Venous leg ulcers and chronic oedema, including lymphoedema, are distressing conditions that bear significant human and financial costs, with prevalence figures making alarming reading. The incidence of chronic wounds is growing at a rate of 11%, creating escalating costs of care and resources (Guest et al, 2017). Guest et al (2017) estimated that the annual cost of managing an unhealed venous leg ulcer was £13,500, compared with £3,000 for a healed venous leg ulcer, putting the cost of unhealed wounds at 4.5 times more than healed ones. The annual cost to the NHS of managing 731,000 leg ulcers is now £1.94 billion (Guest et al, 2017).

More importantly, quality of life for those living with unhealed leg ulcers contributes to mental ill health. Depression and associated social isolation, resulting from physical symptoms such as pain, odour, excess exudate and infection, was the subject of a study by Jones et al in 2006. Psychological effects were noted in a case control study of 80 patients with varicose veins (Abelyan et al, 2018), which identified risk factors for ulceration as reflux in deep veins, a history of leg injury, post-thrombotic syndrome (PTS) and physical inactivity, with the study recommending prevention before the ulcer develops. Popliteal reflux was found to be a key causative factor for non-healing venous leg ulcers (59%) in a study by Hjerpe et al (2010), who recommended compression as the main treatment for this condition.

Treatment aims include:
- Conservative management to prevent a condition from occurring in the first place
- Treatment in the acute intensive phase
- Maintenance of the healed condition (International Lymphoedema Framework [ILF], 2006).

Compression is one of the mainstays of treatment for the management of patients with venous disease, chronic oedema and lymphoedema, with severity measured according to grading systems, such as the CEAP Classification (Clinical Etiology Anatomical Physiological), which was revised by Eklof et al in 2004 to refer more broadly to chronic venous disorders. In the author’s clinical opinion, the CEAP classification is a useful guide for assessment and treatment according to clinical signs, symptoms and aetiology. Partsch (2009) has simplified this further by describing:
- Chronic venous disorders, as the full spectrum of venous abnormalities
- Chronic venous disease, as long duration malfunctions of the venous system
- Chronic venous insufficiency (CVI), as advanced malfunctions that lead to skin changes and oedema formation.

Compression has been shown to reduce venous reflux and increase venous return (Partsch, 2006; Mosti et al, 2008). The Scottish Intercollegiate Guidelines Network (SIGN, 2010) concluded that compression heals leg ulcers more effectively than no compression, and this has been confirmed by the widespread use of compression delivered via different technologies (Rabe et al, 2018).
Characteristics of a good compression device are provision of the appropriate pressure and stiffness for efficacy, balanced with tolerability and comfort to the wearer (Mosti et al, 2008).

Traditionally, compression bandage systems and compression wraps were used in the intensive phase of management to address acute symptoms such as gross oedema, skin changes, irregular limb shape, and where frequent wound care or monitoring is required, e.g. infected wounds or highly exuding wounds (European Wound Management Association [EWMA], 2016). Once the condition has stabilised, compression hosiery is a natural progression, to allow patients mobility and the ability to follow a near-normal lifestyle, with self-care wherever possible (Ashby et al, 2014).

## COMPRESSION HOISERY

Guidelines recommend lifelong use of compression hosiery to maintain the healed state, with varying stiffness for mild, moderate or dense oedematous tissue (SIGN, 2010). Patients should be offered the strongest compression they can tolerate to prevent ulcer recurrence, and informed that compression will probably be required indefinitely.

While there is a wealth of best practice and advisory publications, there remains a paucity of new definitive studies, particularly longitudinal studies that provide good evidence for long-term efficacy. This may be due to ethical considerations, as control groups would be denied compression therapy in situations where it is essential to health and well-being. Older studies conducted on elastic compression stockings have confirmed an increase in blood flow velocity and symptom relief (Somerville, 1997; Kraemer et al, 2000). However, current anecdotal evidence and case studies abound to reassure practitioners and patients of the benefits of using compression hosiery to relieve symptoms of venous disease and prevent recurrence (Bentley, 2001; Drosso, 2007). An international consensus document reviewed studies on medical grade compression stockings with evidence to support their use for the management of venous and lymphatic conditions (Rabe et al, 2018).

### EARLY SYMPTOM RELIEF

Symptoms such as ankle swelling, heaviness, reduced mobility and pain are associated with early venous disorders — often before visible signs occur. Somerville et al (1974) recorded pressures and outcomes of 10 healthy volunteers (all female) and 12 patients with varicose veins following five months of wearing compression garments, demonstrating highly significant improvements in symptoms and a lowering of ambulatory venous pressure, although the improvements were more marked at two months than five months of wear.

