Venous leg ulcer

Clinical education

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VENOUS LEG ULCER: Clinical education

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Venous Wound Education

Introduction

Venous ulcers account for 80-95% of all leg ulcers,[1,2,3,4] making them the most common leg ulcers in the developed world,[5,6] with an estimated prevalence between 0.06% and 2% of the total population,[1,3,4,5,7,8,9,10,11,12,13] with a 2.5% admission prevalence and a 2.2% one-year incidence in long-term care facilities.[5,14] Among persons over the age of 80, 15% have leg ulcers.[8] Ulcer duration is more than one year in over half of all venous ulcer patients.[1,9] Well over 50% of all venous ulcers are recurrent.[1,8,9,11,15] 61% of the venous ulcer patients in long term care facilities are wheelchair bound.[14]

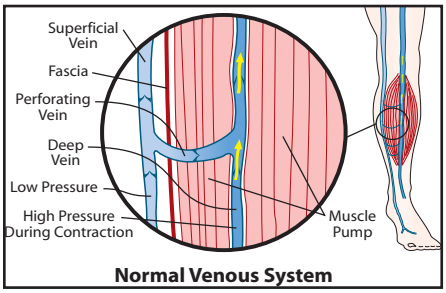
Once thought to be relatively painless wounds, research has revealed that venous ulcers often cause significant suffering and decreased quality of life for the patient.[1,7,16,17,18] In a survey of 94 patients with purely venous ulcers whose wounds did not appear to be infected, 90% reported leg pain.[16] 64% reported horrible or excruciating pain,[16] 64% reported that the pain disturbed their sleep[16] and 69% reported that pain was the worst thing about having a leg ulcer.[16,19] Nociceptive pain (due to sensation and inflammation) and neuropathic pain (due to dysfunctional or damaged nerves) are both associated with venous ulcers.[16,18]

Chronic venous insufficiency (CVI) is the accepted term for the fundamental health deficit that often leads to venous ulcers.[2,3,5,12] CVI increases with age due to decreased elasticity of the achilles tendon and accumulation of venous defects and comorbidities.[1,12,13] It is estimated that 6 million days of work are lost in the United States because of CVI,[13] and 5% of leg ulcer patients are completely unable to work due to their ulcers.[8] The total cost (direct and indirect) of CVI is estimated at $1 billion in each of three European countries: the United Kingdom, Germany and France.[20] District (community) nurses in the U.K. spend up to 50% of their time treating leg ulcers.[11] In Sweden, treatment of venous ulcers costs about €100/ week.[21] The average direct medical cost to treat one venous ulcer patient in the U.S. totals close to $10,000.[1,6,13] The annual direct cost of treating just the venous ulcer component of CVI in the U.S. has been estimated at $1 billion to $2.5 billion annually.[1,7,15,20,22]

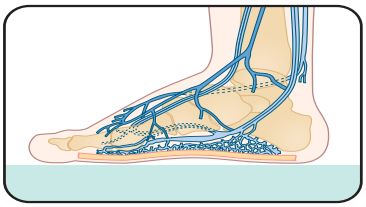
Because venous ulcers tend to recur, treatment includes helping patients identify lifestyle changes they are willing to make to prevent new ulcerations from developing.[15] Research-based leg ulcer interventions improve healing rates and decrease redressing frequency, markedly reducing the overall cost of leg ulcer care.[23,24] As our population ages and accrues more risk factors associated with venous disease, it is becoming increasingly important for all health care providers to learn how to manage patients with chronic venous insufficiency (CVI) to promote quick wound closure while decreasing wound pain and preventing recurrence.[6]

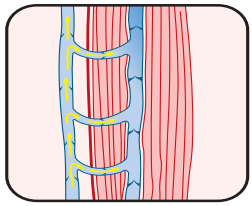
Background: Lower leg venous anatomy

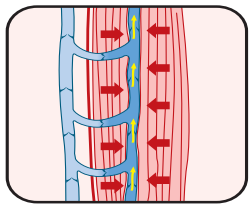
The lower leg venous system includes superficial veins and deep veins connected by communicating, or perforator, veins in a structure much like the rungs of a ladder.[1,7] Veins in all three parts of the lower leg system are equipped with one-way bicuspid valves that direct the blood into the deep system and towards the heart. Normal venous pressure when standing at rest is about 80 mmHg from the weight of the column of blood in the veins.[1] Blood is moved along the veins by the action of the extension of the foot with weight bearing and the contraction of the calf muscles.[1,3,4,12] When this "pump" causes the pressure to temporarily rise in the deep venous system, the valves in the perforator veins close, preventing backflow of blood and protecting the superficial system from excessive pressure.[3] The pressure within the deep system normally drops to less than 10 mmHg when the deep veins empty.[7,25] This sudden drop in pressure causes the perforator valves to open again to permit more blood to flow from the superficial veins into the deep veins and towards the heart.[1,7,17,25] Negative abdominal pressure from deep breathing augments the foot-leg muscle pump.[2,4]



Normal Venous System




Normal Veins – Relaxed


Normal Veins – Working

(Darker blue in these diagrams indicates higher pressures.

The deep system veins are surrounded by muscle.)

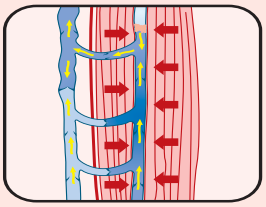
Chronic Venous Insufficiency

Causes

Research shows that "Venous Stasis" is not an accurate term for the pathology that causes venous ulcers[2] - there is actually increased blood flow in the area of the ulcers.[25,26] Chronic venous insufficiency is caused by venous hypertension, which in turn is caused by one of three pathologies related to failure of the foot/calf muscle pump mechanism and valve function.[1,4,7,12] Chronic venous insufficiency is classified by researchers using the exhaustive CEAP system. CEAP stands for: Clinical signs (graded 0-6), Etiology, Anatomic distribution, and Pathophysiological dysfunction. Active venous ulcers are C6.[7,20]

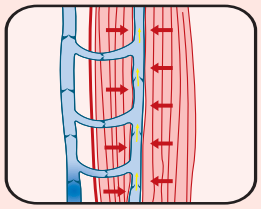
Clinical signs and symptoms typical of chronic venous insufficiency (CVI)

- aching[1,17,20,27] or heaviness of the legs[7,17,20,27]
- edematous lower legs,[3,7,17,20,27,28] especially at the end of the day,[1,7,15] and especially at the ankle.[2,7]
- spider veins or venous "flare" due to lower leg perforator vein incompetence (telangiectasia)[1,2,3,4,7,15,20,29]
- varicose veins[1,2,4,15,20,27,28]
- restless legs syndrome[17,20] or nocturnal leg cramps[2,17]
- venous dermatitis (venous eczema) and increased sensitization[1,2,20,27,28,30,31]
- brown staining from iron deposited into the tissues when red blood cells leak out of the veins and disintegrate (hemosiderin deposits)[2,4,15,29,30]
- sharply demarcated fibrotic skin on the lower third of the lower leg from impaired lymph flow, which creates an inverted champagne bottle look with woody hardness (lipodermatosclerosis)[1,2,3,4,15,20,27]
- areas of ivory colored sclerosis from white blood cells adhering to the capillary walls[26] (atrophie blanche)[1,3,4,15] which have decreased oxygen and nutritive flow,[4] making ulcers in the scarred areas extremely painful and especially slow to heal[1,20]
- ulceration[20,27] is the final sign of CVI



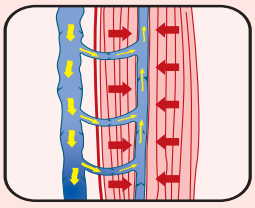
Deep Vein Thrombosis Superficial Hypertension

1) Obstruction of the veins[1,12,32] (usually thrombosis, but also from scarring, malignancy or increased abdominal pressure due to obesity, pregnancy, edema, congestive heart failure or ascites)[4,27]



Muscle Pump Failure

2) Failure of the muscle pump related to inactivity, paralysis, decreased ankle range of motion or disease[4,5]



Varicose Veins

3) Incompetent one-way valves in the veins,[5,12,27,32] which may be: congenital; from damage due to obstruction, trauma or infection; or from venous hypertension (varicose veins or prolonged Standing), which can dilate vessels so that the valve leaflets do not meet, permitting backflow.[1,4,7] Backflow can cause permanent damage to the distal valves, so even when the veins are no longer dilated, they remain incompetent.[1,4]

Darker blue in these diagrams indicates higher pressures.

Wider yellow arrows indicate increased blood flow.

The deep system veins are surrounded by muscle.

Venous dermatitis (venous eczema) from venous hypertension

Initially, patients may present with dry scaling,[2,30] and itching of the lower leg area.[1,2,20,27] Later, chronic inflammation may lead to thickened skin[3,4,30] with scales, red cyanotic-looking plaques[30] or itchy fissures.[30] Acute inflammation can cause the skin of the lower legs to develop red superficial painful and or itchy plaques, often with weepy crusts.[1,4,15,27,30]

Increased sensitization

Patients with venous dermatitis easily become sensitized to products utilized to decrease itching and dryness or infection because of increased skin permeability on the lower legs due to inflammation.[4,30] Residues from sensitizing agents may persist on the skin for weeks, creating the illusion that a subsequently applied product caused the sensitivity reaction.[31]

Skin breakdown and scratching due to itch caused by allergic reactions may lead to new ulcerations.[30] A retrospective analysis of studies in leg ulcer patients from 1975 to 2003 shows that prevalence of sensitization rose from 64% before 1990 to 72% from 1991 to 2003.[31] Hydrogels containing propylene glycol were the only modern dressings causing sensitivity reactions in venous ulcer patients.[7,31] Sensitivity to modern foam or silver dressings did not occur in any of the studies analyzed and is likely to be very rare.[31]

The most common sensitizers in 2003 were:	Other common sensitizers in patients with CVI are:	
• balsam of Peru[7,30,31,33] • lanolin[7,30,31,33] • fragrances and preservatives[7,30,31,33] • certain antiseptics and adhesives[31,33] • neomycin[31,33]	• Gentamicin,[7,30] • Various ointment bases[33] • Emulsifiers[30,33] • Additives in bandages[30]	• Elastane, nylon, or lycra in compression stockings,[34] • Latex,[7,33] • Dyes in compression hosiery,[7,33] • Benzocaine, antihistamine and steroidal creams[7,30]

Venous Leg Ulcers

Causes

It is thought that alterations in blood flow due to venous hypertension from CVI cause white blood cells to adhere to the walls of the smaller vessels of the lower leg.[20] The white blood cells may plug the vessels or leak from them and release tissue destroying enzymes and inflammatory mediators into the tissues.[1,2,4,15,17,20,25,35] Venous ulcers are likely caused by a prolonged and chaotic local inflammatory state induced by this aspect of venous hypertension.[17,25,35] Mild trauma can also precipitate venous leg ulcers in patients with CVI. Venous hypertension causes fluid to leak into the tissues; this edema compresses the capillaries, decreasing blood flow to the skin and increasing damage.[2,8,13] Chronic inflammation prevents venous ulcers from healing at the pace of acute wounds.[4,35,36]

