PRINCIPLES OF BEST PRACTICE

A World Union of Wound Healing Societies' Initiative

Compression
in venous leg ulcers
A consensus document

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FOREWORD

Venous leg ulceration (VLU) and chronic venous insufficiency (CVI) represent a significant health problem and the key to successful management lies in the use of compression therapy. However, numerous factors can influence a clinician's ability to achieve effective compression. The wide range of compression systems available, variations in terminology and a lack of clear understanding of sub-bandage pressures can lead to confusion and ineffective care. In addition, many patients do not present with 'textbook' legs and bring practical challenges to the art and science of compression therapy.

The principles presented in this document represent the consensus opinion of an international expert working group who met in June 2007. They are designed to help clinicians around the world make a real difference to patient quality of life and clinical outcomes. They build upon and are influenced by the recent monograph *Chronic Venous Insufficiency and Venous Ulceration*[1].

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PRINCIPLES OF BEST PRACTICE

Compression is a potent therapy. Used correctly it can promote healing of VLU and change a patient's quality of life; used incorrectly it can result in delayed healing, pain, trauma or even the loss of a limb. Clinicians involved in the treatment of patients with VLU should be competent in selecting and applying compression according to individual patient needs, and be supported in practice to ensure an appropriate continuation of their skill level. This document focuses on the challenges that affect the clinician's ability to achieve effective compression.

UNDERSTANDING COMPRESSION THERAPY

In simple terms, compression works by squeezing the limb, thereby reducing oedema and aiding venous return towards the heart. Its effects on the venous, arterial and lymphatic systems have been discussed in detail in previous publications[1-3].

Pressure

Compression – the direct application of pressure to a limb – is measured in mmHg. It is commonly applied using bandaging, though other forms include hosiery and intermittent pneumatic compression (IPC). The required amount of pressure (**sub-bandage pressure**) is determined by the underlying pathologies as well as the patient's ability to tolerate the compression. In practice, sub-bandage pressure may vary and tends to be lowest when the patient is lying down (**resting pressure**), with higher peaks of pressure occurring during exercise (**working pressure**).

International variations exist in the classification of pressures. The following standard has been suggested recently: **mild** (<20mmHg), **moderate** (≥20–40mmHg), **strong** (≥40–60mmHg), **very strong** (>60mmHg)[4].

While pressures ≥40mmHg are generally recommended for the treatment of VLU[2,4], resting pressures >40mmHg may not be appropriate as patients are often frail or elderly. Resting pressures ≥60mmHg should, in general, be reserved for the treatment of lymphoedema. For some patients, factors such as arterial insufficiency, neuropathy or cardiac failure render **strong compression** unsafe or painful, and **mild or moderate compression** may be required.

Graduation

Graduated compression – a 20–30% reduction in pressure from ankle to below knee – is thought to aid venous return to the heart and occurs naturally when compression is applied to a limb of normal proportions due to the principles of Laplace's Law (Box 1). Patients with altered limb shape may require reshaping of the limb with padding prior to the application of compression (see below) in order to benefit from graduated compression (Figure 2, see page 7). The true importance of graduation, especially for mobile patients, remains unclear.

FACTORS AFFECTING SUB-BANDAGE PRESSURE

It is essential to recognise the many factors that affect sub-bandage pressure.

Bandage factors

Sub-bandage pressure is determined by the principles of Laplace's Law (Box 1)[5]. It is important to be aware of the factors that affect these principles, for example the washing of elastic bandages may alter their elastomeric properties, resulting in reduced tension.

Patient and clinician factors

Calf muscle and foot pump function, the shape of the limb and the patient's ability to tolerate the compression can all impact on its effectiveness. The skill of the clinician, the resources available and the application technique used are also central to achieving success.

BOX 1 | Principles of sub-bandage pressures based on Laplace's Law[5]

$$\text{Pressure} = \frac{N \times T \times 4620}{C \times W}$$

- N = Number of layers applied – *the more layers, the greater the pressure*
- T = Bandage tension – *the greater the force applied, the greater the pressure*
- C = Limb circumference/ shape – *the smaller the circumference at any given point, the greater the pressure*
- W = Bandage width – *the narrower the bandage, the greater the pressure*

1. *Chronic Venous Insufficiency and Venous Ulceration – Aetiology and Treatment.* 2006. For further information contact MEP Ltd: www.mepltd.co.uk
2. European Wound Management Association (EWMA). *Position Document: Understanding compression therapy.* London: MEP Ltd, 2003.
3. Lymphoedema Framework. *Template for Practice: Compression hosiery in lymphoedema.* London: MEP Ltd, 2006.
4. Partsch H, Clark M, Mosti G, et al. Classification of compression bandages: practical aspects. *Dermatol Surg* 2008; 34(5): 600-9.
5. Thomas S. The use of the Laplace equation in the calculation of sub-bandage pressure. *World Wide Wounds* 2002 (Updated 2003). Available from: www.worldwidewounds.com/2003/june/Thomas/Laplace-Bandages.html

COMPRESSION BANDAGING

6. Partsch H. The use of pressure change on standing as a surrogate measure of the stiffness of a compression bandage. *Eur J Vasc Endovasc Surg* 2005; 30(4): 415-21.

