to LILT has historically been directed towards relieving pain (Walker, 1983, Walker and Akhanjee 1985). Investigations into the regeneration of nerves in animal tissue with LILT revealed that it prevents a drop in action potential in injured peripheral nerves, thereby helping to preserve conductivity as well as decrease the degeneration of motor neurons. Accelerated regeneration of the injured peripheral nerves and a lessening of the degenerative changes in the corresponding segments of the spinal cord will also occur (Rochkind et al 1989, Anders et al 1993).

Changes in the electrophysiological parameters of nerves by direct skin mediated photo-neuroimmunological actions have also been reported. The main cells involved in the immune response are B cells and T helper/inducer cells CD4 (T4), suppressor/cytotoxic cells CD8 (T8), natural killer cells, that have been studied by full mitogenic activation and blast transformation. Release of chemical signals in response to LILT also occurs in the form of cytokines and lymphokines (Karu et al 1989).

Wound healing can be slowed under various conditions, and the cells' susceptibility to hypoxic injury will depend largely on their ability to maintain redox potential (Khan and O'Brien 1995). Release of a macrophage-derived growth factor has been demonstrated to promote angiogenesis i.e. neovascularisation in an avascular and hypoxic area of tissue (Banda et al 1985).

Macrophage cells play a pivotal role in the wound healing process (Clarke 1985) and are capable of surviving for extended periods in hypoxic tissue. These cells respond favourably to LILT and are essential if repair is to continue. They are an important source of a variety of biologically active substances and growth factors, which attract fibroblasts and activate other cells and the growth of granulatory tissue (Bolton et al 1990;1991; Rajaratnam et al 1994).

During phagocytosis, mononuclear phagocytes (eg. *macrophages*) and polymorphonuclear leucocytes (e.g. *neutrophil granulocytes*) emit light in the form of *biophotons* (Klima et al 1987). It is also further postulated that excited oxygen molecules (O_2^*) within the cell membrane of phagocytes take part in phagocytosis, as either a possible source or mediator of light during immune defence (Roscher et al 1984). The wavelengths of these endogenous biophotons are within the same range of red and near infra-red light implemented during LILT.

Biological communication and detoxification via the extracellular matrix

The body's cellular defence system involving the reticuloendothelial system is comprised of T and B lymphocytes, macrophages, neutrophilic granulocytes and capillary endothelial cells. Epithelia and vascular endothelia maintain a functioning barrier against a variety of antigenic substances, in combination with the molecular filtering function of the extracellular matrix (ECM) of the connective tissue.

The major detoxification process takes place in the ECM whereby harmful endogenous and exogenous substances are filtered through this tissue space and excreted via venous capillaries and the lymphatic system. When the ECM becomes congested with waste substances (i.e. chemicals, metabolites and heavy metals), tissue drainage is slowed down. This interferes with the passage of essential nutrients, which are necessary for cells to maintain cellular metabolism and redox homeostasis (Regling 1992; Hascall and Hascall 1981)

Maintaining homeostasis

Maintenance of homeostasis of the entire body requires the matrix to react very rapidly to complex changes and this is achieved by the high diversity and rapid turnover and coupling capabilities of the extracellular sugars and regulation of the ECM. This provides a highly ordered state that is distinct from thermodynamic equilibrium, thereby enabling restoration processes to repeatedly occur. Optimum functioning of the ECM is of paramount importance in maintaining biological regulation of an energy exchanging system and determines the normal and pathological reactivity of genetic material of the cell.

Genes govern the manufacture of molecules, but it is the forces exerted by internal electromagnetic energy fields that bring the molecules together (Adey 1990). The ECM is the extracellular environment that acts as a molecular sieve through which all substances leaving a cell or reaching a cell must pass through. Each cell requires an adequate environment to realise its genetically determined functional potential.

A self monitoring autocrine feedback loop maintains the ECM in a constant state of re-modelling by tissue-degrading proteolytic enzymes and their inhibitors. Disturbance of their equilibrium will consequently lead to excessive synthesis of connective tissue resulting in fibrosis or inflammatory degradation of tissue (Pienta and Coffey 1991; Bassett 1968).

