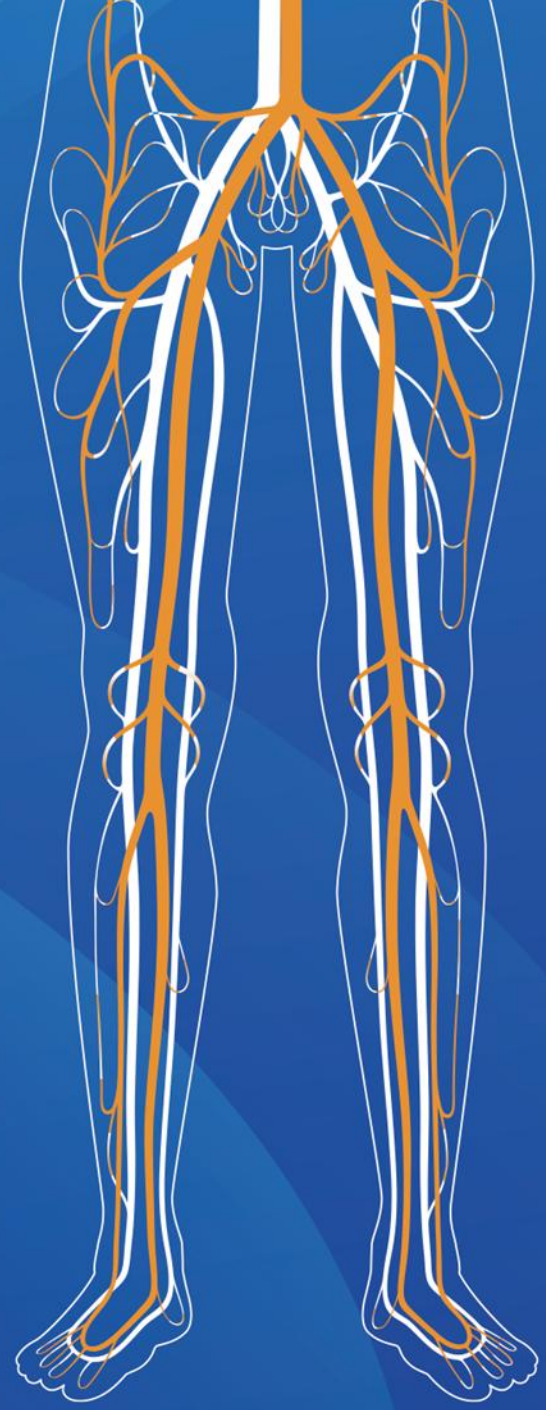
Leg Ulcer and Compression Day:

Advancing the Science of Compression and Skin Health



URGO FOUNDATION
OUR COMMITMENT TO YOUR HEALTH

HMP Education has designated an unrestricted grant from Urgo Foundation and in-kind contributions from Koya Medical and Tactile Medical to support this session.

The Foundation URGO

FONDATION URGO

NOTRE ENGAGEMENT POUR VOTRE SANTÉ

THE URGO FOUNDATION

Created in 2010, the URGO Foundation is an independent, non-profit, and non-promotional organization whose purpose is to contribute to improving the quality of life of patients around the world.

To this end, its mission is to support and train healthcare professionals in the following areas:

- **Healing**
- **Pain management**
- **Access to first aid**



THE URGO FOUNDATION

In the U.S., our focus has been on leg ulcers and lymphedema, wound debridement, and infection management. This program will continue in the coming years, with ongoing efforts to strengthen these areas of care.







THE URGO FOUNDATION

Since
2010

11.7M
euros

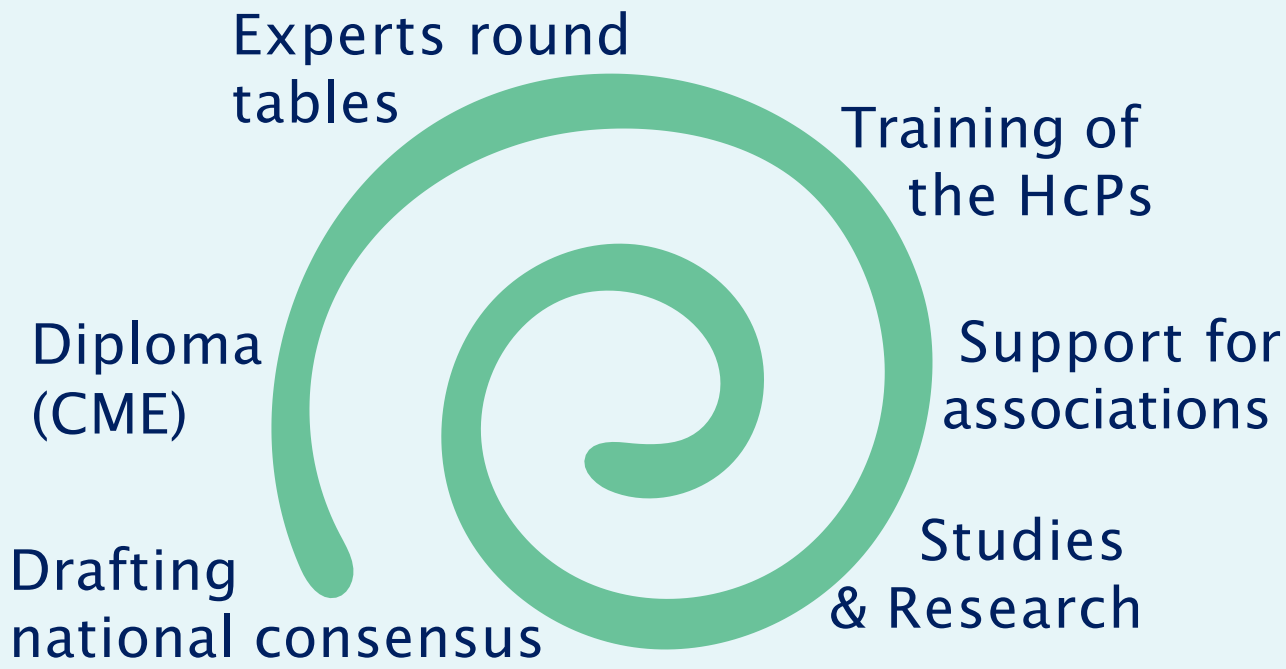
25
countries

291
projects

216K
trained healthcare professionals, patients & caregivers

1M
people who have been made aware

In these areas of intervention, the URGO Foundation acts in **various ways:**



JOIN US!

www.fondation-urgo.org

Faculty

- **Frank Aviles, PT, CWS, FACCWS, CLT-LANA, ALM, AWCC, MLD/CDT Instr**
  Aetherus Wound and Lymphatics; Advanced Wound & Lymphatic Institute (Tampa, FL)
- **Heather L. Barnhart, PT, PhD, CWS, CLT-LANA, CLWT**
  Director of Clinical Operations, Koya Medical; Adjunct Professor, Nova Southeastern University (St. Augustine, FL)
- **Yadwinder Dhillon, MD**
  AZ Wound and Hyperbaric Medicine; Associate Professor, University of Arizona School of Medicine (Phoenix, AZ)
- **Lucian G. Vlad, MD, MHI, FACCWS**
  Fellowship Director, Wound Care and Hyperbaric; Wound Care and Hyperbaric Clinic, Atrium Health Wake Forest Baptist; Wake Forest University School of Medicine (Winston-Salem, NC)

Faculty Disclosures

- **Frank Aviles, PT, CWS, FACCWS, CLT-LANA, ALM, AWCC, MLD/CDT Instr**
  Advisory Board: Histologics; Consultant: Kent Imaging; Mimosa
- **Heather L. Barnhart, PT, PhD, CWS, CLT-LANA, CLWT**
  Director of Clinical Operations, Koya Medical; Speakers Bureau: Urgo Medical
- **Yadwinder Dhillon, MD**
  Consultant: Urgo Medical; Grant/Research Support: Urgo Medical
- **Lucian G. Vlad, MD, MHI, FACCWS**
  Consultant: Solventum, Medical Surgical Business; Urgo Medical; Speakers Bureau: Urgo Medical

Disclosures

- The faculty have been informed of their responsibility to disclose to the audience if they will be discussing off-label or investigational use(s) of drugs, products, and/or devices (any use not approved by the U.S. Food and Drug Administration)
  - Applicable CME staff have no relationships to disclose relating to the subject matter of this activity
  - This activity has been independently reviewed for balance
  - Any AI-assisted content has been reviewed, edited, and validated by the presenter for accuracy, balance, and alignment with current evidence; author(s) assume full responsibility for the content presented
  - This CME activity may include brand names for participant clarity purposes only; no product promotion or recommendation should be inferred

Learning Objectives

- Explain the importance of compression therapy as the standard of care (SOC) for managing venous leg ulcers (VLUs) and phlebolymphedema, and recognize factors contributing to its underutilization in clinical practice
- Assess the impact of venous disease, lymphedema, and phlebolymphedema on skin integrity, and identify evidence-based strategies to prevent and manage skin damage associated with these conditions
- Examine whether current evidence supports the use of Unna boots and similar compression products to improve skin integrity in patients with venous disease
- Outline the “Three Cs” of effective compression therapy — consistency, continuity, and comfort — and evaluate how advances in materials and application techniques can improve patient adherence and clinical outcomes
- Define the emerging concept of the “Fourth C” — cutis — and evaluate how therapeutic compression may improve skin microcirculation, dermal health, and long-term skin integrity beyond ulcer healing

SOC = standard of care; VLU = venous leg ulcer.

Compression Therapy:

Standard of Care for Venous Leg Ulcers and Phlebolymphedema

Yadwinder Dhillon, MD
AZ Wound and Hyperbaric Medicine
Associate Professor, University of Arizona School of Medicine
Phoenix, AZ

Venous Leg Ulcers and Phlebolymphedema: A Costly, Recurring Problem

Epidemiology

1%–3%

of older adults are affected by VLUs — the most common chronic leg wound

≈80%

of all leg ulcers arise from underlying venous disease

$14.9B

estimated annual U.S. payer burden for VLU care (Medicare + private)

41.8%

of lower-extremity lymphedema is phlebolymphedema — the #1 cause, exceeding cancer-related lymphedema

Without effective etiologic therapy, VLUs are chronic and relapsing: Healed ulcers recur in roughly half of patients when compression is not maintained — driving repeated care episodes, lost mobility, social isolation, and impaired quality of life

Rice JB, et al. *J Med Econ*. 2014;17(5):347–356. Dean SM, et al. *J Vasc Surg Venous Lymphat Disord*. 2020;8(5):851–859. Latz CA, et al. *Chronic Wound Care Manag Res.* 2015;2:11–21.

Phlebolymphedema: When Venous Hypertension Overwhelms the Lymphatics

Pathophysiology

Chronic venous insufficiency → sustained venous hypertension

↑ Capillary filtration → interstitial fluid exceeds lymphatic transport capacity

Chronic lymphatic overload → “safety-valve” failure and lymphangiopathy

Combined venous + lymphatic edema: fibrosis, skin changes, cellulitis, ulceration

Key clinical points

- Most common cause of secondary lymphedema of the leg in Western countries
- Progressive if the venous driver is not treated — edema becomes fibrotic and refractory
- Both outflow systems fail together — so therapy must decongest both

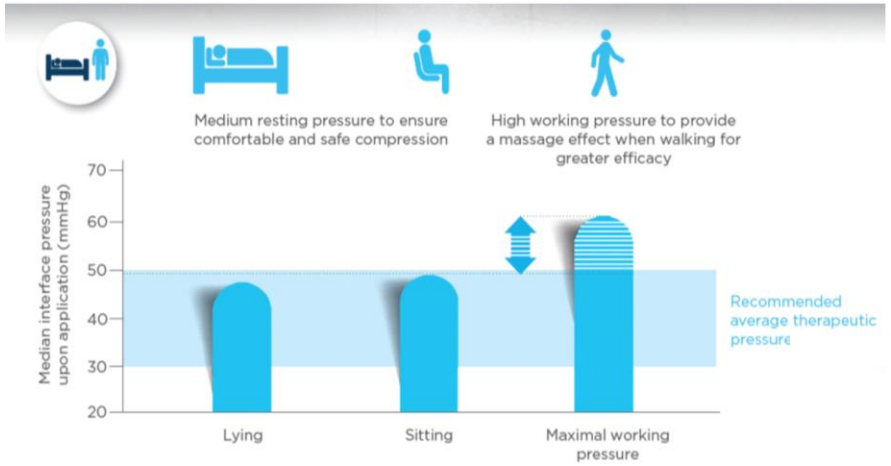
Compression is the only intervention that simultaneously lowers venous pressure and augments lymphatic drainage

Lee BB. *Vasc Specialist Int.* 2020;36(1):1–3. Dean SM, et al. *J Vasc Surg Venous Lymphat Disord.* 2020;8(5):851–859.

Why Compression Works: One Therapy, Multiple Mechanisms

Mechanism of Action

- **Reduces ambulatory venous hypertension:** Narrows vein caliber, improves valve coaptation, counteracts **reflux**
- **Boosts venous return and calf-muscle pump:** Working pressure peaks with each step to augment ejection
- **Cuts capillary filtration and resorbs edema:** Restores Starling balance in the congested limb
- **Stimulates lymphatic drainage:** Essential in phlebolymphedema where lymphatics have failed
- **Dampens inflammation:** Reduces pro-inflammatory cytokines and improves microcirculation in the ulcer bed



The therapeutic dose
≈40 mm Hg sustained, graduated compression at the ankle for VLU — after arterial screening (full compression if ABI ≥0.8; modified 0.5–0.8; avoid if severe arterial disease)

O'Donnell TF, et al. *J Vasc Surg*. 2014;60(2 Suppl):3S–59S.

Cochrane Review: Compression Bandages or Stockings vs No Compression for Venous Leg Ulcers

Cochrane 2021

Objective	Determine whether applying compression improves VLU healing compared with no compression
Design	Systematic review and meta-analysis of RCTs (Cochrane CD013397)
Evidence base	14 RCTs: 1,391 participants; mean age ≈70 yrs; median follow-up 12 wks
Comparison	Any compression (bandages or stockings) vs no compression (dressings ± usual care)
Primary outcomes	Complete wound healing, time to complete healing, adverse events, pain, quality of life

Shi C, et al. *Cochrane Database Syst Rev*. 2021;7:CD013397.