BANDAGE MATERIALS

Bandages may be made of different elastic or inelastic materials. Each has its own advantages and disadvantages and further research is required to fully understand how they work in practice[2]. Clinicians should be aware that many bandages now come as a **bandage system** comprising multiple **components** (see page 3) and that some of these may combine both elastic and inelastic properties. Understanding the properties of the bandage system being used (Box 2) as well as the degree of elasticity or stiffness created, will help clinicians know how different pressures can be achieved.

BOX 2 | Definitions (adapted from[2])

- **Tension** – amount of force applied to the bandage during application. The ability of a bandage to sustain a particular degree of tension is determined by its elastomeric properties
- **Extensibility** – ability of a bandage to increase in length (stretch) in response to an applied force
- **Power** – amount of force required to cause a specific increase in length of an elastic bandage
- **Elasticity** – the ability of a bandage to return to its original (unstretched) length as the tension is reduced

Stiffness

Stiff bandaging may be achieved through the use of inelastic materials or the use of multiple layers of elastic materials. The advantage of a stiff system lies in its ability to remain rigid and to resist changes in the geometry of the calf muscle during exercise. This generates high pressure peaks of 60–80mmHg (the working pressure). These pressure peaks create intermittent, short duration venous occlusions, which in much the same way as a valve, are thought to reduce venous reflux and lower venous hypertension. When the calf muscle pump is at rest (eg when the patient is lying down), pressure peaks do not occur and the resting pressure is lower. Stiffness can be measured using the static stiffness index (SSI) – the change in sub-bandage pressure that occurs when a patient moves from a lying to a standing position. **Note: an ineffective calf muscle pump, due to muscle wasting, immobility or limited ankle mobility, significantly reduces the effectiveness of compression bandaging.**

Elastic materials

Elastic bandages, sometimes referred to as **long-stretch** bandages, contain elastomeric fibres and are capable of stretching and returning to almost their original size. They can sustain pressure for up to a week due to their ability to accommodate changes in limb shape and movement. In practice there is a slight reduction in pressure when the patient is lying down. This is because the circumference – and hence the stretch of the bandage – decreases slightly when the muscles are relaxed. Use of a single elastic bandage to apply strong compression is not recommended due to the risk of pressure damage. Multi-component systems provide a protective padding and are therefore preferred.

Inelastic materials

Inelastic bandages contain few, or no, elastomeric fibres. They include **non-stretch** materials, such as zinc paste bandages, and **short-stretch** materials, which have a minimal extensibility. These bandages can achieve resting pressures of around 30–60mmHg[6]; however this is not sustained and decreases over the first 24 hours with movement and/or as oedema reduces. The working pressure tends to decrease less, resulting in a bandage that provides tolerable resting pressures and higher working pressures. Due to the loss in pressure, frequent bandage application may be required, especially in the early stages of treatment, in order to prevent bandage slippage. The use of an outer cohesive layer may help to secure bandages more firmly in place. **Note: because of their ability to sustain pressure, some clinicians believe that elastic materials may be more effective than inelastic materials for immobile patients or those with a fixed ankle, but less appropriate and more uncomfortable for patients with impaired peripheral perfusion[2]. Further research is required to confirm this and clinicians should be aware that inelastic materials can provide pressure peaks even during small ankle flexions.**

Clinicians should be aware that mixing multi-component bandage systems to create a 'home-made' system may alter the elastic properties of the final bandage

BANDAGE TERMINOLOGY

It is essential that clinicians clearly document the materials chosen, the application technique used and whether the sub-bandage pressure they aim to achieve is strong, moderate or mild. Limited understanding is a major practical problem in delivering effective compression, with one of the biggest barriers being the lack of a common international language. Terminology is at times ambiguous or inconsistent and can be difficult to relate to clinical practice.

The terminology surrounding the use of **layers** can be particularly problematic and should not be used to make assumptions about pressure levels. As there will always be some overlap, giving at least two layers of material at any point on the bandaged leg, a **single-layer bandage** does not exist[4]. The term **components** is a better way to describe the individual products used to create a compression system (eg wool padding, elastic/inelastic bandages) (Table 1).