The central nervous system reacts to internal and external electromagnetic fields when the ECM undergoes changes. This plays an important role in maintaining coherence and integrative communication within the body. This dynamic coherence begins at the sub atomic level to the molecular, cellular and anatomical tissues

and organ levels (Ho and Knight 1998). Water and many of the liquid crystalline molecules within the cell membrane are electrical dipoles, which can transduce and convert mechanical and acoustical oscillations, including oscillating frequencies of light. This can be one way in which the cell membrane increases its permeability and cellular transport processes and removal of waste products (Oschman 1990).

The work of Frohlich (1988) and Davydov (1987), based on quantum physics, has confirmed that the ECM produces coherent laser like oscillations that move through the entire organism. These semiconductor properties form an electronic and photonic network of varied frequencies, which include visible and near visible light (Pienta and Coffey 1991). These frequencies serve as signals that integrate processes involving immune defence, growth including injury repair and the functioning of the body as a whole. Thus photon-induced chemistry gives rise to biological reactions (Smith and Hanawalt 1969).

Effects of lilt on the lymphatic system

Animal studies performed by Leivens (1977) examined localised oedema, adhesion of the scar to underlying tissue and regeneration of lymph and blood vessels in wounds following LILT. Results revealed that tissue adhesion rarely occurred in the laser experimental group, but was present in 100% of the control group by the fourth day after wounding. Tissue adhesion creates a barrier against migration of endothelial cells and new vessel formation within the wounded area. Fibrotic tissue greater than 0.5mm has been shown to inhibit migration of endothelial lymph cells and growth of lymphatic vessels (Clodius 1977).

The Lievens (1977) study outcomes relating to the rate of regeneration of both blood and lymph vessels in the laser group was statistically significant and it was noted that the cut lymph vessels never regenerated in the form of a network, as was seen in the control group. Instead, the cut lymph vessels repaired to their original pattern, and after several days were less permeable and more functional. Lymph vessel permeability in the control group was, however, still evident in 50% of the cases, some for as long as six months.

Another study by Leivens (1985) has demonstrated an increased dilation of blood and lymph vessels immediately following exposure to LILT, while Piller and Thelander (1995) have also observed significant reduction in oedema and tissue fibrosis following LILT.

Experimental studies relating to the pathophysiology of lymphoedema, has revealed histological evidence that enhancement of phagocytic activity stimulated proteolysis of accumulated proteins. This in turn facilitated the release of osmotically retained lymph fluid, and a subsequent increase in the lysis of fibrotic tissue (Casley-Smith and Casley-Smith 1986; Piller et al 1988).

The LILT induced enhancement of immune response and phagocyte activity (Karu 1988) can assist proteolysis and provide additional protection against the development of cellulitis.

Costs of managing lymphoedema

In 1994 the cost of reducing oedema relating to a lymphoedematous limb using manual lymphatic drainage, complex physical therapy and other multifaceted regimes in a public hospital were costly and amounted to approximately AU\$60 per percentage point of reduction and costing up to AU\$3,000 in the first year for a 50% average reduction in oedema (Casley-Smith and Casley-Smith 1986). It is highly likely that these costs would have spiralled upwards in the past 16 years.

Figure 7: Primary lymphoedema prior LILT



Figure 8: Reduced limb circumference and fibrosis after six LILT sessions



The estimated cost of LILT for treatment of lymphoedema during another study conducted in Australia by Piller and Thelander (1995) was approximately AU\$16 per percentage point reduction and a 19% average reduction in oedema within the first 10 weeks of LILT application. Despite these significant clinical results and cost savings being demonstrated over a decade and half, no further cost effective study has been conducted nor has LILT been integrated into the lymphoedema treatment regime within community health centres and hospital outpatient clinics in Australia. The very fact that implementing LILT with an adequately powered non thermal laser to instigate lymphatic drainage would take less time and physical effort than it does to perform manual lymphatic drainage massage is a time cost saving in itself.

New wholistic treatment of lymphoedema with lilt

Lymphoedema not only effects the limbs but the whole person, as the improvement in the mobility and visible appearance of the LILT treated limb results in a more positive state of mind and self-esteem. The most prevalent clinical methods of managing lymphoedema involve manual lymph drainage, compression garments and bandaging. While these methods are highly effective in controlling excess oedema, they do not address the underlying inefficiency of the lymphatic system and related fibrosis that continues to restrict lymphatic and blood flow.