Characteristics

95% of all venous ulcers are in the ankle or lower calf (gaiter area).[1,4,7,8,9,37] The medial ankle is by far the most common site because the long saphenous vein is more superficial and has the greatest curvature there and because this is the area of the highest pressure within the entire venous system.[1,4,7,15,37] Venous ulcers tend to produce copious exudate when uncompressed and are usually shallow, irregular, and often have a yellow fibrous bed.[1,2,4,7,8,13,15]

Risk factors for venous ulcers

As many as 41% of patients with venous ulcers have an increased tendency for blood to clot (thrombophilia), which is often a congenital condition.[5,11,15,37]

Other risk factors for ulceration include:

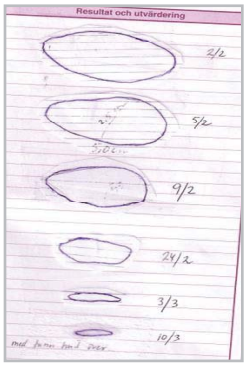
- history of phlebitis or deep vein thrombosis (DVT)[1,4,5,15,37]
- history of leg trauma, such as a fracture, but even minor trauma can cause vessel damage[1,4,7,15,37]
- vigorous exercise (which may cause microtrauma)[5,38]
- CVI or varicose veins in the patient or maternal family history[1,4,6,13,15,17,37,38]
- pregnancy, obesity or ascites, all of which cause increased abdominal pressure, femoral vein compression, and decreased mobility[1,4,7,15,17,27,37]
- multiple pregnancies[4,5,7,13,15]
- greater height, which increases venous system pressure[17]
- recent lower leg edema,[4,5] which may be caused by chronic heart failure[1,4,5,27] or medications[39,40]
- diabetes, which decreases skin health[5]
- increasing age, because valve damage is permanent and cumulative[4,12,15,17]
- poor calf muscle function or decreased range of motion (ROM) in the foot.[4,12,14,20,28] Standing or sitting for prolonged periods of time with the feet dependent dramatically increases susceptibility to ulceration.[1,4,7,11,14,15,17,28]

Treatment Goals

The patient's quality of life should drive all the decisions regarding his or her care.[11] Health care providers should educate the patient on the consequences of various treatment and lifestyle choices to arrive at a negotiated CVI management plan.[11] The plan usually includes: reducing edema and reversing skin changes by improving venous return, decreasing pain, increasing function, facilitating wound closure by improving systemic factors to promote wound healing and providing a wound environment conducive to healing and preventing ulcer recurrence.[1,4,15]

Assessment

Initial lab tests for venous wound patients should include nutritional parameters (CBC, Albumin and Prealbumin, HgbA1C, glucose), total lymphocyte count, kidney and liver function tests, ESR,[15] Hgb and Hct,[41] PT[15] and possibly homocysteine (Hcy).[42,43,44] The complete physical assessment should include a focused look at the lower extremities, noting abnormalities and asymmetry. Record BP, ABI (ABPI: Ankle-Brachial Index) and lower leg circumferences (see details below), pain and overall health history[15] (with medications) and weight with BMI.[45] Wound assessment includes size, tissue, margin, periwound skin and drainage.[5] Assess wound pain[45] and sensation so that a change can be noted. Wound duration and the history of previous wound treatments, recurrences and compression tolerance is also important.[15] Tracing the wound shape onto a transparent film (see photo) makes it easy for caregivers and patients to visualize wound size changes.[45]



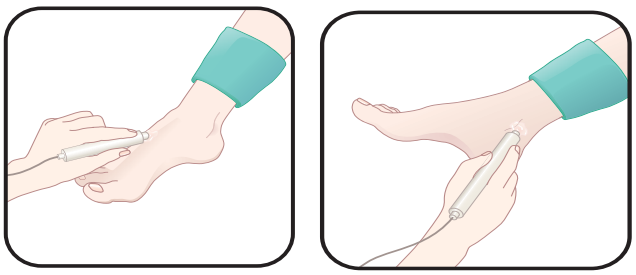
Assessing circulatory status

It is essential to assess a venous ulcer patient's circulatory status to rule out significant arterial insufficiency prior to treatment for CVI. Arterial insufficiency usually causes the lower leg to be cold and to hurt when it is elevated, while in CVI, legs are usually warm and pain is relieved with elevation. But, mixed disease is common, and assessing a patient's ankle-brachial index (ABI) using a hand-held Doppler is necessary prior to compression treatment for CVI.[46]

(Warning: Palpable pedal pulses are NOT proof that a patient has adequate circulation for compression, and the absence of palpable pulses does not always indicate arterial occlusion.[15,46,47])

Evaluating a patient's ABI (ABPI)

The ABI is assessed after the patient has been supine for 15 minutes.[48] Brachial blood pressures are taken on both arms.[48] Then the BP cuff is placed on the leg just superior to the ankle bone and the Doppler probe (using ultrasound gel) is placed at a 45-degree angle to the dorsalis pedis or posterior tibial artery.[48] The cuff is inflated until the Doppler signal is obliterated, then deflated slowly. When the Doppler signal returns, the number is recorded as the ankle systolic pressure. Each ankle's pressure divided by the higher of the two brachial systolic pressures gives that limb's ABI.[47,48,49]



Interpretation of ABI

An ABI of more than 1.2 indicates an invalid test due to non-compressible vessels.[45,50] In patients older than 70 and patients with renal disease or diabetes mellitus,[1,45] the ABI is also unreliable due to possible arterial calcification, so, further vascular testing should be considered to rule out arterial compromise in all of these patients.[5,48] An ABI of 0.9 – 1.2 is considered normal, and patients with an ABI>0.8 who are not in congestive heart failure can safely wear standard compression.[5,48,49] An ABI of 0.6–0.8 indicates mixed venous and arterial insufficiency, so low compression should be used cautiously and only after further medical assessment.[15,16,45,48,51] Patients with an ABI of less than 0.6 should not have any type of compression and require a referral to a vascular surgeon.[5,15,48,51]

Arterial disease may develop over time, so ABI's should be re-assessed every six months.[45]

Assessing edema

Lower leg circumferences should be measured at the widest point and at 2.5 cm above the malleolus.[45] It is important to rule out systemic and reversible causes of edema, such as medication reactions, heart or liver failure and low protein.[2] Usually patients with systemic causes of their edema have symmetrical swelling, while CVI produces some asymmetry.[2] Diuretics, medication change, or diet change will be needed with systemic causes of edema, but diuretics are not appropriate for primary CVI.[2] Suspect accompanying lymphedema, which will require additional treatment modalities, if skin at the base of the second toe is so thick that you cannot pick up a fold of it (Stemmer Sign).[2,7] Edema caused by lymphedema does not respond significantly to limb elevation. With standard compression, fluid from lymphedema may simply move to proximal areas.[4] Refer patients for testing to rule out lymphedema if edema does not improve despite elevation and compression.[4]

Biopsy

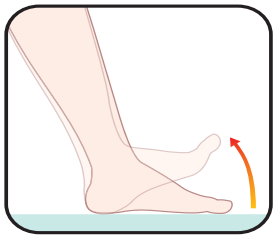
Although venous disease is the most common cause[5,7] of leg ulcers, it is by no means the only cause.[7,52] Sickle cell,[52] arterial insufficiency,[1,13] rheumatologic disorders,[13,53] cancer,[13] infection,[1] medication reactions,[54] vasculitis[1,7,13] and a host of other systemic illnesses can lead to leg ulcers which mimic venous ulcers but require different interventions.[1,21,55,56] It is important to note that the chronic inflammation in venous ulcers can cause them to degenerate into malignancy.[5,7,20] So, if there is no significant decrease in size or increase in granulation of the wound after six weeks of treatment as described in this protocol, a biopsy of the wound base and margin should be considered to confirm the pathology of the leg ulcer.[1,5,7,15,40,52]

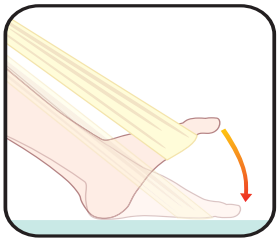
Management

Management of venous hypertension helps prevent venous ulcer formation and is the foundation of venous wound treatment.

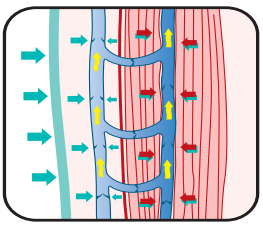
Elevation:[37]
Continuous bed rest with leg elevation will decrease edema from CVI, but this is rarely practical.[1] If at all possible, to decrease edema and increase white blood cell velocity, legs should be elevated above the heart level for 30 minutes, 3-4 times daily.[57] In addition, the foot of the patient's bed should be raised 15-20 cm (6–8 inches) if tolerated.[1,4,5,27,45,57]

Exercise:[37]
Standing or sitting for prolonged periods of time with the feet dependent should be avoided, as should vigorous exercise, but a daily walking program (30 minutes of brisk walking twice a day) should be encouraged to improve circulation and for quality of life.[1,5,15,28,40,45] Gait training and simple restorative exercises to increase the ankle joint range of motion and strength (see diagrams) address the underlying causes of CVI.[12,15,28,45,52,58] Increases in the depth of breathing during exercise aid in venous and lymphatic return.[2,4] Even nonambulatory patients can increase blood flow and decrease edema through passive foot/ankle/lower limb exercises and weight bearing with assistance.[4,15,59] Rocking in a chair, calf pump action while lying supine, and deep breathing all help with venous return.[2,15] In contrast, prolonged standing or sitting, wearing high heels and crossing of the legs reduces venous return.[15]


Every hour, do 30 foot raises


Every hour do 30 foot extensions

Compression: The cornerstone of chronic venous insufficiency therapy is graduated lower leg compression.[1,4,15,37,48,59] Graduated compression increases the blood flow velocity and lymph drainage, so it works on the most probable cause of the venous ulceration (leakage of injurious substances from the vessels) as well as decreasing superficial venous system pressure and reducing edema.[1,4,20] The reduction in venous hypertension and edema that compression affords results in decreased leakage of exudate and increased cutaneous blood flow.[1] Valves that are not touching because of venous distension are pushed back into approximation by compression.[1,20] Compression enhances fibrinolysis and may improve lipodermatosclerosis.[1,4,13,48,60] Patients who wear graduated compression consistently have significantly improved healing rates and decreased recurrence rates.[1,15,61] Many also report relief of venous pain.[13,18,32] Compression for life is essential to prevent recurrence.[1,5,15,27,38,48,52] Two basic types of compression systems are used for treating chronic venous insufficiency: elastic and inelastic. Research has not shown the superiority of any one system of high graduated compression over the others.[48,61,62]


External Compression Vein Support

Specific methods of applying graduated compression are discussed on pages Sec 1:8-9.