Table 1 | Understanding components

Term	Explanation
Multi-component systems	These systems generally combine padding and elastic or inelastic materials, and are widely accepted as being effective in achieving strong compression. The number of components used and the sub-bandage pressure achieved varies considerably. The so-called **four-layer bandage** is an example of a multi-component elastic system and is designed to apply a sustained sub-bandage pressure of 35–40mmHg at the ankle for patients with an ankle circumference of 18–25cm. It comprises a padding bandage (orthopaedic wool), a crepe (inelastic) bandage (to create a base for the compression), and two mild to moderate compression elastic bandages. Other examples include systems designed for different limb sizes and those which address specific issues such as problems of bulk and ease of application. **Note: although the number of components in these systems varies considerably, most achieve strong compression. It is therefore misleading to use terms such as 'two-layer' or 'three-layer' to imply the level of pressure applied.**
Single-component systems	For example, a single stocking. Most modern bandage systems include padding and are therefore not single-component systems.

NB: The terms 'components' and 'bandage systems' have recently been debated and clarified (Partsch et al)[4]

Cautionary note:

The effectiveness of extension indicators on some bandages is unclear and may cause clinicians to apply excess tension, especially around the foot. Some patients report their use causes pain in the foot

BANDAGE APPLICATION

Clinicians should develop a healthy respect for the skills and knowledge required for bandage application, while avoiding becoming so concerned about the risks that they apply insufficient levels of therapy to be effective. Training should be ongoing in order to reduce problems associated with poor application technique such as pressure damage, limb distortion, bandage slippage and ineffective pressure levels.

Bandage application by the patient/carer may facilitate independence. However, in practice few patients can adequately self-bandage. Patients must be supported clinically and be able to apply the bandages effectively on getting out of bed, before oedema begins to accumulate.

APPLICATION TO PRACTICE

Clinicians should consider adopting the term 'multi-component system' and should document the ankle circumference, the target sub-bandage pressure/stiffness level, the individual components used and the method with which they are applied

OTHER COMPRESSION SYSTEMS

HOSIERY

Strong compression hosiery can be used as a first-line treatment, particularly for patients with small, uncomplicated ulcers who wish to self care, who require daily skin care, or who find bandages too hot or bulky. A two-component system is safer and easier to use than a single stocking: the first stocking (10–24mmHg) holds the dressing in place and the second stocking (20–30mmHg) can be removed at night. Due to the lack of padding it is not a practical option for patients at high risk of pressure damage, with large ulcers or high exudate levels. Self-application can be difficult even with the use of an application device. Care must be taken not to harm the wound bed or surrounding skin and to ensure delivery of adequate compression.

Patients whose underlying CVI cannot be surgically corrected are likely to require monitored lifelong compression to prevent ulcer recurrence. This is often achieved using hosiery that gives a mild to moderate pressure of at least 18–25mmHg, and preferably up to 35mmHg if tolerated.

INTERMITTENT PNEUMATIC COMPRESSION (IPC)

Evidence suggests that IPC – a 'boot' comprising air-filled chambers attached to an electric pump – used in combination with compression bandaging may be more effective than bandaging alone[7,8]. The sequential inflation and deflation of the chambers creates intermittent pressure peaks, mimicking the effect of the calf muscle pump and offering a number of benefits (Box 3). IPC improves tissue oxygenation, accelerates venous return, aids oedema reduction and is thought to increase healing rates[2]. It is particularly useful for patients with reduced mobility or wasting of the calf muscle and is sometimes used without bandaging, for example in patients with arterial insufficiency.

BOX 3 | Patients who may benefit from IPC include those who:

- Have reduced calf muscle function, eg due to immobility or limited ankle mobility
- Cannot initially tolerate bandaging due to pain
- Have peripheral arterial disease not suitable for revascularisation and bandaging/hosiery is contraindicated
- Experience problems with oedema control

Disadvantages include cost, noise, inconvenience, possible increased exudate levels and technical complexity, especially for patients at home and elderly people. Access to professional support is essential. Variations include pumps that exert short bursts of high pressure followed by a longer resting phase to improve arterial flow[9] and IPC 'shoes', which mimic the foot muscle pump, for patients who cannot tolerate compression over painful ulceration.

Further research is needed to better understand the benefits and physiological impact of IPC, and to determine the most effective pressure[8]. In practice, pressures of 40–90mmHg tend to be used, depending on comorbidities and tolerance.