Compression Roughly Doubles the Probability of Healing and Reduces Pain

Cochrane 2021

HR 2.17

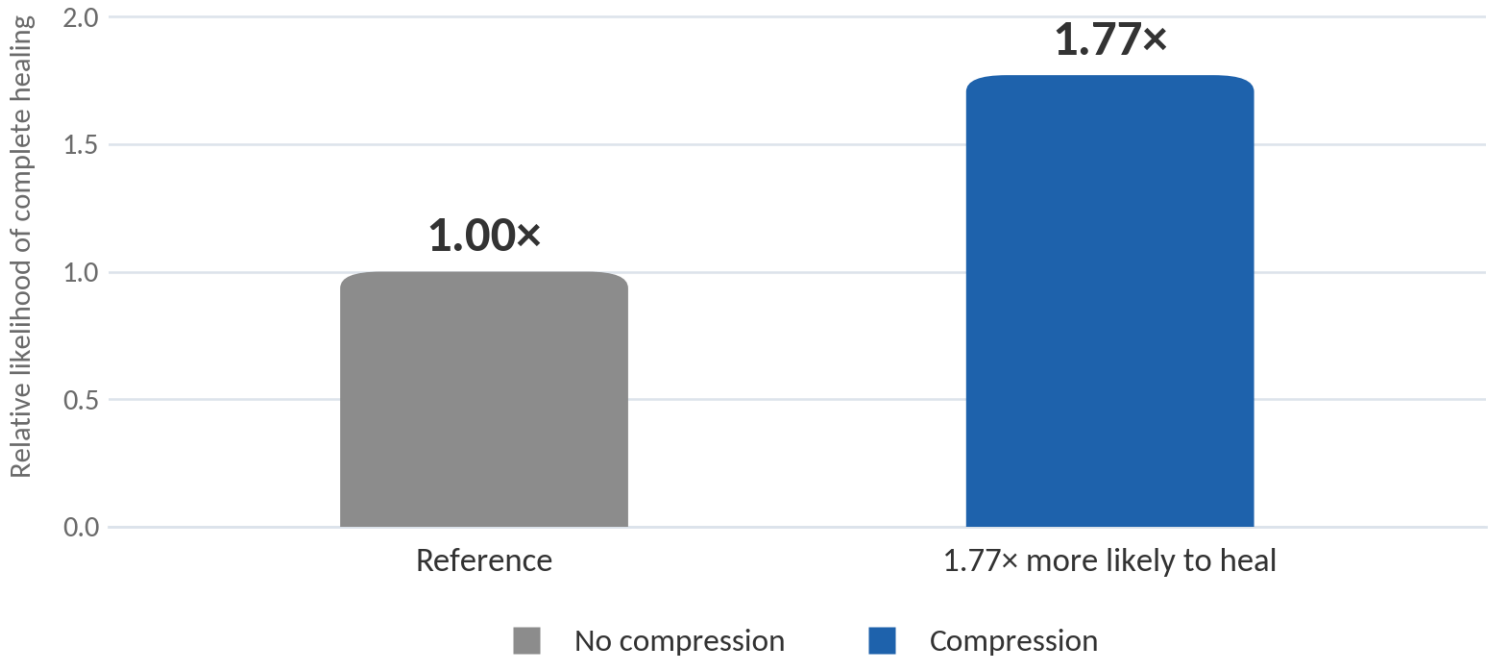
probability of complete healing over time vs no compression (95% CI 1.52–3.10; 5 RCTs, n=733)

RR 1.77

more patients completely healed within 12 months (95% CI 1.41–2.21; 10 RCTs, n=1,215)

−1.39 pts

less pain (0–10 scale) vs no compression (95% CI −1.79 to −0.98)



Moderate-certainty evidence. Compression also probably improves disease-specific quality of life.

Shi C, et al. *Cochrane Database Syst Rev*. 2021;7:CD013397.

ESCHAR Trial: Compression Alone vs Compression + Superficial Venous Surgery

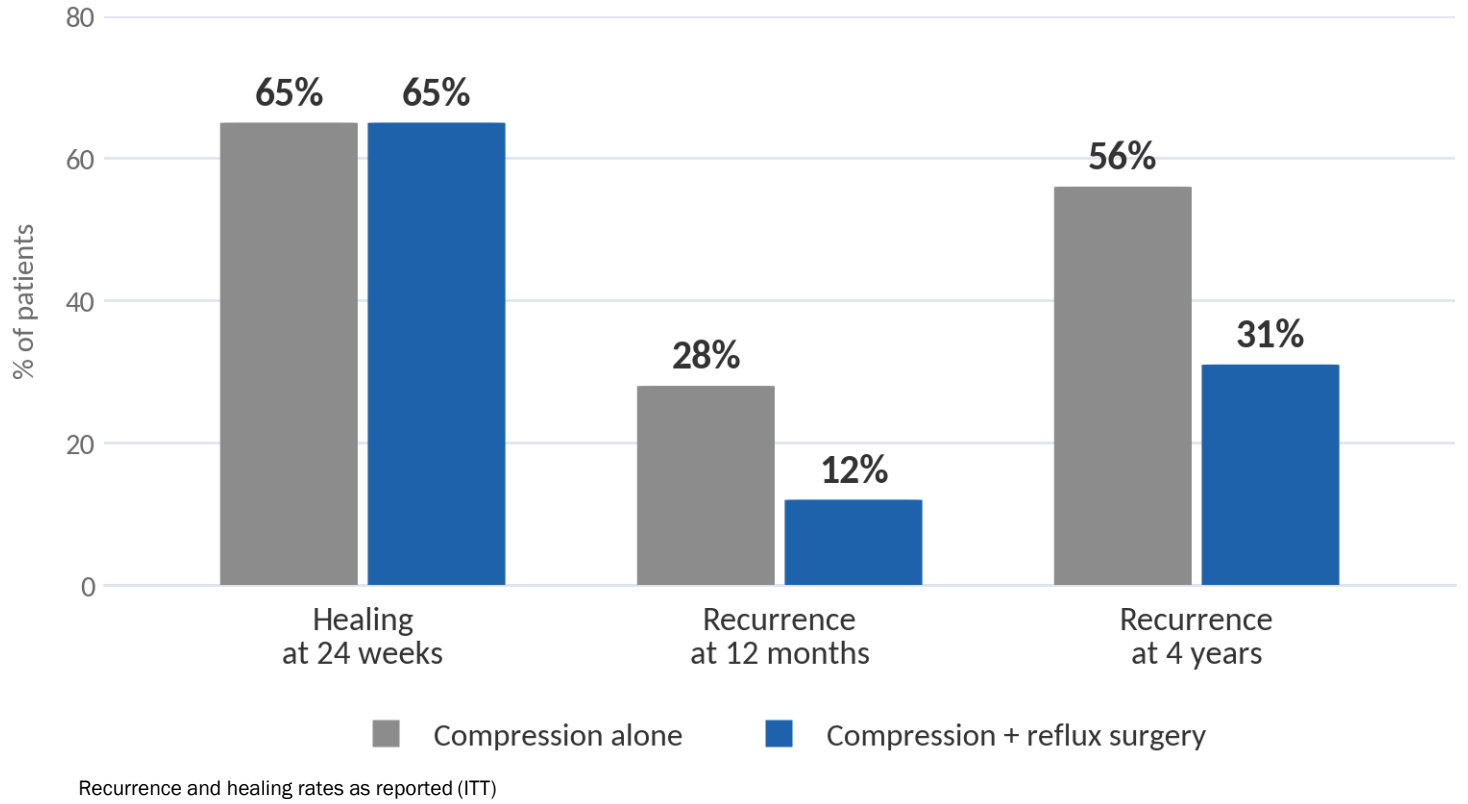
ESCHAR

Objective	Does correcting superficial reflux add benefit to compression for healing and preventing recurrence?
Design	RCT: 500 legs in 500 patients, UK 3 centres, long-term follow-up to 4 yrs
Treatment arms	Multilayer compression alone vs compression + saphenous surgery (superficial reflux ablation)
Indication	Open or recently healed VLU with superficial venous reflux, ABPI ≥0.85
Endpoints	24-wk ulcer healing, ulcer recurrence at 12 months and 4 yrs, ulcer-free time

Barwell JR, et al. *Lancet*. 2004;363(9424):1854–1859. Gohel MS, et al. *BMJ*. 2007;335(7610):83.

ESCHAR: Compression Heals the Ulcer; Correcting Reflux Keeps It Healed

ESCHAR



Recurrence and healing rates as reported (ITT)

89%

of ulcers healed by 3 yrs with compression alone — compression is the engine of healing (93% with surgery; *P*=0.73, NS)

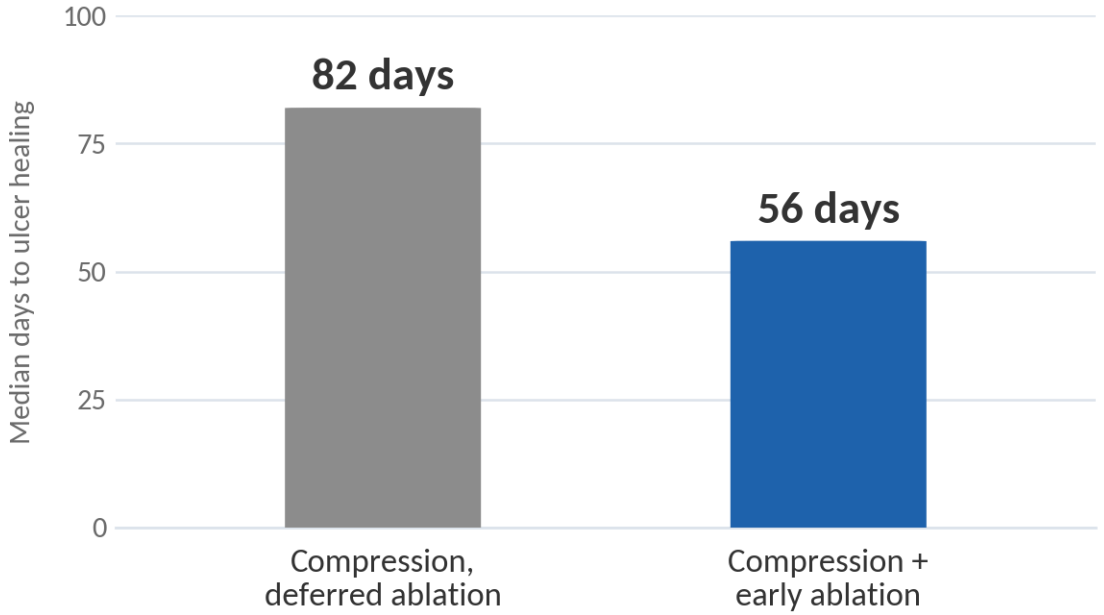
Takeaway: Healing was identical at 24 wks (65% both arms) — but adding reflux correction halved recurrence (12% vs 28% at 1 yr; 31% vs 56% at 4 yrs) and increased ulcer-free time (78% vs 71%)

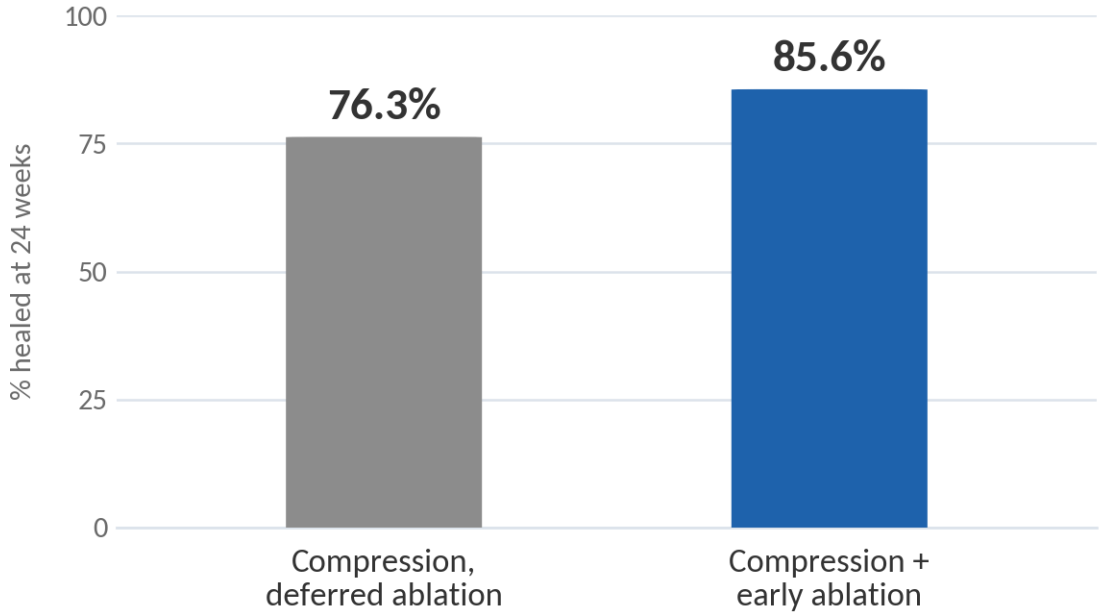
Barwell JR, et al. *Lancet*. 2004;363(9424):1854–1859. Gohel MS, et al. *BMJ*. 2007;335(7610):83.

EVRA Trial: On a Foundation of Compression, Early Ablation Speeds Healing

EVRA: *NEJM* 2018

RCT, 450 patients with VLU ≤6 months: ALL patients received compression therapy; randomized to early (≤2 wks) vs deferred endovenous ablation of superficial reflux





Hazard ratio for healing 1.38 (95% CI 1.13–1.68), *P*=0.001, more ulcer-free time, early ablation is additive to — not a substitute for — compression

EVRA = Early Venous Reflux Ablation.

Gohel MS, et al. *NEJM*. 2018;378(22):2105–2114.