Similarly, Kraemer et al (2000) concluded in their study of 12 healthy women in standing occupations) that wearing various types of graduated compression hosiery during the day may minimise oedema and muscle tissue disruption, thereby increasing comfort in the legs, while Blazek et al (2013), following their study of 108 hairdressers, advised that individuals in standing occupations benefited from wearing compression hosiery to alleviate symptoms of pain and heaviness. This is confirmed by Partsch et al (2004) in a study of 12 patients in sitting or standing professions, which concluded that calf-length compression stockings of 11–21mmHg are able to reduce or even totally prevent evening oedema, recommending these stockings for people with professions involving long periods of sitting or standing.

Walking is a key factor to complement the action of stockings, as the foot pump helps with venous return. In a study by Ibegbuna et al (2003), limbs with graduated elastic stockings had significantly improved haemodynamics by a reduction in residual volume fraction at all speeds than those that did not wear stockings.

Practitioner point

Ease of application and removal, availability, and a comprehensive range of compression products help to ensure appropriate management of venous disorders.

### VENOUS ULCERATION MANAGEMENT

Compression hosiery is now considered as a treatment option as well as a preventative measure, providing comparative outcomes to compression bandages for selected conditions. The VeriUs 4 study of 457 participants with venous leg ulcers found similar healing with a two-layer hosiery kit (95%), as with the four-layer bandage system (98%) (Ashby et al, 2014).

Oedema often co-exists with venous disease. Mosti et al (2012) compared compression stockings with bandages, showing that stockings with pressures of 30mmHg achieved a similar reduction in moderate oedema, as compression bandages exerting initial pressures of 60mmHg, making stockings another option for treatment. It should be noted that stiffness of the garment is as important as pressure levels for clinical effectiveness.

If ulcers occur, symptoms such as skin damage, excess fluid and possible infection will be caused by the wound and, in these cases, adjunct therapy such as dressings should be used. Treatment regimens with more frequent dressing changes present additional challenges for those with compression hosiery, particularly as patients may no longer be able to manage their own care due to the need for monitoring and wound care.

### PREVENTION OF RECURRENCE — BALANCE OF EFFECTIVENESS AND COMPLIANCE

Vowden and Vowden (2009) identified a 40% occurrence of venous leg ulceration in a population of 482 patients in Bradford. Of these, 205 had experienced previous episodes

---
with ulcers being present for over one year. International and national guidelines agree that compression hosiery has a role in preventing recurrence of venous leg ulceration, recommending compression levels of 35–45mmHg at the ankle (EWMA, 2016: Marston and Vowden, 2003). While higher levels of compression are more effective, if tolerance and concordance are an issue, in the author’s clinical experience, lower levels can achieve results.

A study of 300 patients with healed venous leg ulcers reported slightly lower recurrence of 32% with class 3 hosiery compared with 39% in the class 2 group. However, non-compliance was recorded at 42% for the class 3 group and 28% for the class 2 group, demonstrating the balance between effectiveness and tolerability for concordance (Nelson et al, 2006). Compliance, therefore, could be the key to even greater success at preventing recurrence.

This concurs with Clarke-Moloney et al’s study (2012) comparing class 1 and 2 compression hosiery, which confirmed that although higher levels of compression were associated with lower recurrence rates in superficial and deep vein incompetence, better outcomes were seen in patients who were compliant with their hosiery and therefore receiving some form of therapy to minimise recurrence. The risk of recurrence was noted by Moffatt et al (2009), who stated that patients who did not comply with wearing compression stockings post venous ulcer healing were two to 20 times more likely to suffer recurrence.

Transition to compression hosiery
Timescales for starting use of compression hosiery following healing when patients have been in bandaging varies with individual cases. A Best Practice document advised that compression bandages should be continued for two to four weeks after healing, before the application of compression hosiery, to ensure extra strengthening of the skin (Coull and Clark, 2005). Compression hosiery should be introduced once the limb shape and size have stabilised, and when the patient or carer is able to apply hosiery competently (Muldoon and Charles, 2013).

Prevention of deep vein thrombosis (DVT)
Scurr et al (2001) identified the risk of symptomless deep vein thrombosis (DVT) in up to 10% of long-haul airline travellers and concluded that wearing elastic stockings was beneficial in reducing symptomless DVT.