CHALLENGING MYTHS

'Compression therapy for venous ulceration has to be delivered using a bandage'
There are other ways of achieving compression and not all patients will require or be able to tolerate bandaging

'Compression cannot be used in patients with diabetes'
Compression may be used safely in patients with controlled diabetes. Thorough assessment of peripheral perfusion and neuropathy is essential in determining the level of risk and in selecting an appropriate compression system

7. Fletcher A, Cullum N, Sheldon TA. A systematic review of compression treatment for venous leg ulcers. *BMJ* 1997; 315(7108): 576-80.
8. Mani R, Vowden K, Nelson EA. Intermittent pneumatic compression for treating venous leg ulcers. *Cochrane Database Syst Rev* 2001; (4): CD001899.
9. Delis KT, Knaggs AL. Duration and amplitude decay of acute arterial leg inflow enhancement with intermittent pneumatic leg compression: an insight into the implicated physiologic mechanisms. *J Vasc Surg* 2005; 42: 717-25

ASSESSMENT

BOX 4 | CEAP clinical classification[11]

C0	No signs of venous disease
C1	Telangiectasies or reticular veins
C2	Varicose veins
C3	Oedema
C4a	Pigmentation or eczema
C4b	Lipodermato-sclerosis or atrophie blanche
C5	Healed venous ulcer
C6	Active venous ulcer

A COMPREHENSIVE APPROACH

CVI may be caused by reflux due to valve incompetence (non-/post-thrombotic) and/or venous thrombosis/obstruction and subsequent luminal fibrosis. It is exacerbated by reduced mobility. Before applying compression, clinicians should undertake a thorough assessment of the patient, the leg and the wound. Use of the International Leg Ulcer Treatment Pathway[2] is recommended. In addition, quality of life instruments may be useful. When appropriate, access to a comprehensive assessment by a vascular team with a view to corrective surgery is important[10]. The CEAP classification system[11] offers a useful method of recording clinical severity and includes **C**linical classification (Box 4), a**E**tiologic classification (congenital, primary, secondary), **A**natomic classification (superficial, deep, perforator), and **P**athophysiologic classification (reflux, obstruction or both).

Assessing arterial status

A key part of the assessment is to establish whether the patient's arterial supply is sufficiently robust for it to withstand compression. Medical history, symptoms of peripheral arterial disease (PAD) and degree of perfusion of each leg, including ankle brachial pressure index (ABPI) using Doppler ultrasound, should be recorded, or – in patients with diabetes, renal problems or calcified arteries – toe pressure measurements or other examinations considered. Using compression in patients with arterial insufficiency may cause irreversible damage to the limb; vascular investigation and intervention are important and alternative treatments or mild to moderate levels of compression should be considered (Figure 1, see page 6).

Patients who have critical limb ischaemia (Box 5) or ischaemic pain should not receive compression bandaging without assessment by and consultation with the vascular team

BOX 5 | Critical limb ischaemia[12]

Chronic critical leg ischaemia is defined by either of the following two criteria:

- Persistently recurring ischaemic rest pain requiring regular adequate analgesia for more than two weeks, with an ankle systolic pressure ≤50mmHg and/or a toe systolic pressure of ≤30mmHg
- Ulceration or gangrene of the foot or toes, with an ankle systolic pressure ≤50mmHg or a toe systolic pressure of ≤30mmHg

Assessing risk of delayed healing

In addition to PAD, comorbidities such as cardiac failure or diabetes may directly or indirectly (eg due to the effect of medication) delay healing or affect the level of compression that it is safe to apply. Specific risk factors for delayed healing have been identified[13-15] and include mixed arteriovenous disease, presence of popliteal reflux, ulcer recurrence, decreased mobility, ulcer >5cm^2, ulcer duration >6 months, history of venous ligation/stripping, history of hip/knee replacement, and presence of fibrin on >50% of the wound surface. Psychosocial factors may also delay healing and should be addressed. Patients at risk of delayed healing should be identified at an early stage and referred to a specialist centre for surgical or advanced treatments.

Assessing treatment stage

Generally, multi-component bandage systems (with or without IPC) that deliver strong compression are recommended for use during the **therapy phase** of treatment (control of CVI, oedema reduction and ulcer healing) and mild to moderate compression hosiery for the **maintenance phase** (prevention of oedema and ulcer recurrence). Some patients, however, present with practical challenges that make the initial application of strong compression difficult or unsafe, or that affect transition to hosiery. It is important that clinicians recognise and work through these challenges promptly by adopting a **staged approach**, prioritising goals of care and selecting appropriate treatment options (Figure 1, see page 6 and Figure 3, see page 10).