VenUS IV: The Dose of Compression Matters More than the Delivery System

VenUS IV

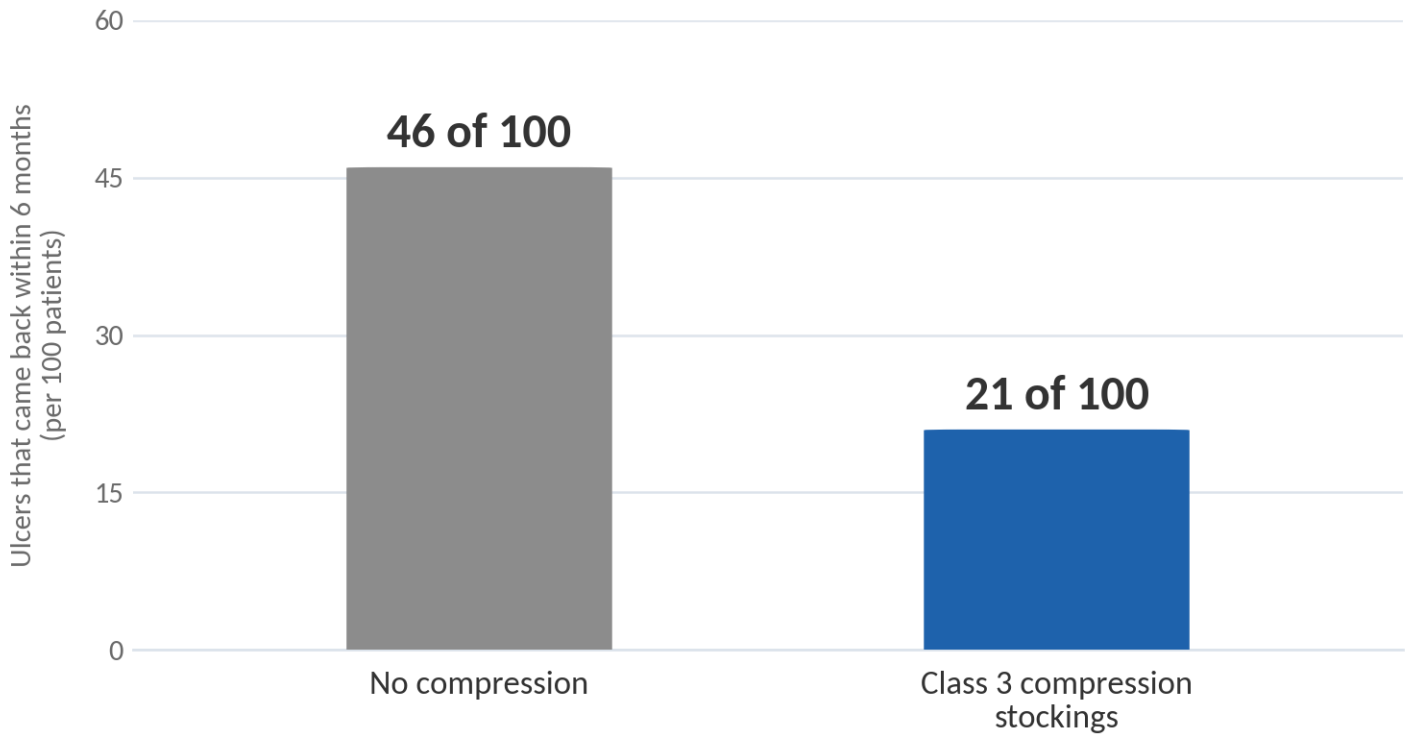
Design	RCT, 457 patients, 2-layer compression hosiery vs 4-layer bandaging, UK community and clinics
Healing	Equivalent: Median 99 vs 98 days, HR 0.99 (95% CI 0.79–1.25), *P*=0.96
Recurrence	Lower with hosiery (HR 0.56, 95% CI 0.33-0.94) — patients keep wearing what they can self-manage
Cost	>95% probability that hosiery is the more cost-effective strategy

Clinical implication: Adequate sustained compression is the active ingredient — bandages, hosiery kits, and adjustable wraps are interchangeable vehicles. Choose the system the patient can tolerate, afford, and apply.

Ashby RL, et al. *Lancet.* 2014;383:871–879.

After Healing, Compression Keeps Ulcers Closed

Cochrane 2024



RR 0.46

risk of re-ulceration with class 3 stockings vs none (95% CI 0.27–0.76; 8 RCTs, n=1,995)

Stronger is better — if tolerated: UK class 3 prevented more recurrences than class 2 (34% vs 53%), but more patients abandoned the stronger stocking. Prescribe the highest level the patient will actually wear — for life.

de Moraes Silva MA, et al. *Cochrane Database Syst Rev*. 2024;3:CD002303.

Phlebolymphedema: Compression-Based Decongestion Is First-Line Therapy

Lymphedema Evidence

Complete decongestive therapy (CDT)

- Intensive phase: multilayer short-stretch (inelastic) bandaging + manual lymphatic drainage + exercise + skin care
- Maintenance phase: Compression garments or adjustable wraps, self-bandaging, continued skin care

In phlebolymphedema, compression also treats the venous driver — pair with evaluation for reflux ablation

What the data shows

- **Ko, et al (n=299, *Arch Surg* 1998): CDT reduced lymphedema volume by ≈60% on average; reduction was maintained in patients who remained compliant with compression — and largely lost in those who did not**
- Systematic reviews of CDT consistently confirm clinically significant limb-volume reduction (Lasinski, 2012)
- Multinational prospective data shows intensive compression bandaging drives the volume response within decongestive therapy (Moffatt, 2021)

Adjuncts (intermittent pneumatic compression, non-pneumatic devices) add benefit — but graduated compression remains the cornerstone

Ko DS, et al. *Arch Surg*. 1998;133(4):452–458. Lasinski BB, et al. *PM R*. 2012;4(8):580–601. Moffatt CJ, et al. *Lymphat Res Biol*. 2021;19(5):447–459.

Guidelines Are Unambiguous: Compression Is the Standard of Care

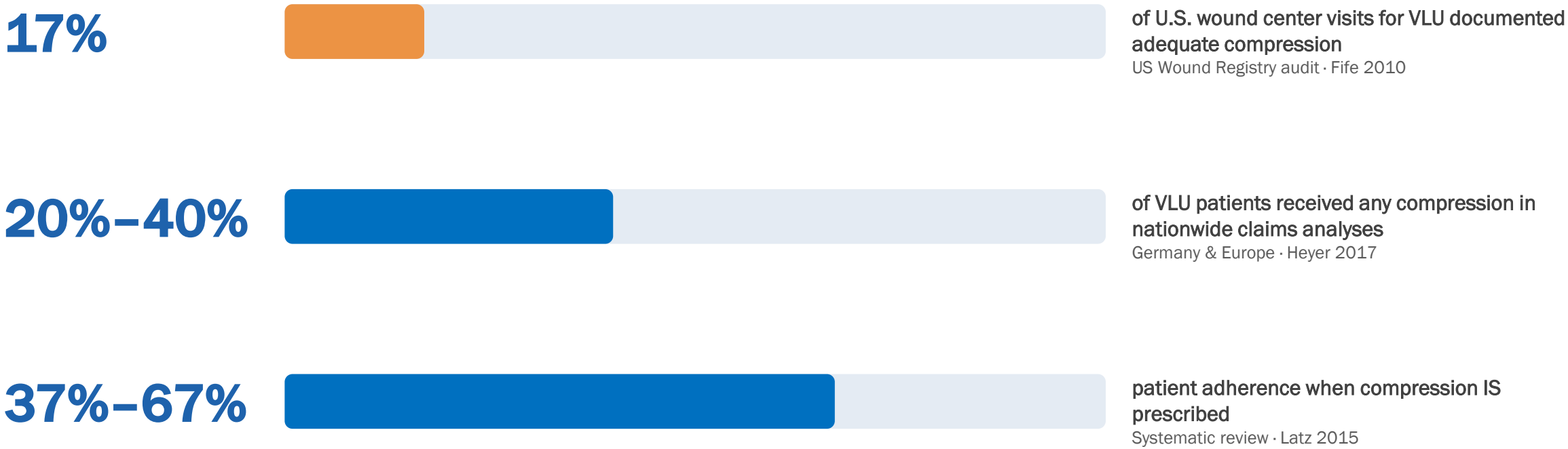
Guidelines	
SVS/AVF 2014	"In a patient with a VLU, we recommend compression therapy over no compression therapy to increase ulcer healing rate" — GRADE 1, Level B. Compression suggested after healing to reduce recurrence (Grade 2)
Cochrane Evidence	Moderate-certainty evidence that compression improves healing, time to healing, and pain (2021); reduces recurrence after healing (2024). Multicomponent systems outperform single component
Practice Standards	Target ≈30-40 mm Hg at the ankle, screen ABI before compressing (full compression ≥ 0.8), reassess and refit, continue maintenance compression indefinitely after healing
Lymphedema Frameworks	International consensus (ILF/NLN): Compression bandaging and garments are the core of decongestive therapy for lymphedema, including phlebolymphedema

No advanced dressing, graft, or adjunct substitutes for adequate compression.

O'Donnell TF Jr, et al. *J Vasc Surg*. 2014;60(2 Suppl):3S–59S.

The Reality Check: Compression Remains Strikingly Underused

The Evidence-Practice Gap



Fewer than 1 in 5 U.S. wound center visits deliver the therapy every guideline calls standard of care

Fife CE, et al. *Wound Repair Regen*. 2010;18(2):154–158. Heyer K, et al. *Int Wound J*. 2017;14(2):338–343. Latz CA, et al. *Chronic Wound Care Manag Res*. 2015;2:11–21.

Why Underuse Persists and How to Close the Gap

Barriers → Strategies

Patient factors

- Pain, heat, itching, discomfort
- Difficulty donning; footwear and lifestyle limits
- Cost of garments and replacements
- Belief that compression won't help; low understanding

Clinician factors

- Limited training and confidence in high-compression bandaging
- Inconsistent ABI screening ⟶ fear of arterial harm
- Variable application technique = sub-therapeutic dose
- Time and staffing constraints

System factors

- Reimbursement gaps (U.S. garments not covered until the Lymphedema Treatment Act, effective 2024)
- Fragmented care and poor referral pathways
- Supply access and delays

Closing the gap: Standardized ABI pathways, hands-on bandaging training and competency checks, self-management systems (hosiery kits, adjustable wraps — VenUS IV), early referral for reflux ablation (EVRA), lifelong maintenance compression after healing, leverage new garment coverage

Bottom line: Compress early, compress adequately (≈40 mm Hg), compress for life

Perry C, et al. *J Adv Nurs*. 2023;79(7):2568–2584. Fife CE, et al. *Wound Repair Regen*. 2010;18:154–158. Latz CA, et al. *Chronic Wound Care Manag Res*. 2015;2:11–21.

Venous Disease, Lymphedema, and Phlebolymphedema Skin Integrity

Frank Aviles
Director of Clinical Strategy, Education, & Innovation, Aetherus Wound and Lymphatics; Co-Owner, Advanced Wound & Lymphatic Institute
Tampa, FL

One Lower Leg, Three Overlapping Problems

The common pathway is persistent edema + inflammation → skin failure

VENOUS DISEASE

Venous hypertension
→ capillary leak
→ inflammation
→ hemosiderin + dermatitis

LYMPHEDEMA

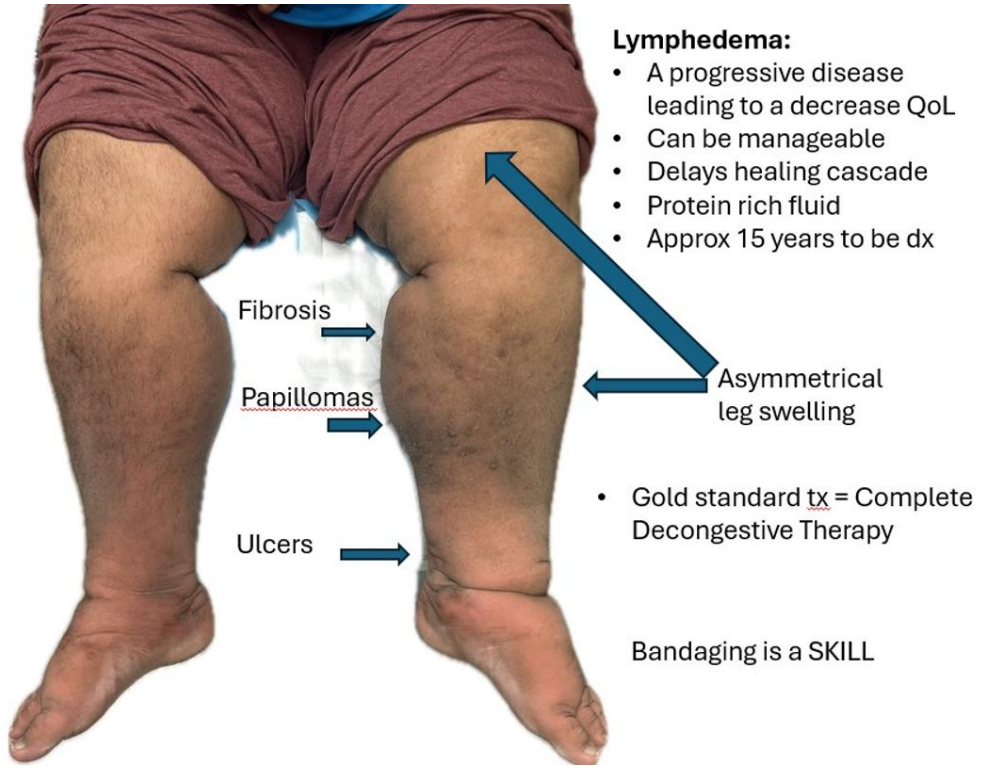
Protein-rich interstitial fluid
→ chronic inflammation
→ fibrosis
→ hyperkeratosis + infection risk

PHLEBOLYMPHEDEMA

Venous overload exceeds lymphatic reserve
→ combined venous + lymphatic failure
→ escalating tissue change

WOCN CLEVDAL algorithm (2022 update); DermNet venous insufficiency overview.