Medication and co-morbidity management: Patients may need alternatives to medications that cause edema, such as certain hormones, antihypertensives, NSAIDs and COX-2 inhibitors.[39,40] Monitor PT times and anticoagulant therapy.[15] Diabetic patients should control glucose levels.[37] The oral medication pentoxifylline, which improves blood flow in the small vessels, is an effective adjunct in treating venous ulcers and should be added if needed.[3,4,7,13,15,52,63,64]

Weight loss: A weight reduction program is advisable for obese patients,[5,15,27,40] and bariatric surgery may be indicated for super-obese (BMI>60) venous ulcer patients.[65]

Avoid vasoconstriction: Vasoconstriction decreases peripheral blood flow. Causes of vasoconstriction, such as cold environment, dehydration, stress, pain,[5,52] and cigarette smoking should be eliminated.[4,5,15,37,40,52]

Pain control: Pain in venous ulcers is usually caused by tissue damage and the resultant inflammation.[66,67] Inflammation leads to more pain, even with usually non-painful stimuli, by exciting the nociceptors.[67] Pain causes decreased mobility, which causes increased ulceration, which causes more pain. Pain causes a stress reaction,[14,68] which increases the risk of ulcer infection[14,40,69] and creates another destructive cycle because infection is a major cause of pain.[67,70]

Great gains can be achieved by breaking these pain cycles. Controlling excessive activities of inflammatory mediators may reduce wound pain and enhance healing.[67] PolyMem and PolyMem Silver wound dressings are not only atraumatic to the wound bed when applied and removed, they also help inhibit the nociceptor response at the wound site,[71,72] which can decrease both pain and the additional inflammation caused by inflammatory mediators.[72,73,74]

Assess location, intensity, quality, and duration of pain, as well as pain precipitators and pain relievers.[5] Negative pressure therapy has been associated with increased wound pain[60,67] and some dressings cause burning on contact with wounds.[18,50] Cooling the ulcer during dressing changes is painful and should be avoided.[18] Manage pain with leg elevation and compression,[15] PolyMem dressings,[71,72,74,75,76,77,78] analgesics, relaxation, etc.[5]

Improve nutrition:[15,27,37]
Protein deficiency can result in leg edema.[41] Adequate levels of protein, vitamin A, vitamin C and zinc are needed for wound healing.[5,40,79] Wound patients require 25–35 kcal/kg/day with 1.0–1.2 g/kg/day protein.[79] Delayed healing due to corticosteroid use can be counteracted with 25,000 IU per day of vitamin A for 10 days.[80] Supplementation should be individualized: adding zinc or vitamin C in patients without deficiency does not improve wound healing[15,52] and too much zinc or vitamin A can even impair healing.[79] Initial studies show that the slow healing of almost 50% of all chronic leg ulcers could be due to elevated levels of the amino acid, homocysteine.[42] Appropriate supplementation with high amounts of vitamins B6, B12 and folic acid returns the levels of homocysteine to normal, dramatically improving healing and preventing recurrence of leg ulcers in the affected individuals.[42,43,44]

Venous dermatitis skin treatment: Due to the risk of sensitivity, legs should be washed with warm water only.[33] Resist skepticism when patients cite a long list of allergies.[33] Patients need to use emollient creams, but they should be encouraged to read the labels.[33] Keeping the treatment simple minimizes the risk of sensitization.[33] Petroleum jelly (paraffin) alone is less likely to cause reactions than most other emollients.[15,33] Apply creams in the direction of hair growth to prevent entry into hair follicles.[33] Use 100% cotton, either as a wrap or as a tubular bandage, under compression wraps.[33] Avoid adhesives in bandages under wraps, since they cannot easily be removed and may sensitize.[2,33] Venous dermatitis may require treatment with measured amounts of topical corticosteroids (Note: sensitivity maybe an issue in some patients).[33] Emollients may enhance a corticosteroid's effectiveness.[33] Treat weeping eczema with topical corticosteroids, emollients, antiseptics and/or astringent agents.[37,58] Compression may need to be abandoned temporarily if severe dermatitis warrants twice daily treatment.[33] PolyMem dressings can help decrease inflammation[72] and control exudate from weeping due to venous dermatitis.[81]

Surgery: Grafting or venous surgery should be considered for wounds that do not heal with appropriate wound care.[7,38] Recent, novel minimally invasive vein surgery (MIVS) techniques such as radiofrequency ablation, endovenous laser, and foam sclerotherapy are less expensive and less risky than previous surgical treatments to correct venous hypertension; some can be done in the doctor's office.[2,82,83,84] Surgical correction of the venous reflux may not improve venous ulcer healing rates, but it dramatically reduces the recurrence of ulcers and should be considered in ulcer patients with superficial venous insufficiency using compression bandaging.[5,11,27,45,82,84,85] The best surgical candidates are patients with sufficient mobility to activate the calf muscle pump, BMI<30, and predominantly superficial or perforator venous incompetence (this includes 50% of venous ulcer patients).[11,17,27,82] Duplex scanning locates the venous system abnormalities.[15,20] Patients are advised to continue wearing compression following surgery.[11,62] Although skin grafting can temporarily close clean wounds,[3,5] grafted wounds tend to recur unless the underlying venous disease is treated surgically, even if the patient uses compression hosiery.[2,13,15,52] Homocysteine levels should be checked and, if abnormal, corrected with supplements prior to expensive interventions.[42]

Venous Wound Infections

Surface wound contamination is common to all venous wounds.[15,86] Wound infection has recently been redefined as multiplication of invasive microorganisms in viable wound tissue resulting in abnormal effects or tissue injury.[86,87] Chronic wound infections are now divided into two categories: superficial and deep.[50,86] Systemic antibiotic treatment is usually reserved for deep infections.[1,6.50]

Superficial venous wound infection (increased bacterial burden)[50] signs and symptoms include:

- delayed healing despite appropriate compression therapy[1,40,50,70,86,89]
- abnormal, friable or absent granulation tissue[5,40,50,70,86,89]
- change in quantity,[50,89,90] viscosity[89,90] or odor of drainage[40,50,86,89,90]
- increase or change in ulcer pain[1,5,40,50,70,86,89]

Deep wound infections may also cause:

- pain, warmth, redness and swelling of the surrounding skin[5,50,70,86,89]
- newly formed ulcers or wound bed extension within inflamed margins of pre-existing ulcers[50,86,89]
- ulcer enlargement[40,50,70,86,89]

Assessing infection in venous ulcers is extremely difficult. Sensitivity reactions may look like infection. Venous leg ulcers may have inflammation, induration, swelling, pain, warmth, foul odor, copious drainage and tenderness to touch without being infected.[90,91] A change in sensation around the wound may be the only sign of infection in immunocompromised patients.[5,70,86]

Quantitatively evaluated swab specimens gathered using the Levine technique are effective for determining treatment for venous ulcers.[15,50,86,92,93] Before gathering specimens using the Levine technique, cleanse the ulcer very thoroughly with warm non-bacteriostatic saline. According to the Levine technique, a swab should be rolled on its side for one full rotation in a 1 cm^2 granulating area of the ulcer with enough pressure to extract fluid from the tissues.[5,50,86,87,92,93]

Wound bioburden (total number of organisms) is not directly related to healing outcome in clinically noninfected venous wounds.[94] But, more than four species on culture is associated with non-healing.[40,86,94] Beta-hemolytic Streptococcus is a threat in wounds even if the numbers are relatively low.[86]

Improving the resistance of the host by restoring blood supply and tissue oxygenation, improving nutrition, maintaining glycemic control, reducing edema and protecting from injury helps manage bioburden.[50,86] Topical antibiotics may cause sensitivity reactions,[37] so silver dressings are a good choice for

topical bioburden reduction, with the usual duration being two weeks.[5,15,37,40,52,86,95,96] Silver that leaches into the wound bed may delay healing.[42,86,97] PolyMem silver dressings pull exudate into the dressing and kill the microbes there, rather than disseminating silver into the wound bed.[97] If wound healing remains stalled despite appropriate treatment as outlined in this protocol or there is evidence of infections spreading beyond the wound edge (cellulitis) or deep in the wound bed, cultures should be used to guide the choice of a 2–4 week course of systemic antibiotics.[5,15,37,45,50,52,86,87,91] If there is still no significant improvement after six weeks of treatment as described in this protocol, a biopsy of the wound base and margin should be evaluated to verify the patient's diagnosis.[1,5,15,40,52] If a wound probes to bone, osteomyelitis must be ruled out.[6,50,86,87]

Dressing Considerations

Chronic wounds heal by different mechanisms than acute injuries.[98] Unlike in acute wounds, in chronic leg ulcers inflammation is not required for wound repair and may in fact be detrimental.[98] Rate of healing in venous ulcers is most closely predicted by venous ulcer size,[2,21,22] duration of wound,[15,22,99] healing edges[15,22,99] and periwound fibrosis.[15,22,99] Edge stimulation (which leads to healing edges) is intrinsically linked to wound moisture balance.[40] Presence of yellow fibrin does not interfere with venous ulcer healing.[2,99] Manual wound cleansing or rinsing at dressing changes can slow healing by cooling the wound bed and by damaging newly formed tissues.[100,101]

PolyMem wound dressings help heal venous ulcers by:

- absorbing excess wound fluid and helping create an ideal moisture balance in the wound bed[102,103]
- decreasing wound inflammation and pain directly through nociceptor inhibition[72,73,78]
- continuously cleansing the wound bed of contaminants such as slough or debris which may cause a local inflammatory response[76] often eliminating the need for manual wound cleansing at dressing changes[76,77,104,105]
- locking fluid into the dressing to help prevent maceration, even under compression[102,105]

When closed, non-healing edges are a particular problem (epibole), often pressing PolyMem or PolyMem Max against them (see photo examples and diagram on the right) for a few days will stimulate the edges and activate epithelization.[71,106] Dressings should be changed daily during this time. As soon as cell migration from the wound edges is visible, the pressure should no longer be applied. Applying pressure to dressings can erode fragile granulation tissue and is not recommended long-term. If seven days of this treatment does not resolve the epibole, surgical intervention may be required. When cell migration from the wound edges is visible, begin dressing the wound as indicated by this protocol.

Compression

Wound care clinicians are accustomed to thinking of treatments as temporary inconveniences until a wound is closed, but successful venous ulcer patients recognize that compression for CVI will be a permanent necessity. The patient may decide that wearing dress shoes to a wedding is more important than rapid healing, or that a daily bath is more important to them than ideal graduated compression.[107] This should not be interpreted as a rejection of all treatment or as disregard for the wisdom of the health care provider. Compression hosiery may be more acceptable to patients than bandaging, especially because feminine or special work footwear becomes an option when hosiery is worn.[107,108] Patients are more likely to consistently wear Class II rather than Class III hosiery.[15,48] Including patients in the care planning and decision making team improves venous ulcer outcomes.[45,50,51,109,110] PolyMem dressings, which help decrease pain and inflammation and promote brisk healing of venous ulcers, meet the needs of both patients and providers. Providers who inform patients of appropriate treatment choices (including medications, dressings, compression and surgery to prevent recurrence), and allow patients to choose their level of inconvenience and discomfort are most likely to develop a negotiated treatment plan patients will consistently follow.[11,50]

Overview

Optimal graduated compression for CVI treatment is 40 mmHg at the ankle, tapering to 12-18 mmHg at the knee.[37,58] Higher compression levels may be indicated if lymphedema is present and lower compression levels are necessary in patients with mixed etiology wounds, including both chronic venous insufficiency and moderate arterial insufficiency.[4] Carefully follow manufacturer's instructions when applying commercially prepared wraps.[58] Laplace's law says the area of smaller diameter (the ankle) will experience greater pressure than the area of larger diameter (the calf) with the same amount of tension and overlap.[4,58] Extra padding should be applied to uneven areas to achieve more consistent graduated compression.[1,4,58] Compression should not extend into the smaller diameter area of the leg just below the knee, because, as Laplace's law demonstrates, this would create an area of higher pressure (reversing the gradient from what is desired).