The anti-fibrinolytic action of LILT on the associated tissue fibrosis of chronic lymphoedema via improved immune response and Phagocyte activity (Casley Smith-Smith and Casley-Smith 1986) mean that the affected ECM is now capable of facilitating migration of endothelial lymph cells and re-canalisation of lymph vessels (Clodius 1977). Add to this the systemic immune support to defend against the occurrence of cellulitis while rapidly reducing limb circumference within minutes (Leivens 1977), and new holistic level of treatment is now possible to address all aspects of lymphoedema.

Diabetic support with lilt

LILT enhanced immune competence has the potential to provide a major benefit in reducing the incidence of infections and morbidity, particularly in diabetic patients.

In diabetes type 2, the supply and removal of cells throughout the body is restricted when the ECM becomes congested with undesirable waste products, and tissue drainage is impaired. The body's capacity to communicate diminishes as regulatory function declines, nervous tissues are compromised and availability of essential nutrients for nerve and tissue repair reduces. This can result in diabetic foot ulceration and blindness.

It is forecast that the incidence of diabetes will double in the next 20 years and impaired wound healing will be the pivotal event responsible for most of the morbidity in diabetic foot disease (McLennan et al 2008). Diabetic lower limb ulceration and amputation result from neuropathy and vascular disease, which predisposes the diabetic foot to injury, bone fracture and infection without sensation. Adequate serum levels of

Figure 5: Secondary lymphoedema and fibrosis before LILT



Figure 6: Reduced fibrosis after 21 LILT sessions

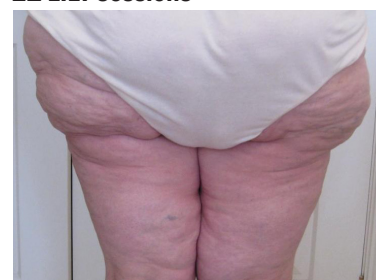


Figure 9: Amputee and neuropathic foot ulcer prior to LILT session



Figure 10: After six LILT sessions



antibiotics may not reach the infected sites due to vascular occlusions. Staphylococcus bacteria can survive intracellularly and infect bone, leading to the development of osteomyelitis (Taylor and Porter 1987). Non healing ulceration is a major pre-disposing factor for 85% of lower limb amputations, and more than 50% of all lower limb amputations are associated with diabetes and increased risk of mortality (Pecorato et al 1990). High glucose levels impair the functioning of human fibroblast cells and inhibit the wound healing potential of the diabetic patient, but could be significantly improved with the integration of LILT into the wound care regime.

Figure 11: Type 1 diabetic non responding ulcer and osteomyelitis for surgical amputation



Figure 12: After 18 LILT sessions



Figure 13: After 32 LILT sessions



Figure 14: After 40 LILT sessions



A diabetic foot requires management by a multi-disciplinary team, in order to contribute and communicate specific knowledge for appropriate treatment. However, the first line of defence to maximise outcomes in any wound treatment should be to support the mitochondria, which is responsible for producing 95% of the cells energy and this vital support is a primary action of LILT.

Early GP referral to community health centres for ulcer prevention

The management of chronic pain and the healing of wounds and their complications put an ever increasing financial burden on healthcare costs worldwide. Early GP referral of patients to community health centres who present with

- venous stasis dermatitis
- venous insufficiency or ischaemia
- chronic pilonidal or non-healing wounds, leg and foot ulcers
- newly developing ulcers
- oedema in upper or lower body limbs

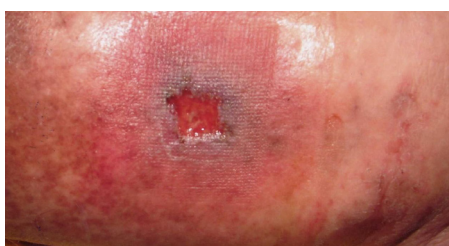
Does lilt have a role in community nursing?

Poorly coordinated and inconsistent management of chronic wounds without LILT has been shown to contribute to lower healing rates and higher costs (MacLellen 2000). National, systematic GP referral for the above listed conditions would be the first major step towards preventing client neglect or mismanagement that could lead to hospitalisation, amputation or prolonged nursing care in the future.

Figure 1: Chronic non healing leg ulcer before first ILIT session



Figure 2: New graduation tissue with decreased maceration and increased vascularisation four days after one ILIT session



Furthermore, existing wound care clinics in community health centres, could ultimately become *ulcer prevention clinics*, and the portability and varying prices of laser devices used in LILT makes it possible for patients to be treated both in their regional community health centre and in their home.