Venous Disease: What the Skin Is Telling You



- Pitting edema, heaviness, aching
- Stasis dermatitis: erythema, scaling, itch
- Lipodermatosclerosis / “inverted champagne bottle”
- Atrophie blanche and ulceration signal advanced damage

DermNet: chronic venous insufficiency; WOCN lower-extremity venous disease guidance.

Lymphedema: The Skin Becomes Part of the Disease



- Persistent swelling stretches and weakens skin
- Fibrosis reduces tissue compliance
- Dry fissured skin creates portals for bacteria
- Lymphorrhea causes maceration and moisture damage
- Recurrent cellulitis can further injure lymphatics

WOCN CLEVDAL: stage-based lymphedema care includes skin/nail care, compression, exercise and CDT referral when indicated.

Phlebolymphedema: When Venous Load Overwhelms Lymphatic Reserve

VENOUS HYPERTENSION → **MORE FLUID + PROTEIN TO CLEAR** → **LYMPHATIC RESERVE IS EXCEEDED**

↓

Persistent edema → fibrosis → dermatitis → ulceration / lymphorrhea

Clinical clue: "Venous" leg remains chronically swollen, fibrotic, distorted, or develops lymphatic skin changes





WOCN CLEVDAL explicitly includes chronic venous insufficiency with phlebolymphedema in its compression pathway.

Skin Health: Adequate Compression (AD) Matters



Prior to AD & CDT



Closed in <2 months

Assess the Skin before It Opens

Look, feel, measure — and identify the driver

1. **LOOK:** Color, scaling, fissures, weeping, papillomatosis, wounds
2. **FEEL:** Temperature, pitting, fibrosis, tissue texture, tenderness
3. **MEASURE:** Edema/girth, wound dimensions, limb asymmetry
4. **SCREEN:** Pulses + ABI/TBI when indicated before compression
5. **ASK:** Mobility, calf pump, prior DVT/cellulitis, compression use

WOCN CLEVDAL: vascular assessment and individualized compression selection are central to lower-extremity management.

Skin Protection: Small Actions Prevent Big Problems



- Cleanse gently; avoid harsh soaps and soaking
- Moisturize intact skin with a non-sensitizing emollient
- Control dermatitis/eczema promptly
- Protect from friction, scratching, footwear trauma, and adhesives
- Manage lymphorrhea with absorbency + edema control
- Teach daily inspection and early reporting of redness, warmth, or drainage

WOCN CLEVDAL recommends skin hygiene, moisturization, trauma avoidance and dermatitis management as part of venous/lymphatic care.

Compression:
Treat the Pressure That Is Damaging the Skin

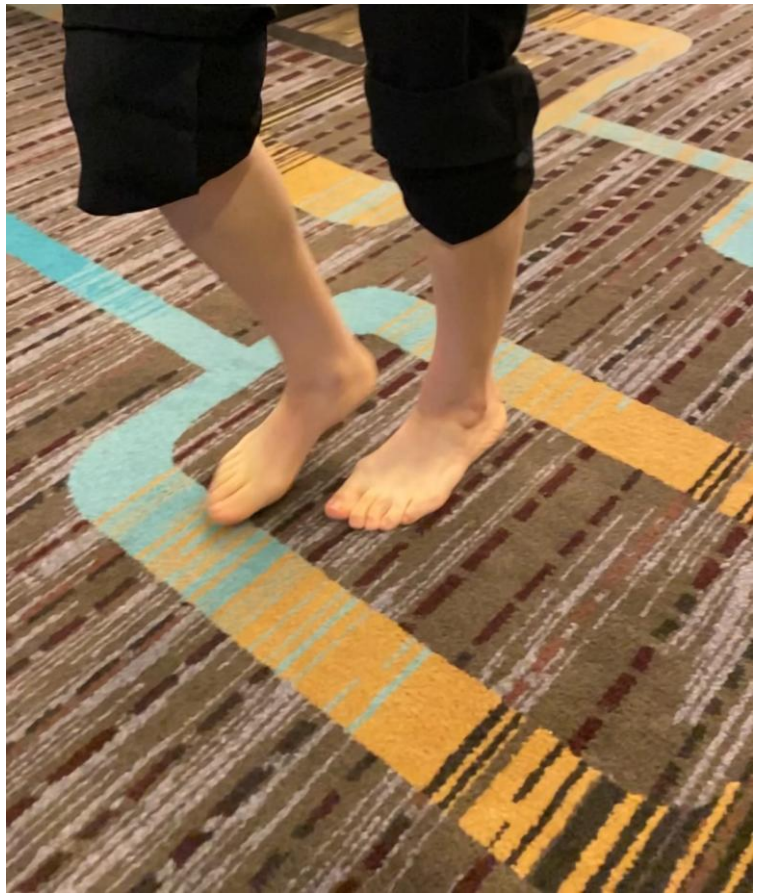


- Cornerstone for venous disease and lymphedema
- Reduces edema and supports venous + lymphatic return
- Choose type/level based on arterial status, limb shape, mobility, dexterity, comfort, and adherence
- Active VLU: Compression improves healing vs no compression
- For mixed arterial disease, modify compression and follow vascular guidance

Do not “wrap first and assess later.” Establish adequate arterial perfusion.

2025 SCAI guideline: compression probably increases venous ulcer healing; WOCN CLEVDAL provides ABI-based compression pathways.

Move the Fluid: Compression Works Better with Muscle



- Walking and ankle motion activate the calf muscle pump
- Progressive resistance + aerobic exercise can supplement compression in VLU care
- Elevation may reduce venous edema when appropriate
- CDT combines compression, exercise, skin care, and MLD for lymphedema
- Consider intermittent pneumatic compression as an adjunct in selected patients

WOCN CLEVDAL: exercise, CDT and intermittent pneumatic compression are adjuncts to compression in appropriate venous/lymphatic patients.

Move the Fluid: Compression Works Better with Muscle



- Walking and ankle motion activate the calf muscle pump
- Progressive resistance + aerobic exercise can supplement compression in VLU care
- Elevation may reduce venous edema when appropriate
- CDT combines compression, exercise, skin care, and MLD for lymphedema
- Consider intermittent pneumatic compression as an adjunct in selected patients

WOCN CLEVDAL: exercise, CDT and intermittent pneumatic compression are adjuncts to compression in appropriate venous/lymphatic patients.

Pneumatic Compression Options

Basic Pneumatic Compression

Appropriate patient selection:

- Below-knee edema, skin changes, or ulceration
- No truncal or proximal swelling
- Chronic edema, lymphedema, venous insufficiency
- Needs a simple daily routine to sustain at home
- Lightweight, travel-friendly





Copyrights to photos obtained by AAWC

Advanced Pneumatic Compression

Appropriate patient selection:

- Non-healing or recurrent leg ulcers and infection
- Proximal or truncal edema present
- Tried and failed conservative compression
- Fibrosis or advanced skin changes





http://www.jucm.com/evaluation-and-management-of-lower-extremity-edema/

79% reduced cellulitis episodes

88% experience limb volume reduction

71% fewer ulcers

Karaca-Mandic P, et al. *JAMA Dermatol*. 2015;151(11):1187-1193. Muluk S, et al. *Eur J Vasc Endovasc Surg*. 2013;46(4):480-487. Blumberg SN, et al. *Ann Vasc Surg*. 2016;30:40-44.

Non-Pneumatic Compression



- Mobile, wearable compression treatment for chronic edema, lymphedema, CVI, and related conditions
- Multimodal, combining therapies in one easy-to-use solution
- Allows for active movement during treatment, promoting lymphangion contractions
- Minimizes interference with ADLs, enhancing patient adherence and quality of life
- Easy to self-administer and adapts to changes in limb size day-to-day

Non-Pneumatic Compression Integrates Three Proven Modalities in One Treatment for Synergistic Clinical Outcomes

Static Compression

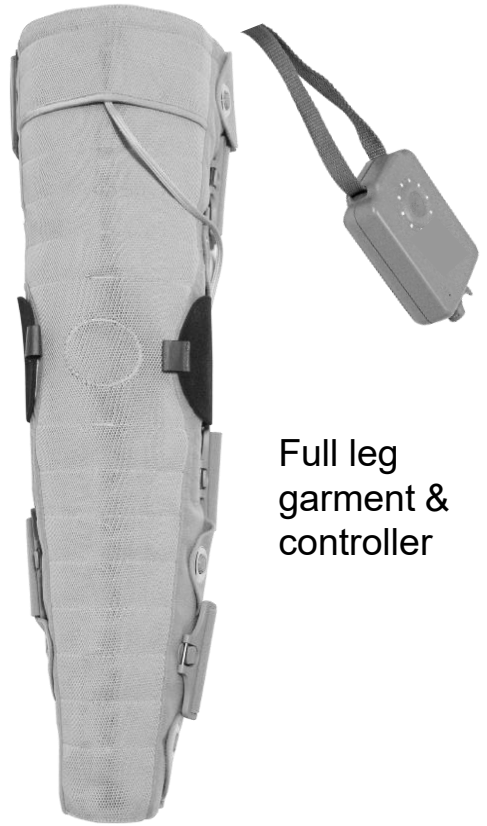
- Inelastic fabric garment applies consistent, uniform pressure
- Improves baseline lymphatic flow and reduces localized swelling

Active Compression

- Nitinol powered by the mobile controller delivers non-pneumatic gradient sequential compression while allowing patients to maintain natural movement

Muscle Engagement

- Promotes muscle engagement, such as the calf and thigh pumps during walking or exercise
- Enhances lymphatic drainage and venous return



Full leg garment & controller

Match the Strategy to the Skin Problem

SKIN FINDING	CLINICAL RESPONSE
Dry/scaly/itchy	Gentle cleanse + emollient; treat dermatitis
Weeping/lymphorrhea	Absorbent dressing + compression / edema control
Fibrotic/distorted limb	CDT; short-stretch or adjustable compression; reassess fit
Active venous ulcer	Wound bed management + compression after vascular assessment
Recurrent cellulitis	Skin barrier protection; recognize and treat infection promptly

Evidence-based strategy summary adapted from WOCN CLEVDAL and lower-extremity venous disease guidance.

The 5 Things I Want You to Remember

1. Skin change is a disease signal — not a cosmetic issue
2. Persistent edema drives inflammation, fibrosis, and breakdown
3. Protect the barrier: Cleanse gently, moisturize, prevent trauma
4. Compression is foundational — but only after appropriate vascular assessment
5. Treat the whole pump: Compression + movement + long-term self-management

Prevent skin failure by treating the edema before the skin opens

Key References and Clinical Tools

1. Ratliff CR, et al. Compression for Lower Extremity Venous Disease and Lymphedema (CLEVDAL): Update of the VLU Algorithm. *J Wound Ostomy Continence Nurs*. 2022;49(4):331-346.
2. Wound, Ostomy and Continence Nurses Society. Compression for Lower Extremity Venous Disease and Lymphedema: An Evidence- and Consensus-Based Algorithm.
3. 2025 SCAI Clinical Practice Guidelines for the Management of Chronic Venous Disease. Compression for venous ulcers was associated with improved healing compared with no compression.

Clinical tool: WOCN CLEVDAL algorithm — vlu.wocn.org

Unna Boots and Beyond:
Does the Evidence Support Compression Products for Skin Integrity in Venous Disease?

Lucian G. Vlad, MD, MHI, FACCWS
Fellowship Director, Wound Care and Hyperbaric
Wound Care & Hyperbaric Clinic, Atrium Health Wake Forest Baptist
Wake Forest University School of Medicine
Winston-Salem, NC

Venous Leg Ulcers: Common, Under-Recognized, Under-Treated

≈600,000

Americans with a VLU each yr; >$3.5 billion annual cost

20%–40%

of VLU patients receive compression at all, despite guideline status

31% · 54%

received no compression (Germany); no compression stockings (Spain)

≈60%

of Medicare VLU claims had no wound measurement recorded

What this looks like in the clinic

- The leg is wrapped in gauze and crinkle-weave fluff bandage rolls for months before anyone names the etiology
- When compression is finally started, it is often the cheapest and most familiar system — the paste boot — rather than the best-evidenced one
- Prevalence rises steeply with age; patients ≥65 have the worst long-term prognosis
- Every downstream slide assumes the diagnosis was made and arterial status was checked — neither is guaranteed

Rice JB, et al. *J Med Econ*. 2014;17:347-356. Tettelbach WH, et al. *J Wound Care*. 2023;32:704-718. German/Spanish data as cited in Kolluri R, et al. *Vasc Med*. 2022;27:63-72. Ulcus Cruris Care pilot study (Germany), 2023.

What Compression Has to Deliver

The target

≥40 mm Hg

at the ankle, graduated to the knee — *strong compression* as defined in VenUS 6 and UK national guidance

30–50 mm Hg is the practical window: below that, venous hypertension persists; above, discomfort and skin damage rise

Inelastic: low resting / high working pressure — needs a working calf pump

Elastic: sustained pressure at rest and while walking

Compression vs no compression (Cochrane 2021, moderate certainty)

HR 2.17

time to complete healing (95% CI 1.52–3.10; 5 RCTs, n=733)

RR 1.77

complete healing within 12 months (95% CI 1.41–2.21; 10 RCTs, n=1,215)

−1.39

mean pain score vs no compression (95% CI −1.79 to −0.98)

Better QoL

disease-specific quality of life probably improves (low certainty)

The debate is not whether to compress. It is which system delivers the dose reliably, in real patients, over months.

Shi C, et al. *Cochrane Database Syst Rev*. 2021;7:CD013397. Partsch B, Partsch H. *J Vasc Surg*. 2005;42:734-738. Arundel C, et al. *PLoS Med*. 2026;23:e1005154.