Patients should be warned to contact the provider immediately and remove the compression if they notice numbness, tingling, increased pain or dusky toes.[4,37] Injury due to inappropriate compression can lead to amputation or even death.[4,8,111] If appropriate graduated compression leads to swelling in the thigh or groin, this indicates that the patient has significant accompanying lymphedema, which will require specialized treatment.[2] Patients may need to be seen twice weekly when compression is first used to assess the wound and the patient's tolerance of the compression, especially if the edema is very painful or if the wound is highly exudating.[109] Once the edema is reduced, the pain and exudate should decrease and weekly changes are appropriate.[109] Compression is contraindicated in patients with decompensated congestive heart failure or severe arterial insufficiency.[48,60,108]

Inelastic (rigid) compression systems provide relatively rigid support, giving little pressure at rest and high pressure with muscle contraction against fixed resistance.[1,32,62] Examples are short stretch bandages, Unna's boot or modified Unna's boot.[1,48,109] The patients' legs should be elevated or elastic bandages can be used to decrease edema prior to initial application of inelastic compression. No compression is applied with application – graduated compression occurs when the calf muscle fl exes against the rigid dressing, or when the foot pump is activated by stretching (usually with weight bearing).[58]

Application of short stretch bandages requires training and skill. Short stretch bandages are now available with a series of hook and loop straps, simplifying application and permitting patients to remove the compression for bathing.[4,32,62] Short stretch systems often begin at the ankle, enabling the patient to wear normal footwear.[48] They work well with thin ankles (less than 18 cm) and with edematous feet and they are often well tolerated in patients with decreased muscle tone and significant pain.[48] The bandages may be washed and reused several times to decrease treatment costs.[48] Short stretch bandages tend to be much more comfortable than elastic bandages because of their low resting pressure. They are suitable for patients with ABI >0.6.[62] After the patient's edema and pain levels have decreased using short stretch bandaging, it is possible multi-layer elastic bandaging will then be tolerated.[58]

The Unna's boot is a paste bandage impregnated with zinc oxide, glycerin, gelatin, and sometimes calamine, applied without tension with the foot at a 90-degree angle to the leg.[5,58] This is usually covered with an elastic wrap and dries to form a rigid cast.[5,58] A cohesive elastic outer bandage is sometimes added to an Unna's boot.[58] An Unna's boot is ideal for patients with dementia who wander and will remove other types of compression. Boots are usually changed once a week, but when edema is rapidly diminishing, they need to be changed more frequently (boots cannot adjust to the decreasing diameter of the leg).[5,109] Unna's boots are as effective as multi-layer compression devices[112] except in patients who cannot support their own weight, even with assistance, because at least passive activation of the foot or calf muscle pump is required to apply compression against the rigid boot.[62,109] Unna's boots are preferred over elastic compression systems for ambulatory patients with mixed arterial/venous leg ulcers (ABI 0.6–0.8).[58]

Elastic compression systems have high pressure at rest and somewhat less pressure with muscle contraction. More significant CVI requires increased graduated compression.[58] Multi-layer wraps, tubular compression devices and USA Class III hosiery all provide high-level graduated elastic compression (40 mmHg at the ankle, 17 mmHg at the knee), which increases healing rates.[11,37,62,108,112,113] Compression at these levels increases the blood flow velocity and reduces

edema.[62] Four-layer wraps tend to be bulky. Multi-layer bandages are intended for use in patients with ankle circumferences between 18 cm and 26 cm measured at 2.5 cm superior to the medial malleolus.[45] They must be correctly applied to provide the appropriate level of compression.[58] An additional layer of the third component can be added to four-layer wraps for ankles of larger diameters to increase the total amount of compression. Not all patients can tolerate four-layer wraps.

Graduated compression stockings (hosiery) are recommended as maintenance therapy to prevent ulcers.[5] These stockings are relatively expensive,[5] so they are not usually recommended for initial compression because a custom fit is required and as the edema decreases, the size needed will change. Legs must be measured individually, since on some patients the size differences between limbs may be significant.[111] Compression hosiery may need to be custom-made in patients with significant lower leg deformity from venous disease. Thigh-high hosiery has not been found to be superior to knee high for CVI unless the leg has a deformity.[15,34] Stockings do not always provide the graduated compression the labels claim they will give.[28]

Advise patients not to fold the stocking over at the top, as having two layers increases compression.[34] Two pairs of stockings should be purchased so that one can be handwashed and air-dried while the other is worn.[5] Stockings lose stretch through use, so they should be replaced every 3–6 months.[5,13,34] Stockings should be removed before bathing at night and be replaced in the morning before the patient rises from the bed (before edema has a chance to develop).[5,58] Apply non-sensitizing (see table on page 3) 24-hour moisturizer after bathing to be absorbed by the skin during the night to prevent itching from dryness.[5] Ankle and knee flexion exercises are advisable even with the use of graduated compression stockings.[28]

Graduated compression stockings may be very difficult to put on. Applying a silk bootee or other device first to decrease friction, or using a frame over which the stocking is stretched may help.[58] Stockings with zippers and twopiece stockings (separate foot and leg pieces that overlap at the ankle) are also available.[5,48] Two layers of Class I hosiery produce higher resting pressures than a single class III stocking and may be easier to put on.[48,114] Another option is a low compression liner with a higher compression overstocking.[48,108] In either case, the patient can take the outer stocking off at night.[108] The patient may, however, find the increase in stiffness caused by the friction between the two layers to be unacceptable.[114] Orthotic compression devices using Velcro are another option.[4]

Single-layer elastic (long-stretch) wraps do not provide graduated compression and are not recommended.[4,112] Antiembolic stockings and standard support hose are not appropriate for patients with CVI.[15,39] Multilayer bandaging systems more effectively maintain the leg's volume.[5] In general, high and multi-layer compression is more effective than lower compression or single layer wraps.[32,48,112] Patients with a significant arterial component to their disease (ABI<0.8) must use modified levels of compression.[1,51,52] But, the most supportive compression the patient will tolerate should be applied consistently when treating venous ulcers without accompanying arterial disease.[7,15,52]

A pneumatic compression pump is an alternative to provide compression in the home for patients who do not tolerate other methods of compression or do not have ankle mobility.[1,5,15,52,58] Compression pumps must not be used in patients with edema from congestive heart failure, active phlebitis, wound infection or active deep vein thrombosis.

The Venous Ulcer Treatment Process

Assess

Initial assessment includes history and head-to-toe physical, labwork (see page Sec1:4), BP, weight with BMI, lower leg circumferences, wound assessment, pain assessment and ABI. If the history and physical assessment indicate that the patient has renal disease, diabetes, a systemic cause of edema or is over 70 years old, or if the ABI is >1.2, further vascular studies should be performed and used to guide decisions concerning the patient's appropriate level of compression.

Document

The parameters of lower leg circumferences, wound size, wound tissue, wound pain/sensation, wound margin, periwound skin, and quantity and quality of drainage should be reassessed and documented weekly.[15] Facilities should adopt a uniform system for measuring wound dimensions, such as the longest length and width perpendicular to one another.[115] A food storage bag has two layers, so it is easy to trace the wound with a permanent marker and then discard the layer that came in contact with the wound. If facility policy permits, photocopies of the tracings can be easily placed in the medical record.[5,45] Viewing serial tracings can encourage patients to continue difficult treatment, because progress is tangible.[116] Color digital photographs are also useful, particularly if multiple clinicians treat the patient.[5]

Cleanse

The majority of uncomplicated venous ulcers have relatively little necrotic tissue on the wound surface and do not require debridement.[7,40,45] If there is significant devitalized tissue, initial sharp debridement may be performed.[13,37,40,66,117] Slough is not an indicator of infection.[92] Allowing fibrin to remain in the wound bed at dressing changes does not slow healing in venous ulcers,[2,99] but damaging the wound bed during cleansing increases susceptibility to infection.[60] Topical bactericidal or antiseptic agents are not recommended.[5,15,86] Surfactants, such as that found in PolyMem dressings, are recommended for cleansing wounds with a lot of surface debris because they break the bonds that attach wound contaminants.[15,52,86]

Solutions used to wash the wound at dressing changes may be cooling and cause pain.[18] Autolytic debridement, which is supported by PolyMem dressings, is the method for debriding venous ulcers with the strongest evidence base,[7,38] and was found to be as effective as enzymatic debridement in venous ulcers.[118] Autolytic debridement is safe and virtually painless.[119,120] When autolytic debridement is utilized, auxiliary staff, patient and family members should be educated to expect an increase in wound fluid, which may be pale yellow or greenish without cause for alarm.[86,121,122] In contrast, infection produces pus that is thick and recurs within one hour of wound cleansing.[86]

Cover

Wound care experts agree on the characteristics of an ideal dressing. PolyMem® QuadraFoam® dressings are unique in meeting 100% of these documented criteria for an ideal venous ulcer wound dressing.

Considerations in selecting a dressing:

Number of days it can remain in place:[60,90,101]
Frequent dressing changes slow healing by disturbing the wound unnecessarily.[101] Frequency of dressing changes and cost-effective use of materials both affect overall treatment costs.[60] Purchase price of the dressing applied is not an indication of cost effectiveness of a particular method of wound care for venous ulcers.[123] Clinicians report that PolyMem dressings are extremely cost-effective because of their long wear time, brisk healing, cut-to-fit feature and decreased necessity of wound cleansing at dressing changes.[76,103,104,105,124,125]

Reason for change or removal:[60,90]
Some foam dressings are firm with a steep edge that can cause pressure erosions or new ulcers under compression.[126] PolyMem dressings are comfortable for patients and have soft flexible edges.

Ease of use:
Application,[60] maintenance,[60] and removal (intact and atraumatic).[60,90]

Ease of teaching caregiver:[60,103]
Because PolyMem dressings contain a built-in wound cleanser, which minimizes the need for wound bed cleansing, often caregivers or even patients can change the dressings themselves.[76,103]

Patient comfort:
Patients consistently report that PolyMem dressings are extremely comfortable because the dressings are flexible enough to conform well, they are atraumatic and they often provide dramatic drug-free pain relief.[76,100,102,127]

A PolyMem QuadraFoam wound dressing should be applied to the venous ulcer prior to application of compression to obtain all of the benefits of an ideal dressing.[76,77,78,81,102,104,124]

For more complete information on Requirements of an Ideal Dressing, see Sec5:1.