Figure 15: Chronic venous leg ulcer and venous dermatitis prior to LILT session



Figure 16: Resolving dermatitis and decreased slough after 13 LILT sessions



Figure 17: Complete healing of ulcer after 26 LILT sessions



Medium to large wounds should ideally be treated three times a week within the community health centre initially, until the wound has reduced in size and morbidity. After that, wound management and LILT treatment could continue to be provided in the client's home, to prevent wound breakdown and further assist with wound closure.

Ongoing wound management either in a wound clinic or in the client's own home would ideally involve LILT treatment at selected intervals beginning with fortnightly, then monthly and three-monthly, during the first twelve months after wound closure to support cellular and immune function, blood and lymph circulation and maximise stabilisation of the wound site, to prevent a recurrence.

Health care costs in an ageing population

A large increase in the number of older Australians over the age of 65 years is expected to double within the next 40 years and with it comes the increased risk of lower limb ulceration (Margolis et al 2002). In 1996, a study in Australia estimated the private hospital cost for managing a chronic leg ulcer was \$8,734 per admission for a mean stay of 23.9 days (Grindlay and MacLellen 1997). Alleviation of inflammation and pain utilising LILT in an age care facility, where clients are already taking a plethora of medications for existing pathologies, would be of major benefit in reducing suffering, health care costs as well as pressure ulcers.

Studies have reported that community leg ulcer clinics are more effective and less expensive than hospital care for the management of chronic leg wounds (Bosanquet et al 1993). Furthermore some community wound clinics have shown that they provide more cost-effective treatment than domiciliary care through improved rates of healing (Bentley 2001; Thurlby and Griffiths 2002). One of the difficulties of living outside the metropolitan area of a city, especially rural Australia, is the time, effort and financial costs for the client to get to the community health centres and hospital outpatient clinics. Consequently, lack of treatment can result in worsening of their wound condition or lymphoedema and further functional impairment and decline in quality of life and overall health of the individual.

CONCLUSION

Evidence based practice

The philosophy of evidence-based medicine is the explicit, judicious and conscientious use of the best existing evidence to make decisions about the care of individual patients (Sackett et al 1996). Given the number of randomised trials and clinical investigations already undertaken in the area of LILT and meta-analysis of LILT

literature related to wound healing (Woodruff et al 2004), the issue is how much of what is proven about LILT is actually being applied in the front lines of patients living in Australia today.

LILT is a biomodulating phototherapy that has stood the test of time and diversity in clinical application worldwide and has been scientifically proven to be capable of supporting an organism's ability to:

- sustain its redox potential (Anders et al 1993)
- increase immune competency (Karu et al 1991)
- enhance lymphatic drainage and angiogenesis (Leivens 1977)
- improve blood flow (Leivens 1985)
- modulate inflammation and pain pathways (Walker 1983)
- accelerated regeneration of soft tissue, bone and neural tissue (Mester 1976; Trelles and Mayayo 1987; Rochkind et al 1989; Woodruff et al 2004).
- regenerate nerve tissue and preserve nerve conductivity (Rochkind et al 1989)

Nurses are at the interface of acute hospital care and community management of chronic wounds and lymphoedema and are therefore the most suitable healthcare practitioners for providing LILT treatment as part of their patient care regime. Moreover, home based nursing care has the potential to be expanded to treat more people in a day than could be otherwise treated in the community health centre or outpatient clinic, as our ageing population increases.

Healing rates have a real potential to be accelerated utilising a multifaceted approach incorporating best practice of evidence-based wound care in conjunction with the supportive biomodulating effects of LILT, in standardised nursing teams and centres throughout Australia, and particularly to prevent amputation in diabetic clients and in remote outback regions, where indigenous Australians have a higher incidence of diabetes (Australian Bureau of Statistics 2001). The utilisation of the natural healing powers of laser light that is non-invasive, painless and free from serious side-effects can support vital bio-regulating processes, particularly in diabetic and neuropathic conditions, with obvious and positive outcomes for patients, families, communities and governments worldwide.

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Figure 3: Impaired circulation of lower leg in 85 year old male



Figure 4: Tissue regeneration and improved circulation after 12 LILT sessions



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