The Unna Boot: 1896 Technology, Still the U.S. Default



Photo: Author's own

Paste bandage + cohesive cover wrap (typical U.S. *Unna boot*)

What it is

- Paul Gerson Unna, 1896: gauze impregnated with zinc oxide, gelatin, glycerin — originally a low-compression (18–24 mm Hg) dressing
- Inelastic once set: high working pressure with calf contraction, low pressure at rest
- Changed every 3–7 days; zinc paste is skin-protective for periwound dermatitis

Why it persists

- Low cost, universally stocked, a single CPT code (29580), every wound clinic knows how to apply it

Why it may underperform

- Pressure is set once and cannot follow the limb as edema resolves — the dose falls between visits
- No pressure indicator; delivered pressure is operator-dependent
- Poorly suited to highly exudative wounds; not self-applied, so continuity depends on clinic access

Paranhos T, et al. *Wound Repair Regen*. 2021;29:443-451.

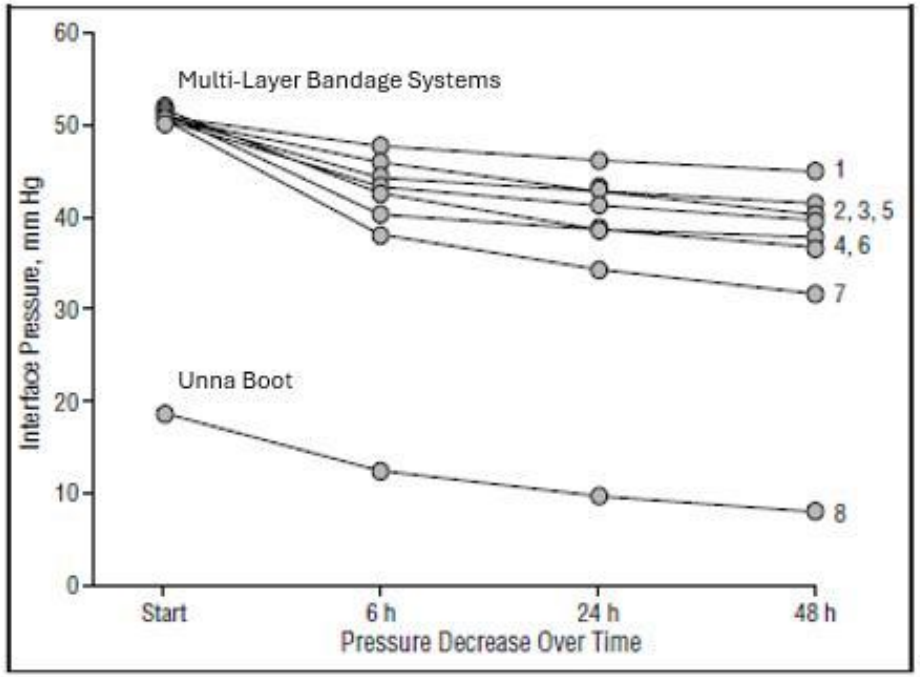
Compression Is Not One Thing

System	Construction	Pressure behavior	Applied by	Typical change	Evidence position
Unna Boot (Zinc Paste)	Single inelastic component; paste + cover wrap	Static; loses pressure as edema falls; low resting / high working	Clinician	Weekly (3–7 d)	Old, small trials; no superiority shown
Short-Stretch Bandage	1–3 inelastic layers	Low resting / high working; needs calf pump	Trained clinician	Weekly or sooner	Inferior to 4LB for time to healing
4-Layer Bandage (4LB)	Padding + crepe + elastic + cohesive	Sustained ≈40 mm Hg at rest and walking	Trained clinician	Weekly	Reference standard (VenUS I, Cochrane)
2-Layer Bandage (2LB)	Padded base + cohesive elastic top	Sustained ≈40 mm Hg; pressure indicators on some systems	Trained clinician	Weekly	Non-inferior to 4LB/2LH (VenUS 6, mITT)
2-Layer Hosiery (2LH)	Liner + overstocking	Sustained ≈40 mm Hg	Patient/caregiver	Daily doffing possible	Equivalent to 4LB (VenUS IV)
Adjustable Wrap (CW)	Hook-and-loop inelastic panels	Adjustable; depends on user re-tightening	Patient/caregiver	Daily adjustment	Slower healing than 4LB/2LH (VenUS 6)

Paranhos T, et al. *Wound Repair Regen*. 2021;29:443-451. Arundel C, et al. *PLoS Med*. 2026;23:e1005154. Hanna R, et al. *Br J Nurs*. 2008;17(20):S16-S24.

A Comparison of Multilayer Bandage Systems During Rest, Exercise, and Over 2 Days of Wear Time

- Unna boots underperform in human leg pressure measurement
  - “Short stretch bandages and the Unna boot with an inelastic zinc plaster bandage generate large pressure waves while walking and showed a marked pressure decrease when the patient was supine, but they lose a lot of their pressure within the first hours of wear”



Unna boots demonstrate substantially lower interface pressure and greater pressure decline over time than multi-layer bandage systems



Hafner J, et al. *Arch Dermatol.* 2000;136(7):857-863.

Direct Evidence: Unna Boot vs Other Compression Systems

Paranhos 2021 systematic review and meta-analysis — 8 studies (6 RCTs), 643 patients, Doppler-confirmed VLU

OR 0.45

complete healing, Unna boot vs comparator (95% CI 0.22–0.92; 4 RCTs, n=245; I^2 = 8%) — favors comparator

+41 days

longer mean time to complete healing with Unna boot (95% CI 21.6–61.0; 2 studies; I^2 = 85%; low certainty)

0 of 8

studies found the Unna boot superior to a comparator on healing

Representative trials

- Polignano 2004 (n=68): 4LB 74% vs Unna 66% healed at 24 wks — 'equivalent'
- Mosti 2011 (n=99): 2-component system vs zinc paste — healing NS; easier removal
- Dolibog 2013 (n=147, 5 arms): 2-month healing 57%-59% with IPC / stockings / multilayer vs 20% with Unna boot

Conclusion: better technology systems are more efficient; the boot remains a low-cost option

Paranhos T, et al. *Wound Repair Regen*. 2021;29:443-451 (PROSPERO CRD42019127947). Polignano R, et al. J *Wound Care*. 2004;13:21-24. Dolibog P, et al. *Int J Med Sci*. 2013;11:34-43. Mosti G, et al. *Wounds*. 2011;23:126-134.

Class-Level Evidence: What Cochrane Tells Us About Construction

1. **Compression beats no compression**
   Every review, every era

2. **Multi-component beats single-component**
   The Unna boot is a single-component system

3. **Elastic-layer systems beat mainly inelastic ones**
   The Unna boot is inelastic

4. **4LB heals faster than short-stretch**
   IPD meta-analysis: HR 1.31 (1.09–1.58); median 90 vs 99 days

5. **2LB and 2LH perform as well as 4LB**
   VenUS IV: hosiery equivalent and more cost-effective;
   VenUS 6: 2LB non-inferior (mITT)

Where the paste boot sits

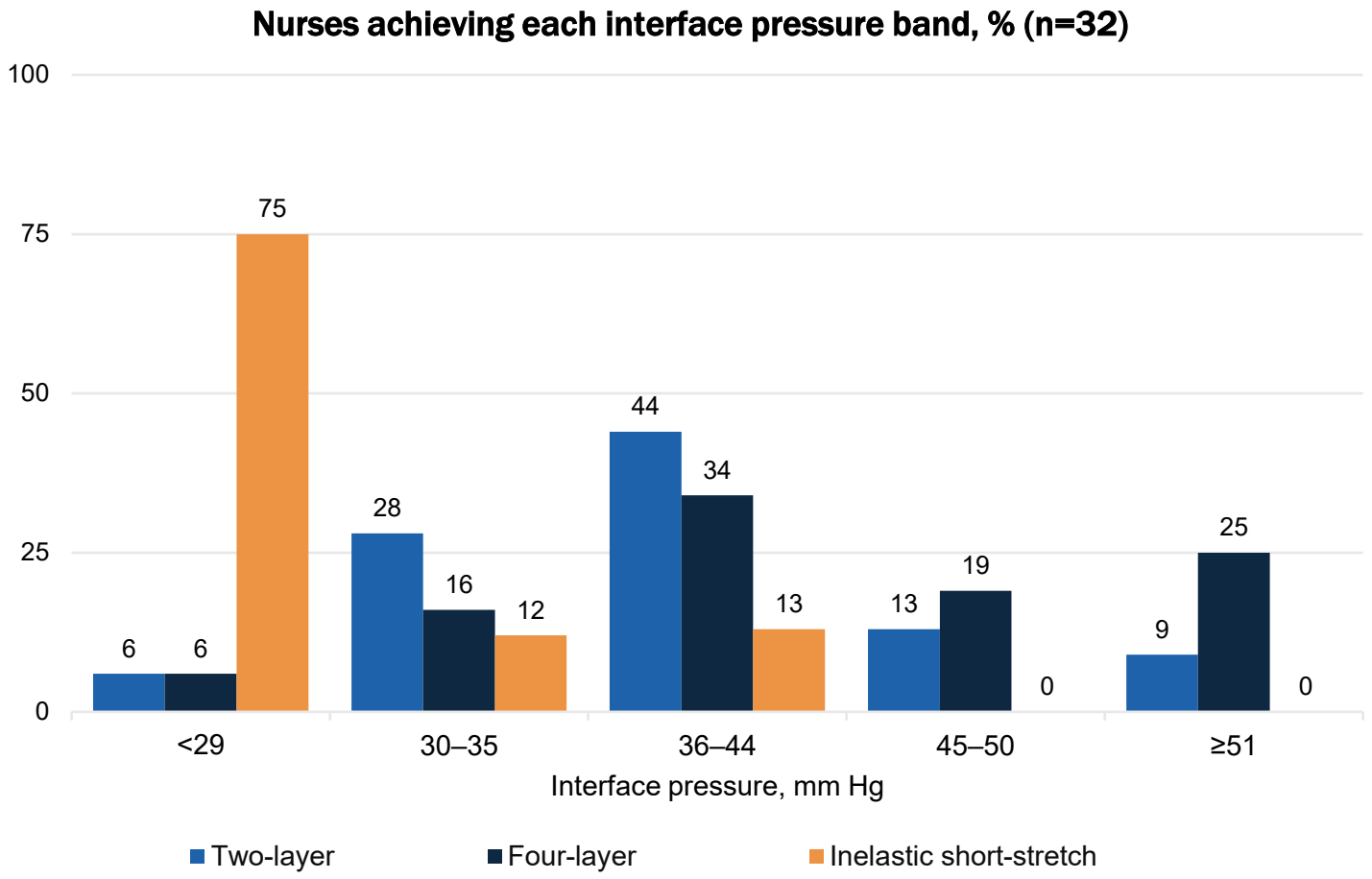
It fails the 2 construction criteria (2 and 3) that predict faster healing across the whole literature.

That is a mechanistic argument, not a trial result — but it is consistent with every head-to-head comparison we have.

Stockings vs bandages (Amsler 2009, 8 RCTs): 63% vs 47% healed; ≈3 wks faster; less pain.

O'Meara S, et al. *Cochrane Database Syst Rev*. 2012;11:CD000265. O'Meara S, et al. *BMJ*. 2009;338:b1344. Ashby RL, et al. *Health Technol Assess*. 2014;18(57). Amsler F, et al. *J Vasc Surg*. 2009;50:668-674.

Application Matters — Hanna 2008: Same Nurses, 3 Systems, 1 Leg



85% · 69% · 25%

in the 30-50 mm Hg therapeutic window: 2LB · 4LB · inelastic

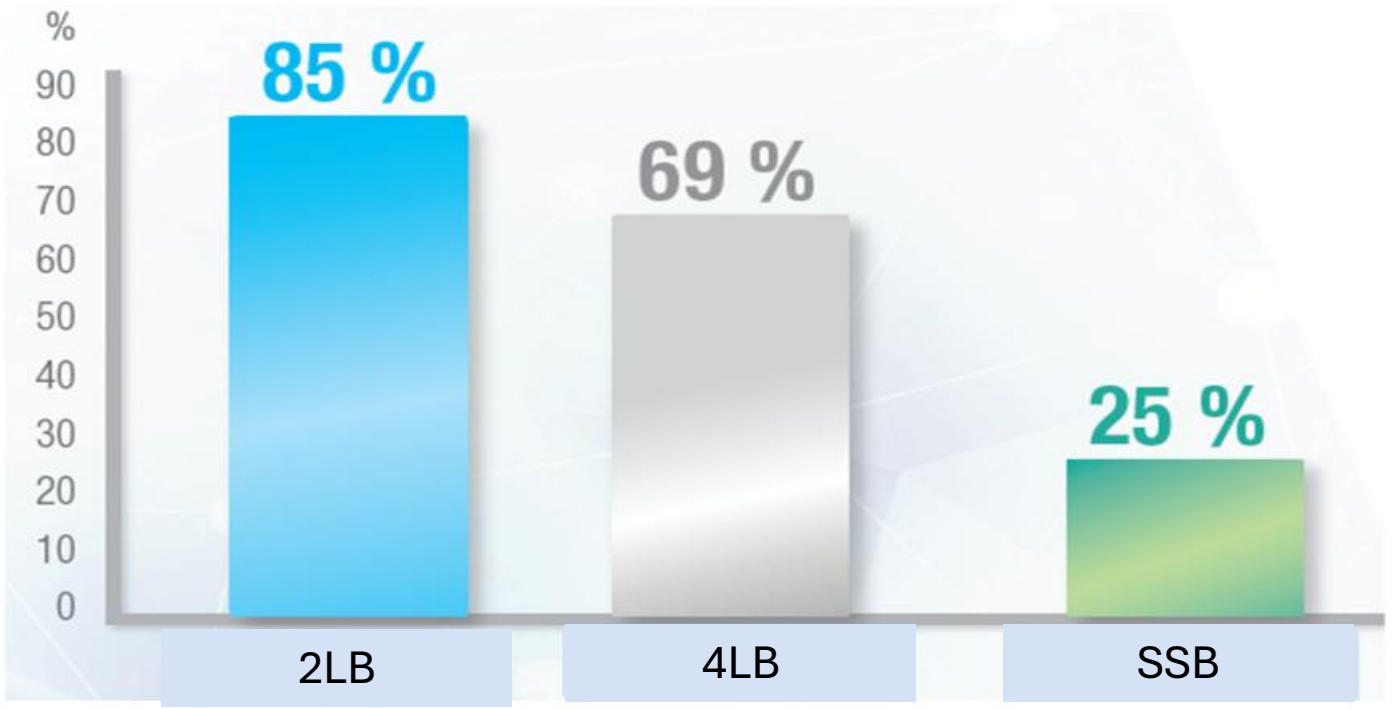
44 · 40 · 23 mm Hg

mean pressure: 4LB · 2LB · inelastic (SD 12, 11, 10)

- 1 in 4 four-layer applications exceeded 50 mm Hg — the skin-damage zone
- 3 in 4 inelastic applications were sub-therapeutic — even in experienced hands
- Pressure indicators narrowed the spread on the second application
- **Lesson for the paste boot: inelastic, indicator-free, operator-dependent**

Hanna R, et al. *Br J Nurs*. 2008;17(20):S16-S24. Industry-supported (Urgo); healthy volunteer, seated; Kikuhime sensor at B1.