Compression: The cornerstone of chronic venous insufficiency therapy is graduated lower leg compression.[1,4,15,37,48,59] Graduated compression increases the blood flow velocity and lymph drainage, so it works on the most probable cause of the venous ulceration (leakage of injurious substances from the vessels) as well as decreasing superficial venous system pressure and reducing edema.[1,4,20] The reduction in venous hypertension and edema that compression affords results in decreased leakage of exudate and increased cutaneous blood flow.[1] Valves that are not touching because of venous distension are pushed back into approximation by compression.[1,20] Compression enhances fibrinolysis and may improve lipodermatosclerosis.[1,4,13,48,60] Patients who wear graduated compression consistently have significantly improved healing rates and decreased recurrence rates.[1,15,61] Many also report relief of venous pain.[13,18,32] Compression for life is essential to prevent recurrence.[1,5,15,27,38,48,52] Two basic types of compression systems are used for treating chronic venous insufficiency: elastic and inelastic. Research has not shown the superiority of any one system of high graduated compression over the others.[48,61,62]

For more complete information on compression, see Sec1:5 & Sec1:8-9.

Venous Ulcer Treatment Protocol
(Text Summary)

1. Assess and document: Initial assessment includes history and head-to-toe physical, labwork (see protocol Sec1:4), BP, weight with BMI, lower leg circumferences, wound assessment, pain assessment and ABI's (ABPI's: Ankle-Brachial Pressure Indexes: for step-by-step instructions, see protocol Sec1:4. If the history and physical assessment indicate that the patient has renal disease, diabetes, a systemic cause of edema, or is over 70 years old, or if the ABI>1.2, further vascular studies should be performed and used to guide decisions concerning the patient's appropriate level of compression. At least once a week (twice a week for the first two weeks, if possible), pain, wound, and lower leg circumferences should be assessed and wounds should be measured traced and/or photographed according to facility documentation standards.

2. Educate the patient about CVI so that they can participate in long-term planning.[45,51,110]

a. Teach prevention as described in the Management section, Sec1:5.

b. Inform the patient and family that debridement (sharp or autolytic) removes tissue that slows healing, so initially the wound may appear larger, because this tissue was hiding the true size of the wound.

c. Differentiate between slough, exudate from autolytic debridement and true infection.[60,86,121] Autolytic debridement produces liquefied slough that is pale yellow or greenish.[121] Infection produces pus that is thick and recurs within one hour of wound cleansing.[86]

d. Patients should be warned to contact the provider immediately and remove the compression if they notice numbness, tingling, increased pain, or dusky toes.[4,37]

3. Initial wound bed preparation: Ideally, rinse with warm saline. Not all wounds require debridement.[45] If the ulcer is filled with adherent fibrous or necrotic material, initial sharp debridement is recommended, if possible. PolyMem wound dressings will facilitate autolytic debridement.

4. Choose the method of compression that will be used. Some prescribers greatly prefer one type of compression over the others. The most important aspect of compression is that the patient wears it.[48,61] What the patient is willing to tolerate may change over time.[58] Partner with the patient.

a. Inelastic compression: An Unna's boot is ideal for patients with dementia who wander and will remove other types of compression. It is less useful in less ambulatory patients and contraindicated in patients who cannot bear weight on their feet. It will need to be changed more frequently than weekly if edema is rapidly diminishing (it cannot adjust to decreasing diameter of leg). Unna's boots can be used with caution in patients with moderate levels of arterial insufficiency (ABI 0.6–0.8).[51,59] A flexible cohesive outer wrap is sometimes added to an Unna's Boot. Short stretch bandages are another popular inelastic dressing choice.

b. Multiple-layer wraps must be applied correctly, may be bulky and are usually changed weekly. Patients must have an ABI>0.8 for standard multiple layer wrap therapy (40 mmHg). Modified lower compression wraps (15–25 mmHg) are available for patients with ulcers of mixed etiologies.[51]

c. Hosiery must be sized correctly, so this is not useful in patients whose edema is diminishing (newly compressed).[48] Hosiery is expensive initially, but it is reusable for 3–6 months. Hosiery is ideal for established patients who want to wear normal footwear, bathe, etc. and are compliant. Since the patient can remove hosiery, it is important that they be willing and able to put it back on, as well.

d. No compression should be initiated until the patient's ABI results are available. If the ABI's indicate significant arterial insufficiency (ABI<0.6), compression must not be applied at all (mixed etiology wound). Patients with extreme discomfort may not be able to tolerate compression. In cases where compression is clinically contraindicated or is not used by patient choice, the wound may have a high level of exudate, necessitating more frequent dressing changes.[90] PolyMem Max should be used on uncompressed venous/mixed ulcers. Some patients are better able to tolerate compression after PolyMem dressing treatment has helped decrease their pain.

5. Dress wounds according to the expected quantity of exudate. Initially, this could be copious, but exudate usually decreases quickly as compression decreases edema and as dressings establish granulation in the wound base. If exudate quantity is unknown, assume that it will be a large amount and do an initial dressing change after a maximum of three days.

a. For large amounts of exudate, use PolyMem Max under inelastic compression, hosiery or in patients who are not currently using compression. Under multiple layer compression in highly exudating wounds, PolyMem Wic alone is also a good dressing choice, because the inner-most layers of compression will absorb excess exudate.

b. For moderate or small amounts of exudate or weeping venous eczema, use PolyMem dressings under the preferred method of compression.

All PolyMem dressing types are also available in silver for when antimicrobial benefits are desired.

6. Dressing changes should be quick and easy – do not routinely cool the wound bed or risk injury to it with manual wound bed cleansing or rinsing. Just remove the PolyMem dressing, assess the wound (including pain) and take a photo if facility policy permits (with a ruler in the frame), place a new PolyMem dressing on the wound and apply compression again. Appropriate periwound skin care (washing the lower leg with plain water and applying moisturizer) may be needed.

7. Restorative exercises should include ankle flexions 5–10 times every few minutes for 1–2 minutes every 30 minutes throughout the day, (see diagrams Sec1:5)[15] plantar flexions and tiptoe exercises, and/or brisk walking 30 minutes twice a day when possible.[15] Non-ambulatory patients may be able to exercise by rocking in a chair vigorously several times a day.[15]

8. Assess for causes of delayed wound healing

a. Suspected Infection: Use Silver versions instead of the recommended PolyMem dressing types for two week intervals in stalled wounds and/or in wounds that have superficial increased bioburden.[50,77,81,102] Consider sharp debridement if large amounts of non-viable tissues are present in the wound bed.[50] PolyMem Silver dressings are appropriate for use on wounds which appear to have deep infections (including cellulitis or osteomyelitis), but these deep infections should be considered for treatment with systemic antimicrobials.[50] PolyMem Silver dressings may also be used long-term for their antimicrobial benefits in immunocompromised patients.[50]

b. Epibole: If the wound edges are closed, rolled and not advancing, place a large piece of PolyMem or PolyMem Max over the wound with a piece of rolled gauze smaller than the wound over it to press the PolyMem or PolyMem Max against the wound edges (see photos and diagram section, Sec1:7) for a few days will stimulate the edges and activate epithelization.[71,106] Dressings should be changed daily during this time. As soon as cell migration from the wound edges is visible, the pressure should no longer be applied. Applying pressure to dressings can erode fragile granulation tissue and is not recommended long-term. If seven days of this treatment does not resolve the epibole, surgical intervention may be required. When cell migration from the wound edges is visible, begin dressing the wound as indicated by this protocol.

c. Other problems: If there is no significant improvement after six weeks of treatment as described in this protocol, a biopsy of the wound base and margin is indicated to confirm the pathology of the leg ulcer.[1,5,7,15,40,52]

d. Arterial disease may develop over time, so ABI's should be re-assessed every six months.[45]

Venous Ulcer Treatment Procedure

Goal: The desired outcome of this procedure is to maximize healing while minimizing recurrence, complications and pain associated with venous ulcers. Interim goals include: reducing edema and reversing skin changes by improving venous return, decreasing pain, increasing function, facilitating wound closure by improving systemic factors to promote wound healing and providing a wound environment conducive to healing. Implementation of this protocol should result in significant cost savings due to a diminished incidence of venous ulcers and shorter venous ulcer treatment times. Treatment costs should also be reduced.

Equipment:

- Clean gloves
- Impervious disposable bag
- Disposable ruler
- System for tracing the wound and/or digital camera, depending upon facility documentation standards
- Compression system suitable for the patient, unless contraindicated
- PolyMem®, PolyMem Max® or PolyMem Wic® Wound Dressing (standard or PolyMem Silver®)

PROCEDURE	RATIONALE/EMPHASIS
I. Uncover: Put on gloves. Assess for pain before and during procedure. Remove any compression and the wound dressing and dispose of the soiled disposable materials appropriately. Do not dispose of compression hosiery and short-stretch bandages that are intended to be hand washed and reused.	I. Pre-medication for pain prior to dressing changes is rarely needed, because PolyMem dressings contain a moisturizer and are non-adherent to the wound surface, reducing the risk of disrupting healing tissues during dressing changes.
II. Assess: At least once a week, thoroughly assess ulcer parameters, lower leg circumferences and pain. Measure, trace and/or photograph wounds according to facility documentation standards. Reassess the patient's tolerance of compression choice. If compression is a type the patient cannot remove, wash the affected leg with plain warm water and apply non-sensitizing moisturizer.	II. Assessment is essential for appropriate documentation and follow-up. Leg circumferences should not be increasing; graduated compression should initially result in decreasing circumferences. Usually patients experience dramatic pain relief when PolyMem dressings are applied. Animal studies suggest PolyMem dressings help interrupt the pain pathways at the wound site while enhancing healing.
III. Cover the wound with a PolyMem standard, PolyMem Max and/or PolyMem Wic Dressing, according to the expected quantity of exudate using the algorithm provided in the Venous Ulcer Protocol Decision Tree.* Substitute PolyMem Silver dressings when antimicrobial effects are desired.	III. With the PolyMem formulation, the dressing change process is simple – just remove the old dressing and place a new dressing on the wound. No wound cleansing is routinely performed during the dressing change process because PolyMem dressings provide continuous cleansing of the wound. PolyMem absorbs up to ten times its weight in exudate, decreasing the risk of maceration.
IV. Apply graduated compression to the lower leg as indicated by the Venous Ulcer Protocol algorithm, following manufacturer's guidelines.	IV. Graduated compression must be appropriate to the patient and applied correctly, or serious harm can result.
V. Assess for causes of delayed healing such as non-advancing wound edges (epibole) or infection and implement recommended interventions for these problems. If the wound has not improved after six weeks of appropriate treatment under the Venous Ulcer Protocol, request that a biopsy be obtained to confirm the pathology of the leg ulcer.	V. Patients who adhere to treatment protocols usually experience dramatically decreased wound size. Non-advancing wound edges and infection are the most common reasons for non-healing in venous ulcers. Venous ulcers can mimic other serious wound types.
VI. Follow-up: Remind the patient to report any signs of compromised circulation immediately. Encourage the patient to participate in restorative exercises to the extent they are able. Reassess ABI's every six months according to facility policy and alter compression treatment accordingly.	VI. Patients must not feel reluctant to report potentially damaging circulation problems due to compression. Even very minimal exercise increases well-being and function in the foot/leg muscle pump.
VII. Document pain, wound location and size, type and tolerance of compression and dressings, teaching, and proposed intervention strategies.	VII. Good documentation allows other clinicians to quickly determine appropriate interventions for the patient, enhancing the quality of care provided.