10. Gohel MS, Barwell JR, Taylor M, et al. Long term results of compression therapy alone versus compression plus surgery in chronic venous ulceration (ESCHAR): randomised controlled trial. *BMJ* 2007; 335(7610): 83.
11. Eklöf B, Rutherford RB, Bergan JJ, et al. Revision of the CEAP classification for chronic venous disorders: consensus statement. *J Vasc Surg* 2004; 40(6): 1248-52.
12. Second European consensus document on chronic critical leg ischaemia. *Eur J Vasc Surg* 1992; 6(Suppl A): 1-32.
13. Margolis DJ, Berlin JA, Strom BL. Risk factors associated with the failure of a venous leg ulcer to heal. *Arch Dermatol* 1999; 135(8): 920-26.
14. Margolis DJ, Berlin JA, Strom BL. Which venous leg ulcers will heal with limb compression bandages? *Am J Med* 2000; 109(1): 15-19.
15. Chaby G, Viseux V, Ramelet AA, et al. Refractory venous leg ulcers: a study of risk factors. *Dermatol Surg* 2006; 32(4): 512-19.

GOAL SETTING

16. World Union of Wound Healing Societies (WUWHS). *Principles of best practice: Wound exudate and the role of dressings. A consensus document.* London: MEP Ltd, 2007.

Following a thorough patient assessment, clinicians should identify goals of care and treatment options according to the underlying diagnosis (Figure 1). It is important to apply sufficient pressure to improve CVI and reduce oedema but also to take into account any comorbidities. A delay in introducing a therapeutic level of compression of even one month may delay healing and prolong symptoms such as pain. However, some compression is better than no compression and a staged introduction may improve concordance for some patients. Clinicians should be aware that there may be more than one way to achieve treatment goals.