Consistency —
Percentage of Nurses Achieving 30-50 mm Hg on First Application



- 85% of nurses (n=32) achieved therapeutic pressure on first application with 2LB, with no prior experience
- SSB achieves sub-therapeutic pressures
- 4LB delivers high pressure, which can be uncomfortable and lead to skin damage

Hanna R, et al. *Br J Nurs*. 2008;17(20):S16-S24.

VenUS 6 (2026): The Largest VLU Treatment Trial Ever Conducted

637 adults with VLU · 33 UK sites · 2021-2024 · mean age 70 (range 25-97) · blinded photographic healing assessment

Compression wraps (CW)	2-layer bandage (2LB)	Evidence-based compression (EBC)
n=213	n=211	4LB or 2LH by choice · n=213

Primary outcome: time to blind-assessed healing (Cox; adjusted for ulcer area, duration, age, mobility, site)

HR 1.01

2LB vs EBC (95% CI 0.79–1.28): non-inferior on mITT analysis (margin 1.33)

HR 0.78

CW vs EBC (95% CI 0.61–1.00; *p*=0.046): healing slower with wraps

HR 0.79

CW vs 2LB (95% CI 0.61–1.01; *p*=0.056)

12-month healing (KM): EBC 79.4% · 2LB 80.1% · CW 76.2%. No differences in infection, deterioration, new ulcers, QoL or pain — all imprecise.

Caveats: 71% received a non-allocated compression at some point; the hypothetical-strategy analysis (HR 1.16, 0.86–1.58) did not confirm non-inferiority; healing events fell short of the 80% power target; no Unna boot arm.

Authors' conclusion: adjustable compression wraps are unlikely to be an optimal first-line treatment. Participants in the compression-wrap group experienced **slower times to healing** and a lower overall number of healed ulcers compared to both the EBC and 2LB groups.

Arundel C, et al. *PLoS Med*. 2026;23(7):e1005154. ISRCTN67321719. NIHR HTA 128625. Open access.

Skin Integrity as an Outcome: The Evidence Gap

Objective 3 asks about skin integrity, not just closure. Here is what the literature can and cannot say.

What we have

- Healing is the primary outcome in essentially every compression RCT; skin outcomes are secondary or absent
- VenUS 6: no significant differences between wraps, 2LB and 4LB/2LH in skin deterioration, ulcer deterioration, infection or new ulceration at 6 and 12 months — with wide CIs
- Recurrence numerically lowest with wraps and highest with EBC — compatible with no difference
- Zinc paste is protective for periwound dermatitis in practice; no controlled data isolates that effect

What we don't have

- No RCT comparing compression systems on dermal health, microcirculation, or lipodermatosclerosis as primary endpoints
- No trial of the Unna boot reports skin-integrity outcomes beyond healing and pain
- Pressure-related skin injury is under-reported: Hanna showed 25% of 4LB applications >50 mm Hg, yet trials rarely capture bandage damage systematically
- Nothing on maintenance compression and skin quality after closure in older adults — this is the "Fourth C" question

Arundel C, et al. *PLoS Med*. 2026;23:e1005154. Shi C, et al. *Cochrane Database Syst Rev*. 2021;7:CD013397. Hanna R, et al. *Br J Nurs*. 2008;17(20):S16-S24. Paranhos T, et al. *Wound Repair Regen*. 2021;29:443-451.

Congested vs Decongested Leg





Before and after decongestion



Improving skin quality through the use of a multilayer compression system (Dual Compression System, DCS*) in patients with chronic venous insufficiency

Emily Greenstein, APRN, CNP, CWON-AP, FACCWS

INTRODUCTION

Patients with long-standing venous insufficiency will often develop pathological changes to the skin due to chronic inflammation. Changes such as atrophie blanche, blanche plaques, epidermal lichenification, hemosiderin staining, lipodermatosclerosis, and venous eczema[1]. These changes can be painful to the patient and lead to ulceration.

PREVIOUS PRACTICE

A variety of compression systems have been utilized to provide compression therapy for patients with venous hypertension. Patients have reported difficulty in finding compression wraps that stay in place. The gold standard treatment is graduated compression therapy; however, the characteristics of uneven contour of the affected leg poses severe challenges to keeping compression devices in place[2].

PROPOSED SOLUTION

A novel multilayer venous compression wrap that combines both a short stretch and a long stretch bandage, contains visual indicators that ensure that the correct therapeutic pressure is always applied. It is also highly evidence based[3-9] and sometimes referred to as the Dual Compression System or DCS*. The combination of a short and long stretch bandage reduces bandage slippage via the use of a novel knitted base layer. The compression wrap was used on multiple patients with a history of skin changes as a result of chronic venous insufficiency. 10 patients were selected consecutively to receive treatment with a novel multilayer compression bandage. All patients had previously been treated with another form of compression. Some of these patients had wounds, and some did not but all had skin that was red, itchy and generally in poor condition.

TABLE 1

Age	Ulcer	Skin Improvement	Comfort Rating	# of Weeks in Wrap
59	N	Y	8 out of 10	3
63	Y	Y	9 out of 10	5
78	Y	Y	7 out of 10	5
76	N	Y	10 out of 10	4
91	N	Y	8 out of 10	8
64	Y	Y	9 out of 10	6
72	N	Y	10 out of 10	3
71	N	Y	8 out of 10	3
56	Y	Y	9 out of 10	5
44	Y	Y	9 out of 10	6

FIGURE 1

59 year old male history of arterial fibrillation, venous insufficiency, Type 2 diabetes, COPD with continuous oxygen use.

Cleansed with pure hypochlorous acid cleanser solution**, Xeroform® , DCS novel bandage wrap



Day 1 Day 14

FIGURE 2

63 year old male history Venous insufficiency, Type 2 DM, Gastric bypass

Cleansed with pure hypochlorous acid cleanser solution**, xeroform, DCS novel bandage wrap



Day 1 Day 7 Day 14 Day 28

FIGURE 3

78 year old male history of Venous insufficiency, Type 2 diabetes

Cleansed with pure hypochlorous acid cleanser solution **, amniotic graft, silicone nonadherent dressing, DCS novel bandage wrap



Day 1 Day 14 Day 28

FIGURE 4

76 year old male history of cellulitis, Venous insufficiency, Type 2 diabetes, lymphedema

Cleansed with pure hypochlorous acid cleanser solution**, Skin protectant lotion, DCS novel bandage wrap



Day 1 Day 14 Day 21

RESULTS

The use of a novel multilayer venous compression was able to improve skin quality in patients with chronic venous insufficiency with a high degree of success (Table 1). Each patient reported the dressings did not slip down to cause discomfort, on a comfort score of 1-10, was comfortable to wear, and improved lower leg skin quality. Two cases are presented (Figures 1 - 4) and the visual improvement is worthy of note. Both patients with wounds and without wounds are represented.

CONCLUSION

The usage of a multilayer venous compression system may improve patient compliance, skin quality, and prevent the development of chronic venous ulcerations. Mechanisms of why this happens have been proposed, including the drainage of lymph (generally that contains tissue waste whose continued presence likely vitiates the skin condition). It is also possible that tissue decompression leads to better micro-arterial circulation to the dermis[10]. The skin improvement seen is highly related to patient satisfaction with the bandage.

REFERENCES

1. Mosti G, Atkin L, Auburn R, et. El. Leg ulceration in venous and arteriovenous insufficiency assessment and management with compression therapy as part of a holistic wound-healing strategy. JWC. 2024; 33(10 sup 8.
2. Kirsner RS, Pardes JB, Eaglstein WH, Falanga V. The clinical spectrum of lipodermatosclerosis. J Am Acad Dermatol. 1993;28(4):623–637.
3. Stücker M et al, Multicomponent compression system use in patients with chronic venous insufficiency: a real-life prospective study. J Wound Care. 2021 May 2;30(5):400-412.
4. Lazareth I, et al. Efficacy of two compression systems in the management of VLUs: results of a European RCT. J Wound Care. 2012 Nov;21(11):S53-4, 556, 558 passim.
5. Lantis JC 2nd, et al. A dual compression system: preliminary clinical insights from the US. J Wound Care. 2020 Sep 1;29(Sup9):S29-S37. doi: 10.12968/jowc.2020.29.Sup9.S29. https://pubmed.ncbi.nlm.nih.gov/32924806/
6. Bowering CK. Use of layered compression bandages in diabetic patients. Experience in patients with lower leg ulceration, peripheral edema, and features of venous and arterial disease. Adv Wound Care. 1998 May-Jun;11(3):129-35. PMID: 9729944.
7. Benigni JP, et al. Efficacy, safety and acceptability of a new two-layer bandage system for venous leg ulcers. J Wound Care. 2007 Oct;16(9):385-90.
8. Hanna R et al. A comparison of interfacepressures of three compression bandage systems. Br J Nurs. 2008 Nov 13-26;17(20):S16-24.
9. Jünger M, et al. Comparison of interface pressures of three compression bandaging systems used on healthy volunteers. J Wound Care. 2009 Nov;18(11):474, 476-80.
10. Mayrovitz HN, Macdonald JM. Medical compression: effects on pulsatile leg blood flow. Int Angiol. 2010 Oct;29(5):436-41.

*UrgoK2, Urgo Medical North America
**Vashe Wound Solution, Urgo Medical North America
This poster was presented with the support of Urgo Medical North America
802-PB012

To Compress or Not Compress: Diabetic Foot Ulcers with Concurrent Venous Dermatitis and / or Stasis Skin Changes

Yvette Mier, BSN/RN/CWON – Clinical Supervisor, Wellstar Kennestone Regional Medical Center, Outpatient Wound Center. Marietta, GA

INTRODUCTION

Diabetes mellitus affects approximately 11.6% of the U.S. population, with 25% developing a diabetic foot ulcer (DFU) during their lifetime and 24% progressing to amputation. In parallel, 35% of the U.S. population has venous and lymphatic dysfunction. The shared risk factors between these two populations suggest a high likelihood of clinical overlap.

Stasis dermatitis and chronic skin changes are a cutaneous manifestation of underlying venous and lymphatic dysfunction. When present in patients with DFU's, wound healing is delayed up to 40%. Identification and management of venous and lymphatic dysfunction is a critical component in optimizing DFU outcomes, particularly with respect to limb preservation.

METHODS

A retrospective case series was conducted involving 15 randomly selected patients treated at an outpatient wound care center within the past five years. Inclusion criteria were patients with DFU's in conjunction with venous and lymphatic dysfunction, as evidenced by stasis dermatitis or chronic skin changes. There were no exclusion criteria.

All patients underwent a comprehensive vascular assessment to evaluate arterial perfusion and venous reflux. Standardized DFU treatment protocols were implemented, including cleansing with a pure hypochlorous acid solution, sharp debridement, offloading, and glycemic control. Advanced wound care modalities were applied as clinically indicated. Venous and lymphatic dysfunction was managed using a two-component, dual-layer compression therapy system delivering a minimum of 20–30 mmHg. Stasis dermatitis and edema response to compression therapy was monitored through serial visual assessment.

RESULTS

Resolution of stasis dermatitis was observed in all cases within 1 to 4 weeks following initiation of compression therapy. Fourteen of the fifteen DFU's achieved complete epithelialization within a time frame of 3 to 23 weeks. One patient required amputation due to the development of gas gangrene. No adverse events related to compression therapy were reported, underscoring its safety when preceded by appropriate vascular evaluation.