*Occasionally a patient may experience discomfort upon application of the PolyMem dressing due to the dramatic pulling of the exudate from the wound. This discomfort can be prevented by applying a scant quantity of water to the dressing surface immediately prior to dressing application.

Venous Protocol Summary Decision Tree

This decision tree is based on the evidence detailed in the text version of this protocol.

Categories of Graduated Compression referred to in this decision tree

Inelastic systems

- Unna's boot
- Duke boot (modified Unna's boot)
- Short stretch bandages

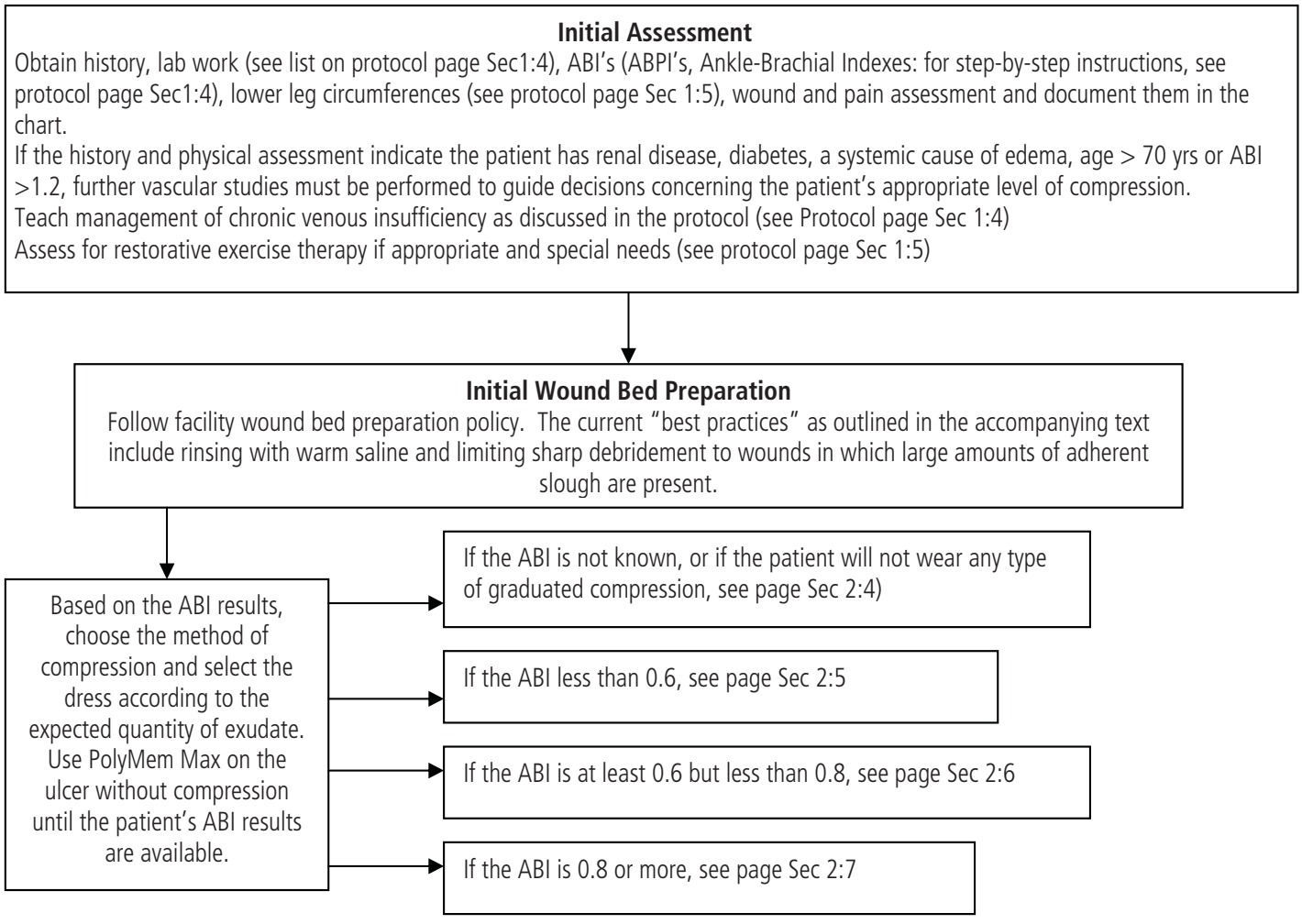
Elastic Systems

- Standard multilayer wrap
- Modified multilayer wrap (less compression)
- Compression hosiery at specified compression

DESCRIPTIONS OF PolyMem QuadraFoam Dressings referred to in this decision tree

- **PolyMem**
  Standard thickness Quadrafoam with a semipermeable membrane backing
- **PolyMem Max**
  Extra thick, extra absorbent QuadraFoam with a semipermeable membrane backing
- **PolyMem Wic**
  Quadrafoam with no semipermeable membrane backing, which allows excess exudate to pass through the dressing into the absorptive layer of a multilayer graduated compression wraps.

Silver versions are available for all PolyMem dressing types for when anti-microbial benefits are desired.



The ABI is unknown, or the patient will not wear any type of graduated compression.
(Based upon ABI results, refer to the appropriate page of this decision tree if this limitation is lifted)

Use PolyMem Max on the ulcer without compression.

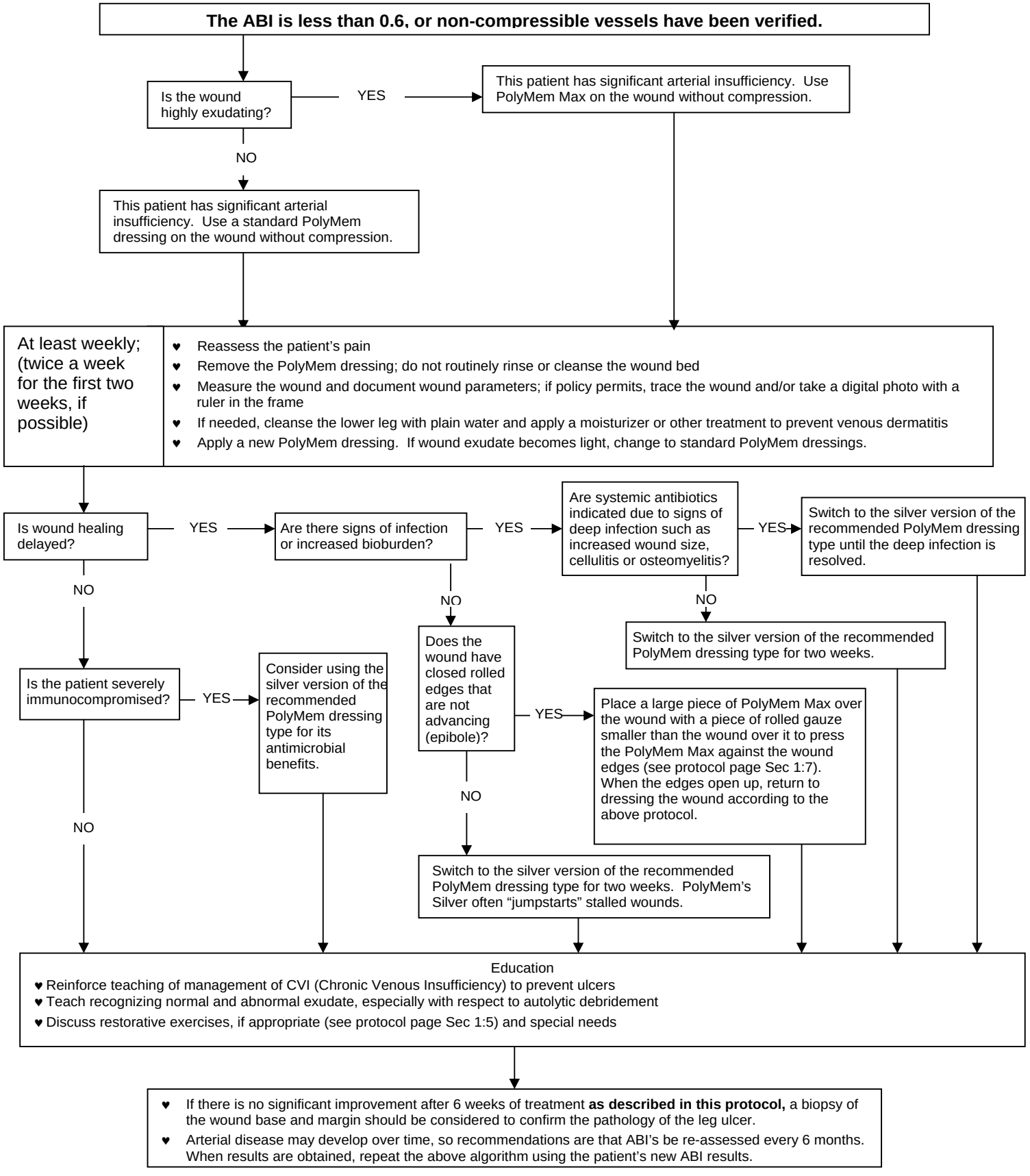
At least weekly; (twice a week for the first two weeks, if possible)