Post-thrombotic syndrome (PTS)
Following numerous studies, the use of compression stockings is now recommended by the International Compression Club (ICC) to minimise PTS (Rabe et al, 2018). Blattler and Partsch (2003) found that early compression and ambulation improves venous recanalisation and reduces vein diameter, with additional quality of life benefits such as reduced pain and swelling. A notable study is a randomised trial by Brandjes et al (1997) of 194 patients, which concluded that patients who wore compression stockings following an initial post-thrombotic episode had a 50% reduction in recurrence that could lead to PTS than those who did not wear stockings. In 2004, Prandoni et al found in a randomised controlled trial (RCT) of 180 patients that below-knee stockings reduced the rate of proximal DVT by 50%, compared with no stockings after a follow-up period of five years. Prandoni et al (2004) also stated that there was no difference in the effectiveness of thigh-length stockings compared to below-knee stockings for PTS, and that below-knee garments were better tolerated.

Thomas (1999) concluded that below-knee were as effective as thigh-length stockings and suggested that anti-embolic stockings presented a greater risk of tissue damage in some vulnerable patients if incorrectly applied than graduated compression stockings, due to the pressure profile. This was reiterated in a review by Ingram in 2003, who recommended that the knee-length stockings were as effective as thigh-length, and more likely to be accepted by patients because of increased comfort, as well as being less expensive.

Post surgery
The benefits of wearing compression stockings after surgery for pain relief was discussed in a study of 79 patients by Elderman et al (2014). It recorded significant reduction in pain scores and the use of analgesics in patients wearing stockings for two weeks, compared with those who did not wear stockings following endovenous laser therapy.

Types of hosiery and level of compression
Choice of hosiery is dependent on several factors, including condition and severity of the disorder, risk factors, concurrent aetiologies, the individual patient (and carer), and consideration of comfort and lifestyle needs.

Circular- or flat-knit, level of compression and classification for intended use
Hosiery is classified according to manufacturing techniques, stiffness, and pressures exerted on the limb. As with all compression, information is needed on pressure and stiffness, as these factors determine performance during walking and standing (Partsch, 2006). British Standard hosiery is circular-knitted and more elastic than the flat-knitted European Class hosiery, which is stiffer. For this reason, flat-knit hosiery is more appropriate to manage dense tissue associated with lymphoedema, whereas the elasticity of circular-knit hosiery is both more comfortable and aesthetically acceptable to patients, and is generally easier to apply for venous disorders and mild-to-moderate oedema (Todd, 2015).

Hopkins (2007) explained the grading, which is done according to test methods that are required for manufacturers. Three standards used include:
- British (BS6612)
- French (ASQUAI)
- German (RAL - GZ)

(Hopkins, 2007; Bjork and Ehmann, 2019).
The S.T.R.I.D.E document (Bjork and Ehmann, 2019) includes a new category of stiffer circular-knit hosiery, with the benefits of both technologies.

Many position documents, best practice statements and educational resources are available to assist clinical decision-making, according to patient and condition needs, considering lifestyle, mobility, ability to don and doff, and tissue shape and texture.

Closed- or open-toe, below-knee or full-length garments
Longer foot length or foot deformities may necessitate open-toe hosiery, or it may be that the patient simply finds them easier to put on than closed-toe garments. Where varicosities or swelling exist above the knee, it is essential to address these complications with thigh-length hosiery, although this is generally more difficult to use.

Studies have shown that below-knee hosiery is as effective as thigh-length and better tolerated by wearers (Prandoni et al, 2012). Additionally, a review by Ingram (2003) revealed that there was a lower risk of restrictive bands with knee-length hosiery (6.7%) than with thigh-length garments (16.7%). This may be attributed to correct fitting, recorded as 70% for below-knee stockings, compared with 37.5% for thigh-length stockings.

Off-the-shelf or made-to-measure garments
Rabe et al (2018) cautioned against the use of medical compression stockings (MCS) where there is a risk of cardiac overload in patients with congestive cardiac failure. However, they advised that, with specialist intervention, moderate oedema may be treated with light MCS with no detrimental effects.

Compression stockings are also contraindicated in critical limb ischaemia and peripheral neuropathy, which necessitate vascular and holistic assessment to exclude the risk of necrosis. This is clearly set out in the guidelines (i.e. SIGN, 2010; EWMA, 2016; World Union of Wound Healing Societies [WUWHS], 2008; and the Royal College of Nursing [RCN], 2006).