CASE 1



CASE 2



CASE 3



PATIENT #	ULCER AGE PRIOR TO START OF CARE	WOUND SIZE AT START OF CARE	# OF WEEKS FROM ADMISSION TO ULCER CLOSURE	HbA1c	OFFLOADED	COMPLIANT WITH OFFLOADING?	CLEANSING AGENT USED	ADVANCED WOUND CARE MODALITY USED	VENOUS SKIN CHANGES OR DERMATITIS PRESENT	IF DERMATITIS PRESENT, #OF WEEKS TO RESOLUTION	HgA1c2	Co-morbidities
1	4 MONTHS	1 x 0.5 x 0.3CM	18	10.5	CROW BOOT	NO	PURE HYPOCHLOROUS ACID	NO	YES	4 WEEKS	10.5	Diabetes, Lymphedema, Morbid Obesity, history of sepsis, Cardiomyopathy, Hypertension, Charcot foot, Osteomyelitis, Stroke with prolonged hospitalization, DVT, Sleep apnea
2	2 MONTHS	0.8 X 1.5 X 0.3CM	16	7.9	CROW BOOT	YES	PURE HYPOCHLOROUS ACID	BIO-ENGINEERED, LIVING, CELL-BASE SKIN SUBSTITUTE	YES	N/A	7.9	Diabetes, Lymphedema, Congestive Heart Failure, Morbid Obesity, history of sepsis, ESRD on dialysis
3	3 MONTHS	4.8 L X 4.8 L X.1CM	10	8.9	ROYCE WALKER	YES	PURE HYPOCHLOROUS ACID	NO	YES	2 WEEKS	8.9	Diabetes, Lymphedema, Obesity, Budd-Chiari syndrome, Chronic Kidney Disease- grade 3, Hepato-renal syndrome, History of obstructive inferior vena cava.
4	3 MONTHS	12 X 5 X 0.2CM	10	6.7	ROYCE WALKER	YES	PURE HYPOCHLOROUS ACID	NO	YES	3 WEEKS	6.7	Diabetes, lymphedema, ESRD on dialysis, Peripheral arterial disease, Asthma, Congestive heart failure, Depression, Stroke, DVT.
5	1 MONTH	8.5 X 3.0 X 1.8CM	16	7.2	KNEE SCOOTER	YES	PURE HYPOCHLOROUS ACID	HBO AND CRYOPRESERVED, LIVING HUMAN SKIN ALLOGRAFT	YES	2 WEEKS	7.2	Diabetes, Lymphedema, Obesity, Hypertension, Osteomyelitis, Chronic kidney disease
6	2 WEEKS	1.5 X 1.5 X 0.1CM	23	6.2	NO	N/A	PURE HYPOCHLOROUS ACID	NO	YES	N/A	6.2	Diabetes, Lymphedema, Hypertension, Renal insufficiency, Fatty liver disease, DVT's with multiple PE's.
7	2 WEEKS	0.9 X 0.8 X 0.3 CM	3	4.8	ROYCE WALKER, WHEELCHAIR	YES	PURE HYPOCHLOROUS ACID	HBO	YES	N/A	4.8	Diabetes, Lymphedema, End Stage Renal Disease, PAD revascularized Thyroid disease, Osteomyelitis, Morbid Obesity, DVT, history of bariatric surgery
8	3 MONTHS	5.8 X 4.2 X 1.8CM	AMPUTATION	12.9	CROW BOOT	NO	PURE HYPOCHLOROUS ACID	HBO	YES		12.9	Diabetes, Hypertension, Lymphedema, Charcot foot and ankle
9	3 MONTHS	1 X 1 X 1CM	13	7.1	DARCO DUO	YES	PURE HYPOCHLOROUS ACID	HBO, BILAYERED BIOENGINEERED SKIN SUBSTITUTE	YES	4 WEEKS	7.1	Diabetes, Lymphedema, Peritoneal dialysis, Hypertension, Cardiomyopathy, History of Colon and renal cancer, History of TMA
10	1 MONTH	0.9 X 0.9 X 0.1CM	19	6	DARCO DUO	YES	PURE HYPOCHLOROUS ACID	ENGINEERED EXTRACELLULAR MATRIX	YES	1 WEEK	6	Diabetes, Lymphedema, Equinus deformity, History of sepsis, Hypertension
11	6 WEEKS	19 X 7 X 3 CM	15	10.5	DARCO DUO	YES	PURE HYPOCHLOROUS ACID	NO	YES	2 WEEKS	10.5	Diabetes, lymphedema, Hypotension, history of MI
12	2 MONTHS	10.7 X 5.5 X 0.7CM	16	12.2	CRUTCHES	NO	PURE HYPOCHLOROUS ACID	NO	YES	2 WEEKS	12.2	Diabetes, Lymphedema, Hypertension
13	1 MONTH	2.5 X 2 X 0.1CM	7	5.9	DARCO DUO	YES	PURE HYPOCHLOROUS ACID	NO	YES	2 WEEKS	5.9	Diabetes, Lymphedema, Klippel-trenaunay-weber syndrome, Obesity, Hypertension, History of multiple DVT's
14	1 MONTH	2.5 X 1 X 0.2CM	9	8.9	DARCO DUO	YES	PURE HYPOCHLOROUS ACID	NO	YES	1 WEEK	8.9	Diabetes, Lymphedema, HIV, CAD, Chronic Kidney Disease- stage 3
15	1 MONTH	2.5 X 3 X 0.1CM	10	6.8	DARCO DUO	YES	PURE HYPOCHLOROUS ACID	NO	YES	3 WEEKS	6.8	Diabetes, Lymphedema, Atrial fibrillation, Peripheral arterial disease, Asthma

CASE 4



DISCUSSION

Despite its demonstrated efficacy, compression therapy remains underutilized in the management of DFUs, primarily due to concerns surrounding peripheral arterial disease (PAD), which is present in 20% of patients with diabetes. This case series suggests that, when guided by comprehensive vascular assessment, compression therapy can be safely employed to enhance wound healing and reduce the risk of amputation.

One limitation of this case series is the influence of socioeconomic factors, which impacted access to advanced wound care modalities and adequate nutrition, both of which are known to affect healing trajectories.

REFERENCES

1. Alavi, A., & Sibbald, R. G. (2023). Diabetic foot ulcers in conjunction with lower limb lymphedema: Pathophysiology and management. Chronic Wound Care Management and Research, 10, 1–10. https://doi.org/10.2147/CWCMR.SXXXXXX. Dove Press
2. Gallagher, K. A., Mills, J. L., Armstrong, D. G., et al. (2024). Current status and principles for the treatment and prevention of diabetic foot ulcers in the cardiovascular patient population: A scientific statement from the American Heart Association. Circulation, 149(4), e232–e253. https://doi.org/10.1161/CIR.0000000000001192
3. Lyons, M., et al. (2024). Multifactorial analysis of risk factors for foot ulcers in patients with neurovascular complications of diabetes. Frontiers in Endocrinology, 15, 1399924. https://doi.org/10.3389/fendo.2024.1399924
4. Wounds International. (2023). Compression therapy: A guide to safe practice. Retrieved from https://www.woundsinternational.com/resources/details/compression-therapy-guide-safe-practice
5. Moffatt, C. J., Keeley, V., & Quere, I. (2021). The concept of chronic edema—A neglected public health issue and an international response: The LIMPRINT study. Lymphatic Research and Biology, 19(2), 121–126. https://doi.org/10.1089/lrb.2020.0085

*UrgoK2, Urgo Medical North America

This poster was presented with the support of Urgo Medical North America
802-PB010

Rapid Resolution of Venous Dermatitis Using Dual Compression Therapy: A Case Series

Yvette Mier, BSN/RN/CWON – Clinical Supervisor, Wellstar Kennestone Regional Medical Center, Outpatient Wound Center. Marietta, GA

INTRODUCTION

Chronic venous disease (CVD) affects approximately 25% of the U.S. population and typically progresses from mild symptoms such as leg restlessness, itching and rash to chronic edema with ulceration. Timely diagnosis and intervention are crucial to preventing disease progression and infection. Unfortunately, many patients endure prolonged symptoms due to misdiagnosis in its early stage.

This case series examines the diagnostic and therapeutic challenges associated with venous dermatitis and explores the role of compression therapy, specifically using a dual component compression system (DCS), which combines long and short stretch bandages.

METHODS

Patients with venous dermatitis of 2 weeks to 18 months duration were included. Each underwent a comprehensive vascular assessment to rule out arterial insufficiency and assess for venous reflux. All were treated with a dual component compression system applied once or twice weekly.

RESULTS

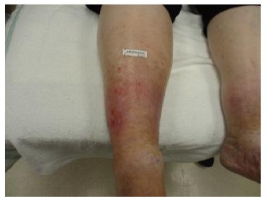
Complete resolution of venous dermatitis was observed in all cases within 8 weeks of initiating the dual compression system. Following resolution, patients were transitioned into long-term compression garments for maintenance.

PATIENT NUMBER	VENOUS DERMATITIS TRIGGER	COMPRESSION APPLIED	REPORTED WEEKS DERMATITIS PRESENT PRIOR TO WOUND CENTER ADMISSION	WEEKS IN TREATMENT	VENOUS DERMATITIS RESOLVED
1	Compression garment non-therapeutic due to age	Urgo K2 40	8	4	YES
2	Pruitis	Urgo K2 20	4	1	YES
3	Spontaneous	Urgo K2 40	22	3	YES
4	Non-compliance with prescribed compression garment	Urgo K2 40	14	3	YES
5	Spontaneous	Urgo K2 40	52	4	YES
6	Compression garment non-therapeutic due to age	Urgo K2 40	6	5	YES
7	Spontaneous	Urgo K2 40	36	4	YES
8	Spontaneous	Urgo K2 40	12	4	YES
9	Compression garment non-therapeutic due to age	Urgo K2 40	2	8	YES
10	Poor quality compression garment	Urgo K2 20	14	2	YES
11	Non-compliance with prescribed compression garment	Urgo K2 40	24	1	YES
12	Non-compliance with prescribed compression garment	Urgo K2 40	22	1	YES
13	Cellulitis	Urgo K2 40	48	1	YES
14	Sub-therapeutic compression	Urgo K2 40	40	3	YES
15	Non-compliance with prescribed compression garment	Urgo K2 40	12	1	YES
16	Sub-therapeutic compression	Urgo K2 20	8	2	YES
17	Spontaneous	Urgo K2 20	9	4	YES
18	Sub-therapeutic compression	Urgo K2 40	32	4	YES
19	Non-compliance with prescribed compression garment	Urgo K2 40	10	2	YES
20	24 hours / day without elevation	Urgo K2 40	2	2	YES

CASE 1




CASE 2




CASE 3




DISCUSSION

These findings underscore the importance of early recognition and treatment of CVD. Venous dermatitis, whether associated with reflux or not, often precedes more severe complications but can be effectively managed with targeted therapy. Compression therapy appears to resolve venous dermatitis through two principal mechanisms:

1. Improved Lymphatic Drainage: Compression reduces lymphedema. When lymphatic flow is enhanced, it prevents the accumulation of inflammatory, protein-rich lymph fluid, thereby improving skin condition.
2. Enhanced Microcirculation: Although compression reduces venous and microvenous distention, it may also induce vasodilation in the microarteriolar circulation. This response is due to the adaptation of the calf musculature and surrounding tissues to the external compression, ultimately enhancing tissue perfusion and skin health.

Together, these mechanisms highlight the multifaceted role of compression therapy in managing venous dermatitis and preventing disease progression.

REFERENCES

1. Kelechi, T.J., Brunette, G. and Burgess, J.J. (2022) 'Chapter 24 Lower Extremity Venous Disease, Venous . Leg Ulcers, and Lymphedema', in Wound, Ostomy and Continence Nurses Society Core Curriculum . Wound Management. 2nd. Philadelphia, PA: Lippincott Williams & Wilkins, pp. 455–492.
2. Lantis JC et al. A dual compression system: preliminary clinical insights from the US. J Wound Care. 2020 . Sep 1;29(Sup9):S29-S37. doi: 10.12968/jowc.2020.29.Sup9.S29.
3. Lazareth I, Moffatt C, Dissemond J, et al. Efficacy of two compression systems in the management of VLUs: results of a European RCT. J Wound Care. 2012 Nov;21(11):553-4, 556, 558 passim.
4. Lebwohl, M. et al. (2023) 'Stasis dermatitis: A challenging patient journey', JEADV Clinical Practice, 2(4), pp. 675–688.
5. Mayrovitz HN, Macdonald JM. Medical compression: effects on pulsatile leg blood flow. Int Angiol. 2010 Oct;29(5):436-41.
6. Stücker M, Münter KC, Erfurt-Berge C, LützkendorfS, Eder S, MöllerU, DissemondJ. Multicomponent compression system use in patients with chronic venous insufficiency: a real-life prospective study. J Wound Care. 2021 May 2;30(5):400-412. .
7. Yosipovitch G, Nedorost ST, Silverberg JI, Friedman AJ, Canosa JM, Cha A. Stasis dermatitis: An overview of its clinical presentation, pathogenesis, and management. American Journal of Clinical Dermatology. 2023;24(2):275-286.

*UrgoK2, Urgo Medical North America

This poster was presented with the support of Urgo Medical North America
802-PB011









Choosing a System for the Older Adult

1 Arterial status first

15%-30% of VLU patients have coexisting peripheral arterial disease (PAD). ABI (or toe pressure if calcified) before any strong compression — every time, every leg

2 Calf-muscle pump

Inelastic systems (paste boot, short-stretch) work through ambulation; limited mobility, ankle stiffness, or wheelchair use argues for an elastic multi-component system

3 Fragile, atrophic skin

Over-compression (>50 mm Hg) causes damage; indicator systems and padding reduce risk; zinc paste can soothe periwound dermatitis, but check for sensitization

4 Who will apply it, and how often

A weekly clinic system is only as continuous as transportation allows; hosiery and wraps enable caregiver application, but VenUS 6 shows wraps heal more slowly

5 Edema trajectory

Rapid decongestion in the first 1-2 wks lowers pressure under any static bandage. Re-wrap sooner or use a system that tracks limb volume

6 Adherence and comfort

Bulk, heat, footwear, and pain drive removal; lighter 2-layer systems rate better for comfort; comfort predicts concordance, and concordance predicts healing

PAD = peripheral arterial disease.

Arundel C, et al. *PLoS Med*. 2026;23:e1005154. Paranhos T, et al. *Wound Repair Regen*. 2021;29:443-451. Kolluri R, et al. *Vasc Med*. 2022;27:63-72.

Does Evidence Support the Unna Boot? A Verdict

Compression: YES	Any strong compression roughly doubles the hazard of healing vs none. The error is not compressing
Unna boot: ADEQUATE, NOT OPTIMAL	Never shown superior to any comparator; pooled data lean against it; single-component and inelastic — the construction Cochrane links to slower healing
First line: 4LB, 2LH, or 2LB	The systems with large-trial evidence; 2LB is non-inferior (VenUS 6 mITT) and easier to apply to therapeutic pressure (Hanna)
Adjustable wraps: A ROLE, NOT FIRST LINE	Self-management and access advantages; ≈22% slower healing in VenUS 6, though CI touches null
Skin integrity: UNPROVEN FOR ALL	No system has an RCT-demonstrated skin-integrity advantage; delivered pressure and application quality are the modifiable risks

Synthesis of sources cited on preceding slides.