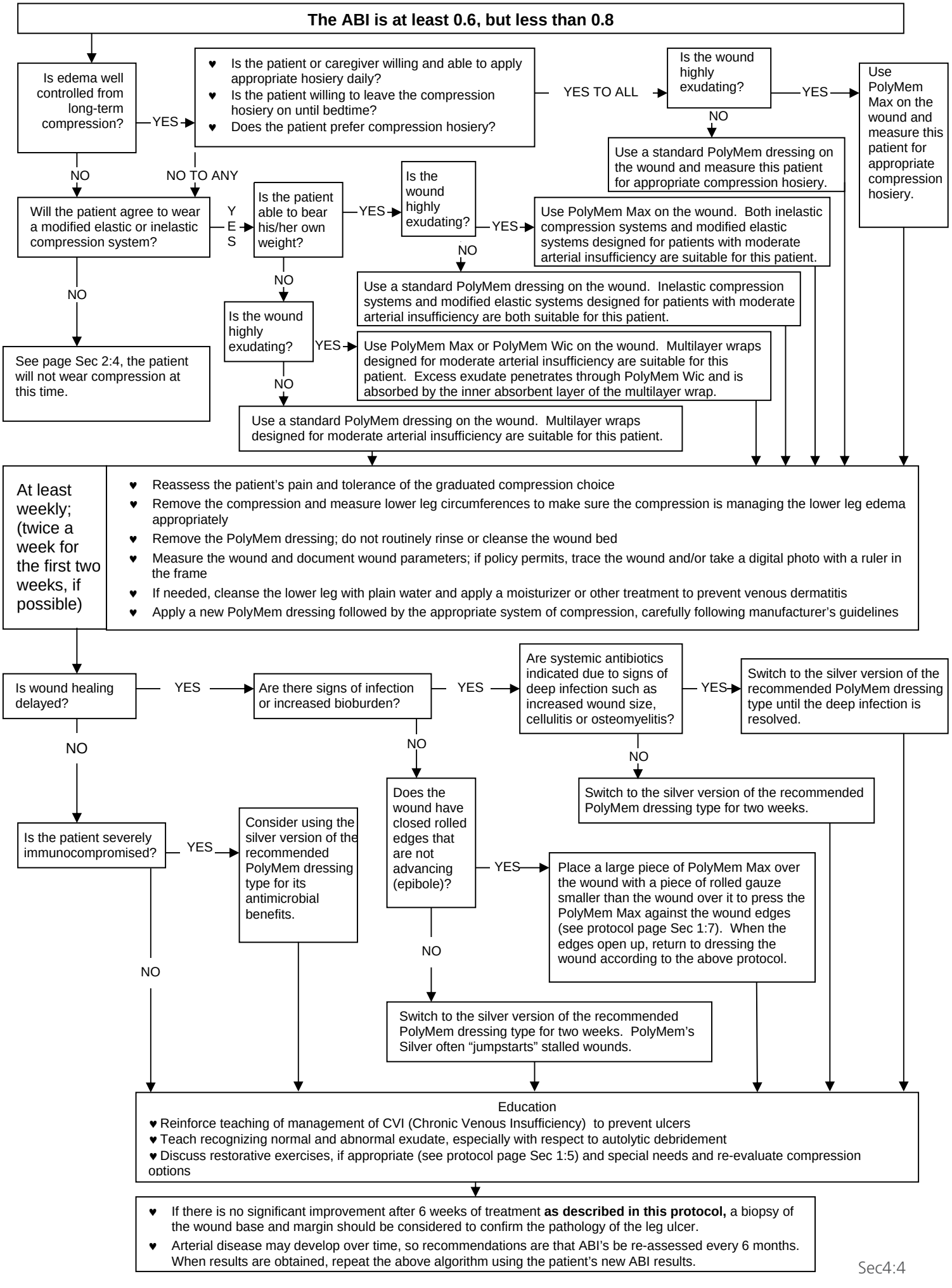
- ♥ Reassess the patient's pain
- ♥ Remove the PolyMem dressing; do not routinely rinse or cleanse the wound bed
- ♥ Measure the wound and document wound parameters; if policy permits, trace the wound and/or take a digital photo with a ruler in the frame
- ♥ If needed, cleanse the lower leg with plain water and apply a moisturizer or other treatment to prevent venous dermatitis
- ♥ Apply a new PolyMem dressing. If wound exudate becomes light, change to standard PolyMem dressings.

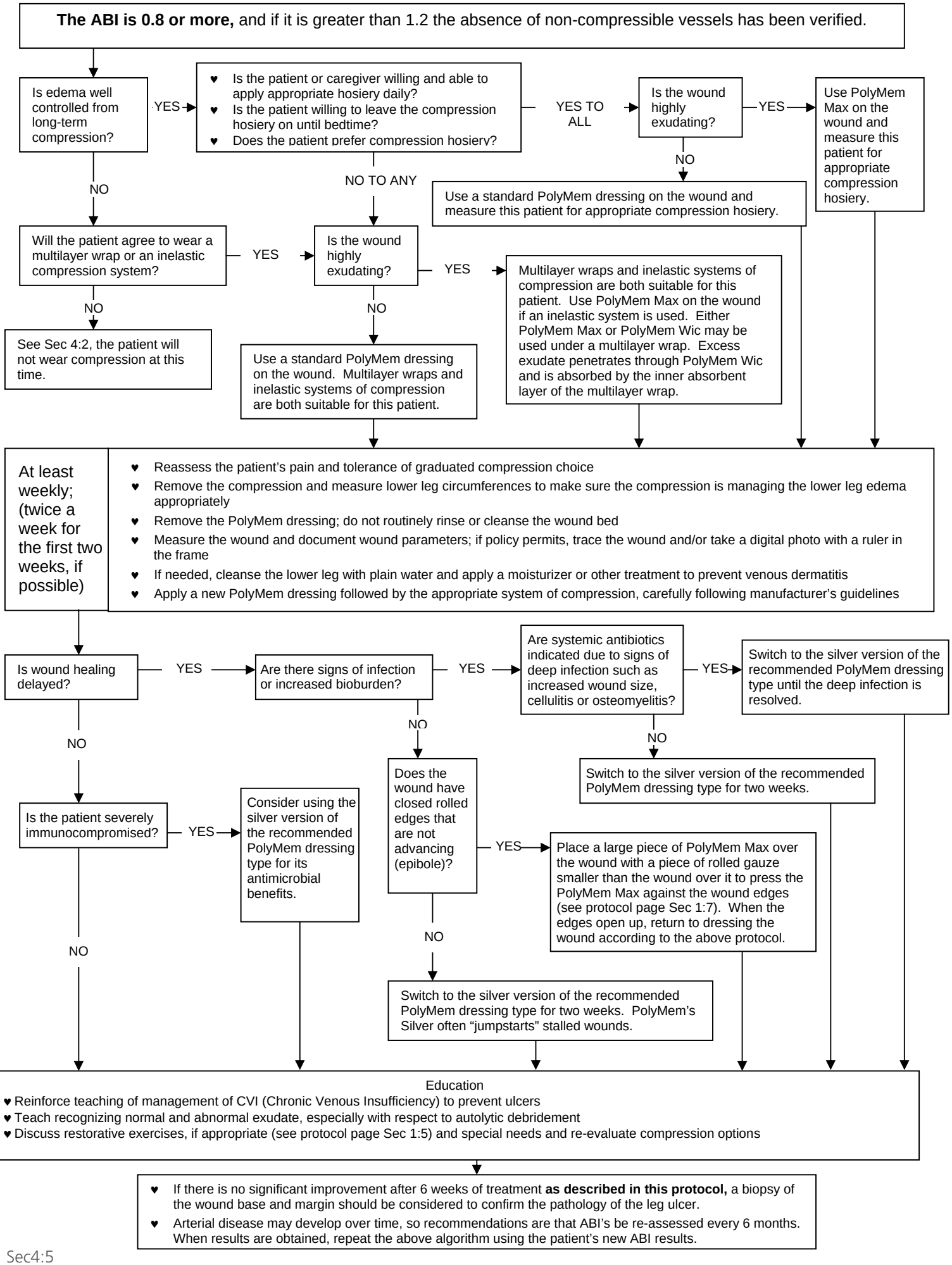
Is wound healing delayed?
- YES → Are there signs of infection or increased bioburden?
  - YES → Are systemic antibiotics indicated due to signs of deep infection such as increased wound size, cellulitis or osteomyelitis?
    - YES → Switch to the silver version of the recommended PolyMem dressing type until the deep infection is resolved.
    - NO → Switch to the silver version of the recommended PolyMem dressing type for two weeks.
  - NO → Does the wound have closed rolled edges that are not advancing (epibole)?
    - YES → Place a large piece of PolyMem Max over the wound with a piece of rolled gauze smaller than the wound over it to press the PolyMem Max against the wound edges (see protocol page Sec 1:7). When the edges open up, return to dressing the wound according to the above protocol.
    - NO → Switch to the silver version of the recommended PolyMem dressing type for two weeks. PolyMem's Silver often "jumpstarts" stalled wounds.
- NO → Is the patient severely immunocompromised?
  - YES → Consider using the silver version of the recommended PolyMem dressing type for its antimicrobial benefits.
  - NO

Education
- ♥ Reinforce teaching of management of CVI (Chronic Venous Insufficiency) to prevent ulcers
- ♥ Teach recognizing normal and abnormal exudate, especially with respect to autolytic debridement
- ♥ Teach the advantages of compression and the patients' compression choices, if the reason the patient is not using compression is not medically based.
- ♥ Discuss restorative exercises, if appropriate (see protocol page Sec 1:5) and special needs

- ♥ If there is no significant improvement after 6 weeks of treatment **as described in this protocol,** a biopsy of the wound base and margin should be considered to confirm the pathology of the leg ulcer.
- ♥ Arterial disease may develop over time, so recommendations are that ABI's be re-assessed every 6 months. When results are obtained, repeat the above algorithm using the patient's new ABI results.


The ABI is less than 0.6, or non-compressible vessels have been verified.
Is the wound highly exudating?
YES
This patient has significant arterial insufficiency. Use PolyMem Max on the wound without compression.
NO
This patient has significant arterial insufficiency. Use a standard PolyMem dressing on the wound without compression.
At least weekly; (twice a week for the first two weeks, if possible)
♥ Reassess the patient's pain
♥ Remove the PolyMem dressing; do not routinely rinse or cleanse the wound bed
♥ Measure the wound and document wound parameters; if policy permits, trace the wound and/or take a digital photo with a ruler in the frame
♥ If needed, cleanse the lower leg with plain water and apply a moisturizer or other treatment to prevent venous dermatitis
♥ Apply a new PolyMem dressing. If wound exudate becomes light, change to standard PolyMem dressings.
Is wound healing delayed?
YES
Are there signs of infection or increased bioburden?
YES
Are systemic antibiotics indicated due to signs of deep infection such as increased wound size, cellulitis or osteomyelitis?
YES
Switch to the silver version of the recommended PolyMem dressing type until the deep infection is resolved.
NO
NO
NO
Switch to the silver version of the recommended PolyMem dressing type for two weeks.
Is the patient severely immunocompromised?
YES
Consider using the silver version of the recommended PolyMem dressing type for its antimicrobial benefits.
Does the wound have closed rolled edges that are not advancing (epibole)?
YES
Place a large piece of PolyMem Max over the wound with a piece of rolled gauze smaller than the wound over it to press the PolyMem Max against the wound edges (see protocol page Sec 1:7). When the edges open up, return to dressing the wound according to the above protocol.
NO
NO
Switch to the silver version of the recommended PolyMem dressing type for two weeks. PolyMem's Silver often "jumpstarts" stalled wounds.
Education
♥ Reinforce teaching of management of CVI (Chronic Venous Insufficiency) to prevent ulcers
♥ Teach recognizing normal and abnormal exudate, especially with respect to autolytic debridement
♥ Discuss restorative exercises, if appropriate (see protocol page Sec 1:5) and special needs
♥ If there is no significant improvement after 6 weeks of treatment **as described in this protocol,** a biopsy of the wound base and margin should be considered to confirm the pathology of the leg ulcer.
♥ Arterial disease may develop over time, so recommendations are that ABI's be re-assessed every 6 months. When results are obtained, repeat the above algorithm using the patient's new ABI results.