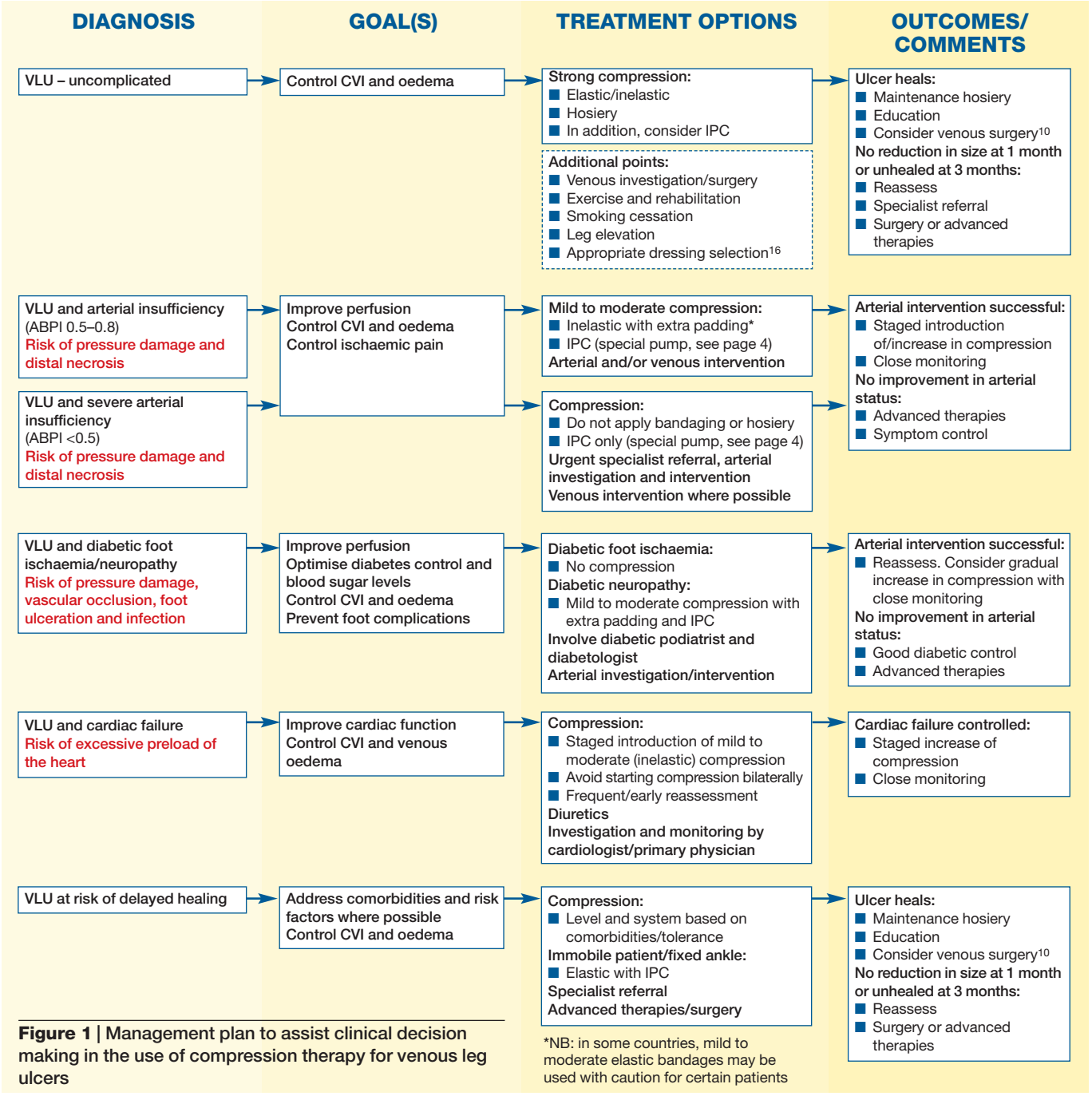

Figure 1 | Management plan to assist clinical decision making in the use of compression therapy for venous leg ulcers

PROBLEM SOLVING

BOX 6 | Measuring limb circumference

First ask the patient to place the foot flat to the ground and record the distance from the ground to the sites of measurement (eg ankle and calf). Subsequent measurements should be made at the same sites to enable accurate comparisons to be made. Ensure good infection control measures are used (eg use a disposable tape measure) and local protocols are adhered to

FACTORS AFFECTING COMPRESSION

It is important that clinicians recognise at an early stage any factors that may reduce the effectiveness of compression and that they take appropriate measures to address them.

Altered limb shape and tissue consistency

An unusual limb shape and altered skin consistency (eg due to lipodermatosclerosis or lymphoedema) can fundamentally alter the effectiveness or safety of compression. Patients are at increased risk of bandage slippage, lack of graduation and uneven pressure distribution, resulting in tourniquet effects, pressure damage and further limb distortion (Figure 2). Careful observation should be made at each dressing change including looking for bands of swelling or forefoot puffiness due to bandage slippage, and comparing each leg. Changes in limb shape due to reduced oedema should be monitored by measuring the circumference at defined sites (Box 6).

Management should focus on ensuring effective compression and reducing the risk of pressure damage. It is essential to reshape the leg with orthopaedic wool or foam before applying compression (Figure 2b). Bandage slippage may be minimised by using an adhesive or cohesive bandage. If an inelastic system is being used, frequent application (every 2–3 days) will be required until the oedema has reduced. If oedema extends into the toes or thigh, toe or thigh length bandaging may be required. Forefoot oedema can be reduced by increasing the pressure over the affected area and by using extra padding to ensure that the bandages do not create a tourniquet around the ankle. IPC should be considered in addition to bandaging.

An unusual limb shape is not a contraindication for compression but careful monitoring is required to ensure the bandaging is safe and effective **(see page 1)**

Figure 2 | Difficult limbs: a) Inverted champagne bottle shape; **b)** Loss of calf muscle with pressure damage (left leg) and correct reshaping (right leg).

Difficult ulcer site

The location of the ulcer may determine how effective compression is or the way in which it is best applied. For example, ulcers over bony prominences are prone to excess pressure; extra padding using orthopaedic wool or foam may be required. Care should be taken when distributing the padding to avoid creating a distorted shape.

Ulcers located in the soft concave area behind the medial or lateral maleoli may have limited contact with the bandages or hosiery and therefore receive insufficient pressure. Kidney-shaped foam or gauze pads applied under the compression can help to overcome this problem.

Frequent recurrence

For some patients, maintenance of a healed ulcer can seem like an impossible challenge. Bandaging may be continued for a number of weeks following healing before transitioning to the highest level of hosiery the patient can tolerate and that is safe. This is because any slight accumulation of oedema due to reduction in sub-bandage pressure can cause the fragile new tissue to break down. Patients should receive ongoing support and necessary aids to maximise concordance. Made-to-measure hosiery, corrective venous surgical intervention or monitored lifelong bandaging should also be considered. **Note: an accurate fit is essential in preventing painful accumulation of oedema or frequent ulcer recurrence[2,3].**

Reduced mobility

Reduced general or ankle mobility can significantly decrease the effectiveness of compression. Clinicians may consider offering patients an exercise rehabilitation programme. Elastic materials, capable of sustaining high pressures at rest, are thought by some clinicians to be more effective than inelastic materials[2]. In addition IPC should be considered for this group of patients.

COMPLICATIONS OF COMPRESSION

It is important that clinicians are aware of the potential side effects of compression, that they take appropriate measures to reduce any risks and act promptly should complications occur.

Pain

Pain has a major impact on a patient's ability to tolerate compression and a proper assessment, including noting pain scores/patient's diary comments and detecting any increase/change in pain sensation, is important[17]. Compression, when applied appropriately, should reduce pain. However, the introduction of effective compression may not alleviate pain initially and may cause anxiety and discomfort.