Fragile skin, very thin legs with bony prominences, and misshapen toes may all be vulnerable to excess pressure during compression, particularly if measuring, fitting and application are incorrect (Beldon 2013). Bradley (2001) expounded the benefits of graduated compression stockings, but also advised that patients should be monitored closely, and taught to self-monitor for signs of tissue damage from ill-fitting hosiery.

Dermatological considerations
Fragile skin, or skin that is sensitive to materials such as lyca and other elastic, may benefit from pure cotton, and care should be taken with donning and doffing to avoid mechanical skin damage (Coul and Clarke, 2005). British Standard hosiery is available in cotton and nylon.

Compliance/concordance and applier skill
One of the main issues is donning and doffing, particularly for patients who have limited mobility or dexterity. In these cases, circular-knit hosiery may be more suitable to facilitate self-care; in cases where flat-knit hosiery is indicated, applicator aids may be appropriate (Todd, 2015).

Correct application and information for patients and clinicians are vital for effective clinical outcomes and successful patient cooperation. In a Leicestershire trust, Walker and Lamont (2007) audited 180 patients who required graduated embolic compression stockings (GECs) and found that only 34% were given stockings and 7% were ill fitting. The reasons for patients not accepting the stockings were discomfort due to heat, itching, tightness, blistering and the fact that the stockings kept rolling down. There is now a policy in place and training for patients and nurses.

Training and education
Jones and Nelson (2001) advised that patient education needs to start at the first clinical assessment to explain why compression is essential, so that patients understand the consequences of not wearing their hosiery, even after healing has occurred. The study suggested that offering individual patients a choice of hosiery, or an option to change to brands that are more comfortable, may improve concordance. It also stressed the importance of nurses understanding both the rationale for the lifelong use of compression hosiery, and the fact that measuring and fitting are an essential component of successful treatment.

Regular communication with the practitioner has been shown to have a positive effect on compliance. A RCT of 40 patients using compression stockings compared minimal practitioner patient contact with an active programme of regular contact and advice (Uhl et al, 2018). Compliance was measured by a Thermotrack skin temperature device that recorded when the hosiery was being worn. Those receiving in-
deep clinician participation were 71% compliant, compared with 48% of those in the control group with minimal contact, thereby reinforcing the need for effective communication with patients.

Availability and service provision
Clinicians have come to rely on industry to provide training in the use of compression hosiery, as the comfort and success of management is dependent on the correct selection, measuring and fitting of each garment.

Once the patient has been assessed as suitable to make the transition into hosiery, prompt access to the appropriate garments is essential to ensure continuity of treatment with compression. If the patient does not fit into off-the-shelf hosiery, made-to-measure garments will need to be ordered, and the speed and quality of delivery are important considerations.

Correct prescribing and service provision still present a challenge, as identified in a survey of 630 clinicians conducted in September 2018 (JCN/GPN online survey). Analysis of the responses revealed that approximately 57% of clinicians experienced problems with incorrect sizes, styles, colours, additional costs, and quantities ordered, while 76% had issues with waiting times and delays. Twenty-eight percent of the clinicians had issues with waiting times and quantities ordered, while 76% experienced problems with incorrect dispensing rate (Daylong data on file, 2016).

Publishers are also committed to looking at new ways to reach out to patients in patient forums, as part of healthcare professional conferences, so that manufacturers and clinicians understand patient needs and can respond to them (Wound Care Today Conference, 2019).

CONCLUSION

Unlike short-term therapy with compression bandaging, compression hosiery is a lifetime course of management and success depends on many factors involving different stakeholders, including patients. Compression hosiery offers individuals the ability to self-care, maintain independence and a near normal lifestyle. It is essential that the patient is assessed correctly, appropriate hosiery is selected, measuring and fitting are precise, and the right training is given to patients. Alongside clinical partners, manufacturers must be committed to delivering quality garments on time and to providing training and service support to clinicians and patients. Above all, patients need to understand the importance of wearing their hosiery and to feel confident that they are receiving the best care, which will promote concordance with treatment.

REFERENCES


Regular reviews of patients and their garments will ensure correct fit and effectiveness, especially if the limb shape changes (Jones and Nelson, 2001).

Practice point

Useful tips for patients about their condition, and the easiest methods of donning and doffing, are important to facilitate adherence to therapy.

Daylong (2016) ISO 9001 audit, data on file
Drosso M (2007) A study into the prevention of ulcer recurrence and the effectiveness of the Activa 40mmHg hosiery kit. Poster Presentation, Glasgow