The ABI is at least 0.6, but less than 0.8
Is edema well controlled from long-term compression?
YES
♥ Is the patient or caregiver willing and able to apply appropriate hosiery daily?
♥ Is the patient willing to leave the compression hosiery on until bedtime?
♥ Does the patient prefer compression hosiery?
YES TO ALL
Is the wound highly exudating?
YES
Use PolyMem Max on the wound and measure this patient for appropriate compression hosiery.
NO
Use a standard PolyMem dressing on the wound and measure this patient for appropriate compression hosiery.
NO
NO TO ANY
Will the patient agree to wear a modified elastic or inelastic compression system?
YES
Is the patient able to bear his/her own weight?
YES
Is the wound highly exudating?
YES
Use PolyMem Max on the wound. Both inelastic compression systems and modified elastic systems designed for patients with moderate arterial insufficiency are suitable for this patient.
NO
Use a standard PolyMem dressing on the wound. Inelastic compression systems and modified elastic systems designed for patients with moderate arterial insufficiency are both suitable for this patient.
NO
Is the wound highly exudating?
YES
Use PolyMem Max or PolyMem Wic on the wound. Multilayer wraps designed for moderate arterial insufficiency are suitable for this patient. Excess exudate penetrates through PolyMem Wic and is absorbed by the inner absorbent layer of the multilayer wrap.
NO
Use a standard PolyMem dressing on the wound. Multilayer wraps designed for moderate arterial insufficiency are suitable for this patient.
NO
See page Sec 2:4, the patient will not wear compression at this time.
At least weekly; (twice a week for the first two weeks, if possible)
♥ Reassess the patient's pain and tolerance of the graduated compression choice
♥ Remove the compression and measure lower leg circumferences to make sure the compression is managing the lower leg edema appropriately
♥ Remove the PolyMem dressing; do not routinely rinse or cleanse the wound bed
♥ Measure the wound and document wound parameters; if policy permits, trace the wound and/or take a digital photo with a ruler in the frame
♥ If needed, cleanse the lower leg with plain water and apply a moisturizer or other treatment to prevent venous dermatitis
♥ Apply a new PolyMem dressing followed by the appropriate system of compression, carefully following manufacturer's guidelines
Is wound healing delayed?
YES
Are there signs of infection or increased bioburden?
YES
Are systemic antibiotics indicated due to signs of deep infection such as increased wound size, cellulitis or osteomyelitis?
YES
Switch to the silver version of the recommended PolyMem dressing type until the deep infection is resolved.
NO
Switch to the silver version of the recommended PolyMem dressing type for two weeks.
NO
Does the wound have closed rolled edges that are not advancing (epibole)?
YES
Place a large piece of PolyMem Max over the wound with a piece of rolled gauze smaller than the wound over it to press the PolyMem Max against the wound edges (see protocol page Sec 1:7). When the edges open up, return to dressing the wound according to the above protocol.
NO
Switch to the silver version of the recommended PolyMem dressing type for two weeks. PolyMem's Silver often "jumpstarts" stalled wounds.
NO
Is the patient severely immunocompromised?
YES
Consider using the silver version of the recommended PolyMem dressing type for its antimicrobial benefits.
NO
Education
♥ Reinforce teaching of management of CVI (Chronic Venous Insufficiency) to prevent ulcers
♥ Teach recognizing normal and abnormal exudate, especially with respect to autolytic debridement
♥ Discuss restorative exercises, if appropriate (see protocol page Sec 1:5) and special needs and re-evaluate compression options
♥ If there is no significant improvement after 6 weeks of treatment as described in this protocol, a biopsy of the wound base and margin should be considered to confirm the pathology of the leg ulcer.
♥ Arterial disease may develop over time, so recommendations are that ABI's be re-assessed every 6 months. When results are obtained, repeat the above algorithm using the patient's new ABI results.


The ABI is 0.8 or more, and if it is greater than 1.2 the absence of non-compressible vessels has been verified.
Is edema well controlled from long-term compression?
YES
♥ Is the patient or caregiver willing and able to apply appropriate hosiery daily?
♥ Is the patient willing to leave the compression hosiery on until bedtime?
♥ Does the patient prefer compression hosiery?
YES TO ALL
Is the wound highly exudating?
YES
Use PolyMem Max on the wound and measure this patient for appropriate compression hosiery.
NO
Use a standard PolyMem dressing on the wound and measure this patient for appropriate compression hosiery.
NO TO ANY
NO
Will the patient agree to wear a multilayer wrap or an inelastic compression system?
YES
Is the wound highly exudating?
YES
Multilayer wraps and inelastic systems of compression are both suitable for this patient. Use PolyMem Max on the wound if an inelastic system is used. Either PolyMem Max or PolyMem Wic may be used under a multilayer wrap. Excess exudate penetrates through PolyMem Wic and is absorbed by the inner absorbent layer of the multilayer wrap.
NO
See Sec 4:2, the patient will not wear compression at this time.
NO
Use a standard PolyMem dressing on the wound. Multilayer wraps and inelastic systems of compression are both suitable for this patient.
At least weekly; (twice a week for the first two weeks, if possible)
♥ Reassess the patient's pain and tolerance of graduated compression choice
♥ Remove the compression and measure lower leg circumferences to make sure the compression is managing the lower leg edema appropriately
♥ Remove the PolyMem dressing; do not routinely rinse or cleanse the wound bed
♥ Measure the wound and document wound parameters; if policy permits, trace the wound and/or take a digital photo with a ruler in the frame
♥ If needed, cleanse the lower leg with plain water and apply a moisturizer or other treatment to prevent venous dermatitis
♥ Apply a new PolyMem dressing followed by the appropriate system of compression, carefully following manufacturer's guidelines
Is wound healing delayed?
YES
Are there signs of infection or increased bioburden?
YES
Are systemic antibiotics indicated due to signs of deep infection such as increased wound size, cellulitis or osteomyelitis?
YES
Switch to the silver version of the recommended PolyMem dressing type until the deep infection is resolved.
NO
Switch to the silver version of the recommended PolyMem dressing type for two weeks.
NO
Is the patient severely immunocompromised?
YES
Consider using the silver version of the recommended PolyMem dressing type for its antimicrobial benefits.
Does the wound have closed rolled edges that are not advancing (epibole)?
YES
Place a large piece of PolyMem Max over the wound with a piece of rolled gauze smaller than the wound over it to press the PolyMem Max against the wound edges (see protocol page Sec 1:7). When the edges open up, return to dressing the wound according to the above protocol.
NO
NO
Switch to the silver version of the recommended PolyMem dressing type for two weeks. PolyMem's Silver often "jumpstarts" stalled wounds.
Education
♥ Reinforce teaching of management of CVI (Chronic Venous Insufficiency) to prevent ulcers
♥ Teach recognizing normal and abnormal exudate, especially with respect to autolytic debridement
♥ Discuss restorative exercises, if appropriate (see protocol page Sec 1:5) and special needs and re-evaluate compression options
♥ If there is no significant improvement after 6 weeks of treatment **as described in this protocol,** a biopsy of the wound base and margin should be considered to confirm the pathology of the leg ulcer.
♥ Arterial disease may develop over time, so recommendations are that ABI's be re-assessed every 6 months. When results are obtained, repeat the above algorithm using the patient's new ABI results.

Requirements of an Ideal Dressing

The ideal dressing must fulfill a wide variety of requirements in order to meet clinical needs. Below is a chart that lists the requirements for an ideal dressing found in the literature along with the corresponding evidence that PolyMem QuadraFoam Dressings meet or exceed the corresponding requirement(s).

An ideal dressing will:	How PolyMem Dressings meet this goal:
Create and maintain a moist environment[5,15,52,60,90,96,101,120,128] and allow gaseous exchange[96]	PolyMem QuadraFoam dressings bring moisture to dry wounds while absorbing excess exudate, and they provide an ideal moisture vapor transmission rate.[129]
Facilitate autolytic debridement[60]	PolyMem dressings not only provide an optimal moist healing environment, they also contain a surfactant to enhance autolytic debridement by breaking the bonds between the slough and the wound bed.[15,52,60,76,77,104,105,129]
Conform to fill tunneling, etc.[60,90]	PolyMem dressings swell gently as they absorb exudate, so they nestle into the wound. They are extremely flexible and elastic to easily conform to all shapes of wounds.[125,127,130]
Come in numerous shapes and sizes[60,90]	Standard PolyMem, extra-thick PolyMem Max, and cavity filler PolyMem Wic are available in several convenient sizes and cut-to-fit sheets as well as various sizes of bordered rectangles, squares, sacral-shapes and ovals for small or large wounds.[125,131]
Absorb[15,60,90,96,120] and lock excess exudate in the dressing[101]	Super-absorbent starch in PolyMem[129] helps keep wound fluid from causing excoriation of wound edges[35,90] and periwound maceration,[15,90,120] which can enlarge the wound,[52] by locking excess wound fluid in the dressings as a gel.[124] Glycerol in the dressings[129] is a further protection against maceration.[77,102,132]
Provide thermal insulation[60,96,101,120]	PolyMem's foam helps keep wounds consistently warm, which increases healing.[100,133,134] In addition, PolyMem's built-in wound cleanser usually eliminates the need for wound bed cleansing or rinsing at dressing changes.[76,77,100,104,105,124,129] When wounds are cooled from cleansing, it can take three hours for mitotic and leucocytic activity to return to normal.[101]
Act as a bacterial barrier[60,96,120]	PolyMem dressings have a thin-film backing to protect wounds from contamination, including liquid penetration, while permitting the optimal rate of moisture vapor transmission.[129]
Not cause pain or damage at dressing changes[60,73,90,96]	PolyMem dressings are non-adherent and do not tend to sting or burn, even when applied to extremely sensitive skin.[76,77,104,135] A common source of pain and wound bed damage during dressing changes is manual wound cleansing, which is often eliminated when PolyMem dressings are used.[18,129]
Free from particulate or toxic contaminants[96]	PolyMem is 100% non-toxic and remains intact, even when saturated.[129]
Reduce or eliminate pain at the wound site[60,90,136]	PolyMem dressings can inhibit the nociceptor response at the wound site, often dramatically reducing wound pain without the use of drugs.[72,75,76,77,78,100,103,127,135]
Promote wound healing[120]	Case studies highlighting the use of PolyMem dressings consistently demonstrate brisk healing when compared to experience with other modern dressings.[71,76,77,100,105,124,125]
Prevent malodor and dermatitis[90,120]	Glycerol, found in PolyMem dressings,[129] helps decrease wound odor.[81] PolyMem dressings can decrease inflammation[72,74] and can help heal venous dermatitis.[81]
Inhibit inflammation[17,90]	PolyMem dressings can inhibit the nociceptor response at the wound site, often dramatically reducing inflammation.[72,74]

All PolyMem dressing types are also available in silver for when antimicrobial benefits are desired.

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