BOX 7 | Analgesic options[17]

- World Health Organization pain ladder for nociceptive pain
- Low-dose tricyclic antidepressants/ anticonvulsants for neuropathic pain
- Non-steroidal anti-inflammatory drugs (NSAIDs)

The following practical tips may be helpful:

- Ensure arterial status has been adequately assessed. Teach the patient to recognise critical changes, eg limb colour/perfusion. If PAD-related pain is present, refer to a vascular specialist and consider using mild to moderate inelastic bandaging with IPC. If the ABPI is <0.5 avoid bandages/hosiery and consider IPC and an urgent vascular review.
- Explain to the patient that discomfort during the first 1–2 weeks may occur and agree on an appropriate analgesic regimen for this period (Box 7). Introduce compression using a staged approach (see Figure 3, page 10).
- Visit frequently to support the patient, prevent bandage slippage and minimise painful effects of exudate. Apply a non-adhesive, non-sting primary dressing and treat infection, dermatitis or other painful conditions. Apply adequate absorptive padding to protect pressure points and minimise slippage.
- Encourage leg elevation and exercise to reduce painful oedema, but be aware that this may increase pain in a small number of patients.
- If pain remains uncontrolled, undertake a full reassessment. Refer for specialist intervention and, if available, to a pain team.

Pressure damage

Patients with impaired peripheral perfusion, thin or altered limb shape, foot deformities or dependent oedema (due to sitting for long periods) are at increased risk of pressure damage. Other risk factors include reduced sensation/pain sensation, long-term systemic steroid use and presence of a chronic disease (eg rheumatoid arthritis) associated with reduced mobility, loss of calf muscle and foot/ankle deformity.

The following practical tips may be helpful:

- Avoid strong, sustained compression and consider using inelastic systems and IPC.
- Apply extra padding over bony prominences.
- Ensure bandaging is not too tight and that overlap is even. 'At risk' areas include the ankle, dorsum of the foot and the calf.
- At each dressing change look for signs of pressure damage such as erythema, blistering or altered limb shape. If dependent oedema is present encourage limb elevation.
- Ask the patient if he/she is experiencing any discomfort.

APPLICATION TO PRACTICE

Inappropriate bandage selection or poor application technique may fundamentally alter a patient's attitude to compression

17. World Union of Wound Healing Societies (WUWHS). *Principles of best practice: Minimising pain at wound dressing-related procedures. A consensus document*. London: MEP Ltd, 2004.

BOX 8 | Suggestions for future developments

- **Compression systems** that
  - use waterproof, vapour-permeable, antimicrobial, lightweight and hypoallergenic materials
  - include sensors to detect sub-bandage pressure and other factors such as infection and exudate
  - enable self care and adjust to the patient's position/limb shape
  - provide variable levels of compression
- **Educational tools** that
  - are interactive and address practical problems
  - can be adapted for use in different countries
  - offer patient support and encourage better self care
- **Policies** that
  - aid better understanding of the importance of compression by healthcare providers
  - enable full reimbursement for all compression systems

Loss of calf muscle

Wasting of the calf muscles is a common problem for patients receiving long-term compression. It is likely to be due to reduced patient activity and underlying comorbidities or medication rather than as a direct result of the compression.

The following practical tips may be helpful:

- Ensure the bandage allows good knee and ankle mobility. When applying the bandage, ask patients to flex their ankle to 90 degrees or as near as possible, in order to allow optimal ankle movement.
- Ensure flat, comfortable shoes are worn to allow good ankle flexion.
- Encourage participation in an exercise and rehabilitation programme.

Skin problems

Skin problems, such as maceration/excoriation due to heavy exudate levels, dryness, itching, allergic or irritant eczema and erosive pustular dermatosis, are often associated with compression, topical preparations, or chronic inflammation due to the CVI.

The following practical tips may be helpful:

- Ensure adequate exudate control and use of appropriate primary dressings[16].
- Use a cotton stockinette liner or paste bandage against the skin to avoid irritation from wool padding.
- Moisturise the skin frequently with a simple emollient. Use a downward movement in the direction of hair growth to reduce the risk of folliculitis.
- Eczema – refer for patch testing. Consider treating with topical corticosteroids but be aware they are also potential allergens. Reduce the dose slowly to avoid risk of rebound eczema.
- Review all products being used if eczema or erosive pustular dermatosis occurs[18].

DIFFICULTY TOLERATING COMPRESSION

Some patients may have difficulty accepting compression due, for example, to its effect on factors such as work, bathing/showering or choice of clothing or footwear. Climate and cultural factors are also important considerations. All options should be explored with the patient (Figure 3, see page 10) and the compression system chosen should encourage concordance (Table 2). It is important that future developments in compression should focus on improving access to therapies that are both acceptable to patients and effective (Box 8).

Table 2 | Key practical considerations for delivering effective compression

The system chosen should…	Consider whether it:
…encourage safe and accurate application	✓ is the correct system for the patient's ankle circumference ✓ is easy to apply ✓ can be applied accurately and consistently by all those involved in care
…encourage patient comfort	✓ allows the patient to wear appropriate footwear and clothing ✓ is tolerable if the climate is hot/humid ✓ caters for cultural/religious factors and patient preferences ✓ is comfortable and conformable ✓ copes with exudate levels
…be capable of maintaining pressure and not slip	✓ is likely to stay in place until the next dressing change ✓ can be adapted to cope with limb distortion
…minimise the risk of side effects	✓ enables the patient to mobilise and achieve good ankle/knee mobility ✓ accounts for any patient allergies and uses hypoallergenic materials ✓ minimises risk of skin irritation
…be available and reimbursable	✓ is easily available and cost-effective ✓ if not reimbursable, is affordable by the patient

18. Dawn G, Loney M, Zamiri M, et al. Erosive pustular dermatosis of the leg associated with compression bandaging and fungal infection. *Br J Dermatol* 2003; 148(3): 489-92.

MEETING EVERYDAY CHALLENGES

CHALLENGE	GOAL(S)	PRACTICAL SOLUTIONS	OUTCOMES/ COMMENTS
Altered limb shape/tissue consistency Risk of uneven pressure distribution, tourniquet effects, pressure damage and further oedema	Ensure compression is safe and effective Reduce oedema distortion where possible	■ Reshape the leg with padding ■ Use adhesive or cohesive bandages to reduce slippage ■ Bandage frequently until oedema has reduced ■ Consider toe/thigh bandaging ■ In addition, consider IPC	**Leg shape normalised:** ■ Reassess ankle circumference and sub-bandage pressure **Slippage/distortion:** ■ Reassess adequacy of padding ■ Explore alternative compression systems **Ulcer heals:** ■ Made-to-measure hosiery
Difficult ulcer site	Ensure appropriate level of local pressure to the ulcer site	■ Apply extra padding if ulcer is over a bony prominence ■ Apply kidney-shape pads over ulcers behind malleolus	**No improvement:** ■ Reassess ■ Specialist intervention
Frequent ulcer recurrence when in hosiery	Maintain intact skin	■ Continue bandaging for a number of weeks (eg 2–6) following healing ■ Ensure correct size and strength of hosiery	**Continued recurrence:** ■ Lifelong bandaging ■ Ongoing assessment ■ Venous surgery/ligation
Reduced mobility	Promote good ankle and general mobility Ensure compression is effective	■ Consider elastic bandaging and IPC ■ Exercise and rehabilitation	**No improvement:** ■ Reassess ■ Specialist intervention
Complications of compression: ■ Pain ■ Pressure damage ■ Loss of calf muscle ■ Skin problems	Minimise complications	**Pain:** ■ Diagnose and treat cause ■ Consider a staged introduction of compression and appropriate analgesia **Pressure damage:** ■ Ensure correct pressure level and distribution ■ Avoid sustained strong compression ■ Consider inelastic systems and IPC **Loss of calf muscle:** ■ Ensure compression allows good joint mobility and appropriate footwear **Skin problems:** ■ Diagnose and treat cause ■ Ensure frequent bandage application and appropriate skin/wound care	**No improvement:** ■ Reassess ■ Specialist intervention
Difficulty tolerating compression, eg due to bandage bulk, lifestyle, climate or cultural factors	Find a treatment that is both acceptable and effective	■ Consider alternative compression system/style/colour ■ Limit bulk around the ankle/foot ■ Initial bandaging to reduce oedema, then strong compression hosiery and IPC (to reduce bulk and heat) ■ Self-bandaging/removal of bandages at night to enable skin care ■ Daily bandaging or a bandage protector to enable bathing/showering ■ Wearing of well-fitting knee high boots in winter has, on occasion, been found by some clinicians to aid compression treatment. Inclusion of insoles may alleviate foot oedema	**Unable to tolerate compression:** ■ Specialist referral ■ Surgical intervention ■ A combination of exercise, yoga and massage may be enough to reduce or eliminate the need for compression in early CVI

Figure 3 | Common challenges for clinicians in the use of compression therapy for venous leg ulcers. The essence of good compression therapy lies in regular reassessment, enabling early recognition of challenges and setting of realistic treatment goals

APPLICATION TO PRACTICE

Best practice in compression is not simply about the ability to apply a bandage to a limb. It involves choosing a system and applying it in such a way that takes into account the patient's individual requirements, the goal of therapy and the stage of treatment