Clinical Pearls

- Name the etiology and check arterial status before choosing any wrap; most VLU failure begins before compression is ever applied
- Strong compression (≈40 mm Hg at the ankle) is the treatment — the product is the delivery vehicle; choose the vehicle that delivers the dose reliably
- The Unna boot has never outperformed a comparator; use it when it is the only option or when zinc-paste skin protection is the priority — not as the default
- Prefer multi-component systems with an elastic layer (4LB, 2LB, 2LH); 2-layer systems with pressure indicators hit the therapeutic window most consistently
- Adjustable wraps solve access and self-management but expect slower healing (VenUS 6); reserve for patients who cannot attend weekly
- Re-wrap early during the decongestion phase: any static bandage loses pressure as the limb shrinks
- Skin-integrity benefits have not been demonstrated for any compression product in an RCT; over-compression is the documented skin risk

References

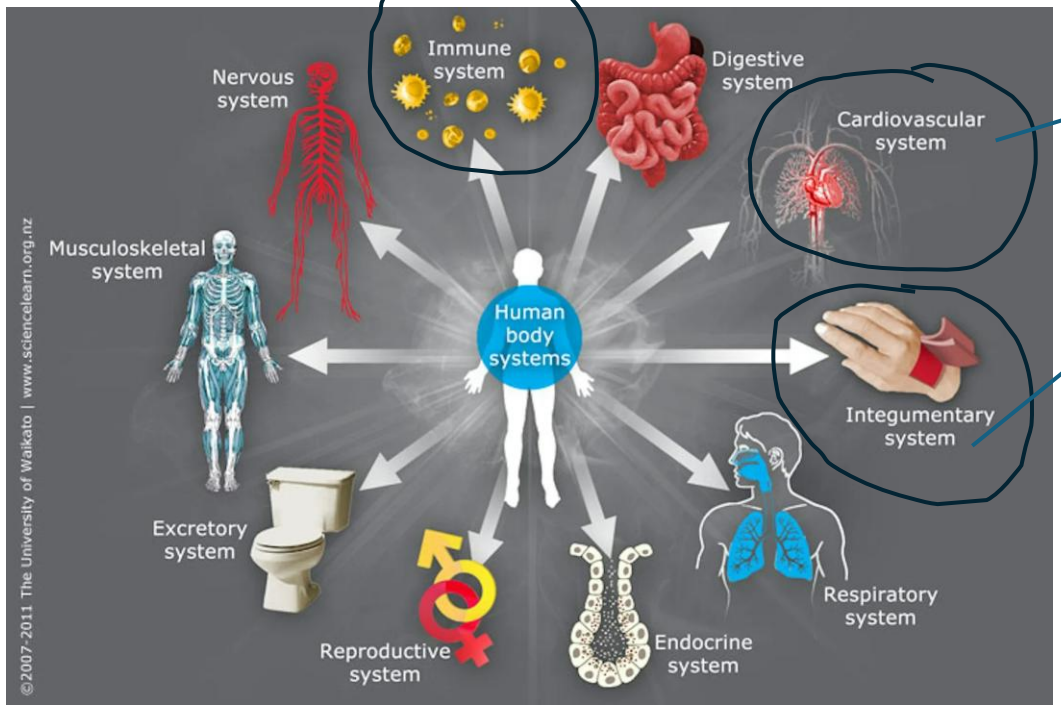
- Arundel C, et al. Compression therapies for venous leg ulcers: VenUS 6, an open, multicentre, randomised clinical trial. *PLoS Med*. 2026;23(7):e1005154.
- Shi C, et al. Compression bandages or stockings versus no compression for treating venous leg ulcers. *Cochrane Database Syst Rev*. 2021;7:CD013397.
- O'Meara S, et al. Compression for venous leg ulcers. *Cochrane Database Syst Rev*. 2012;11:CD000265.
- O'Meara S, et al. Four layer bandage compared with short stretch bandage for venous leg ulcers: IPD meta-analysis. *BMJ*. 2009;338:b1344.
- Paranhos T, et al. Systematic review and meta-analysis of the efficacy of Unna boot in the treatment of venous leg ulcers. *Wound Repair Regen*. 2021;29:443-451.
- Hanna R, et al. A comparison of interface pressures of three compression bandage systems. *Br J Nurs*. 2008;17(20):S16-S24.
- Polignano R, et al. A randomised controlled study of four-layer compression versus Unna's boot for venous ulcers. *J Wound Care*. 2004;13:21-24.
- Dolibog P, et al. A comparative clinical study on five types of compression therapy in patients with venous leg ulcers. *Int J Med Sci.* 2013;11:34-43.
- Ashby RL, et al. VenUS IV: compression hosiery compared with compression bandaging in the treatment of venous leg ulcers. *Health Technol Assess*. 2014;18(57).
- Amsler F, et al. In search of optimal compression therapy for venous leg ulcers: a meta-analysis. *J Vasc Surg*. 2009;50:668-674.
- Tettelbach WH, et al. Treatment patterns and outcomes of Medicare enrolees who developed venous leg ulcers. *J Wound Care*. 2023;32(11):704-718.
- Rice JB, et al. Burden of venous leg ulcers in the United States. *J Med Econ*. 2014;17:347-356.
- Kolluri R, et al. An estimate of the economic burden of venous leg ulcers associated with deep venous disease. *Vasc Med*. 2022;27:63-72.

The Fourth “C”

Heather Barnhart, PT, PhD, CWS, CLT-LANA, CLWT
Director of Clinical Operations, Koya Medical
Adjunct Professor, Nova Southeastern University
St. Augustine, FL

Learning Objective

To understand how compression can influence microcirculation and integumentary health, let's set the stage by discussing the concept of lymphostatic dermopathy and the interconnection of the VAIL systems.



"L"

"V & A" = VAIL

"I"

Image: https://www.sciencelearn.org.nz/resources/1885-body-systems

Key: Lymphatic System (LS) Helps Keep Edema from Forming

Dynamic insufficiency



Mechanical insufficiency

Continuum

Edema → *symptom*

System is overwhelmed but not damaged

Disruption in the EGL

Lymphedema → *disease*

System is damaged or diseased
Currently no cure

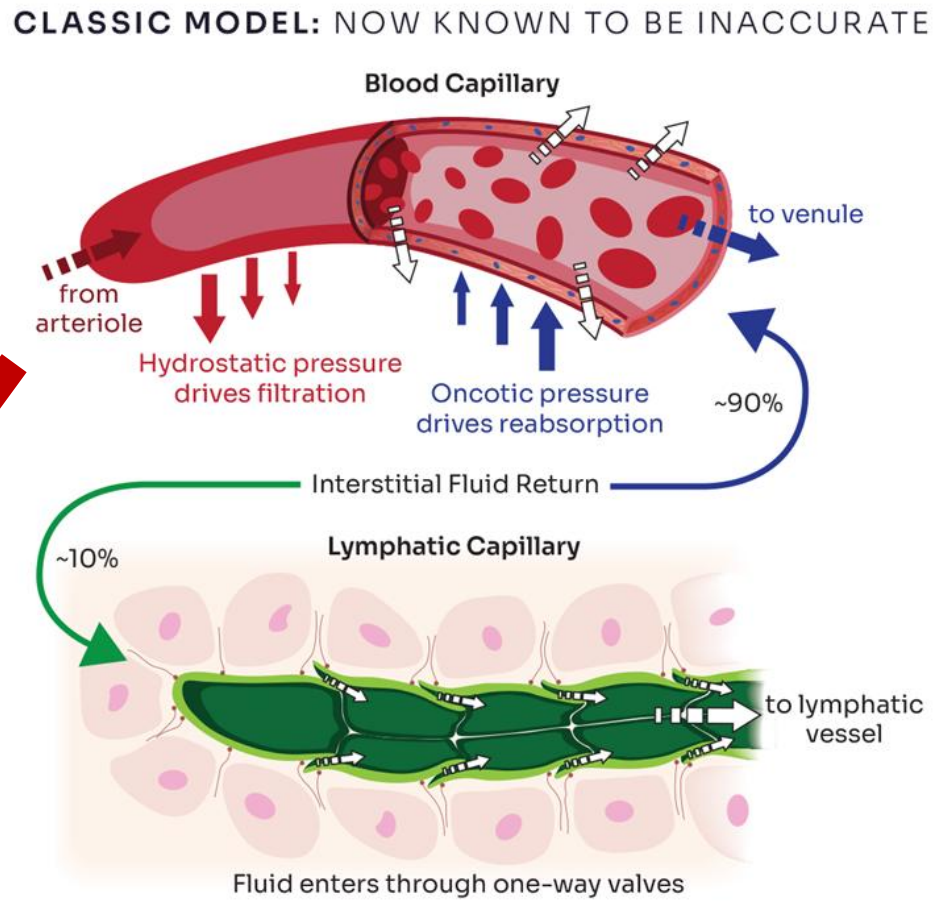
Fluid imbalance = Edema = Accumulation of lymph fluid in tissues

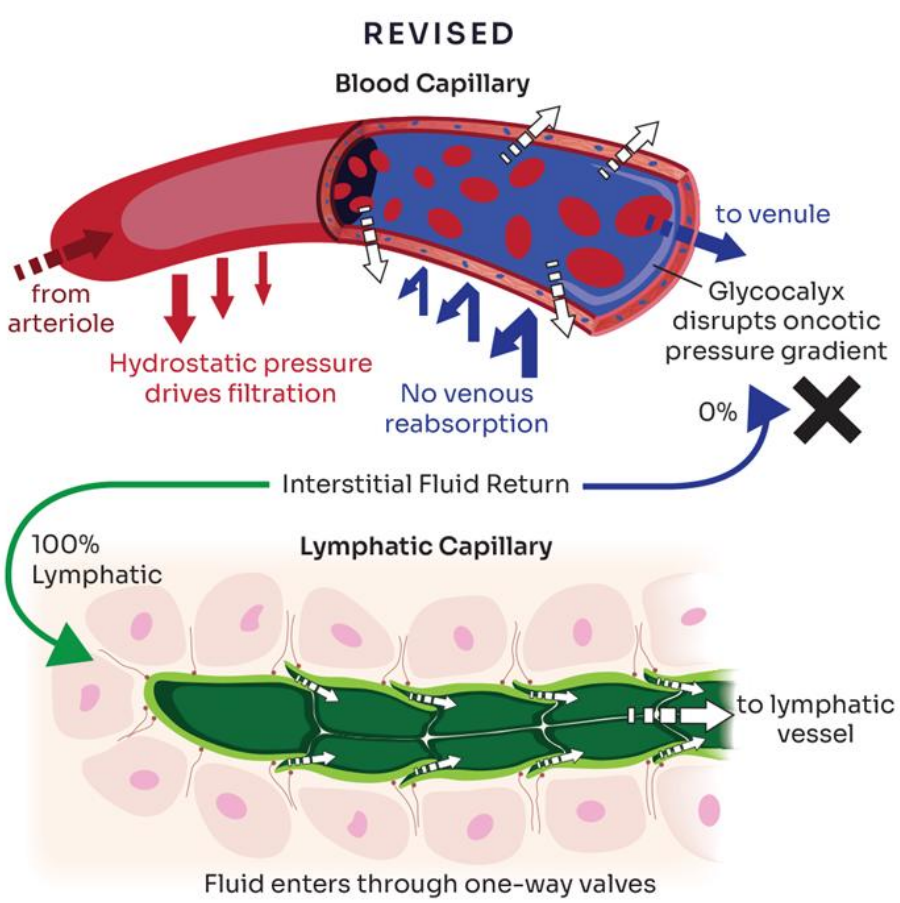
All edema is lymph-edema

LS = lymphatic system.

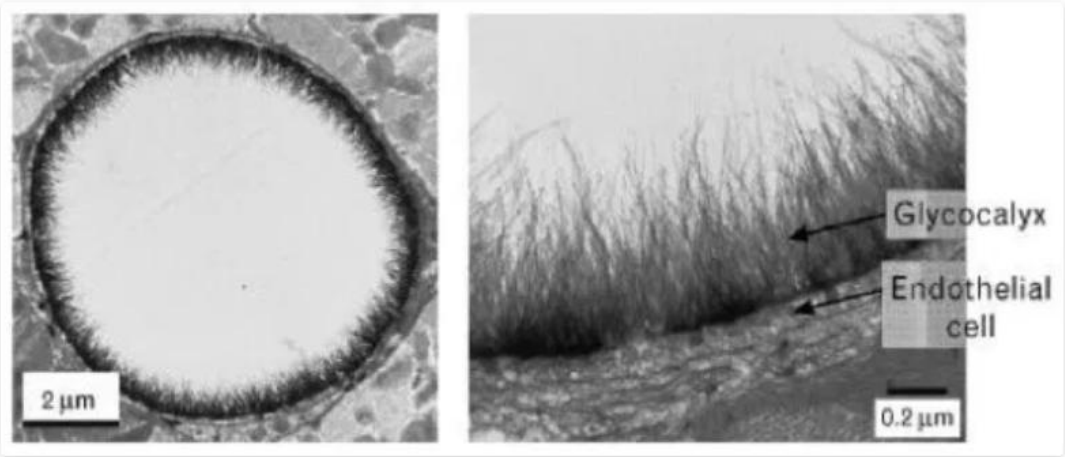
Lymph and the Microcirculation

Lymph is formed when blood plasma passes through capillary walls at the arteriole end





Starling's Law Redefined



Reprinted with permission from Biddle, C., 2013. Like a slippery fish, a little slime is a good thing: the glycocalyx revealed. *AANA journal*, *81*(6).



Endothelial Glycocalyx Layer (EGL): gel-like matrix with hair-like projections extending into the lumen of blood vessels; acts as a molecular sieve regulating fluid and macromolecule movement

There is only a diminishing net filtration across the capillary bed

Blood flow shear forces act on the endothelial cells (mechanotransduction), which respond to the mechanical signals, producing and releasing nitric oxide, which dilates the vessel

This allows the plasma to leave the vessel and enter the interstitial space as lymph

EGL = endothelial glycocalyx layer.

What Constitutes Lymph?

The fluid that causes edema is lymph. When the LS picks up lymph, it is called a lymphatic load. The LS transports the load to regional lymph nodes, where adaptive immunity is initiated and the fluid is cleansed.

Lymph is made up of

- ✓ All fluid
- ✓ 50%+ of blood plasma proteins
- ✓ Lipids
- ✓ Byproducts of tissue/wound healing
- ✓ Dead and senescent cells
- ✓ Cancer cells
- ✓ Enzymes/MMPs
- ✓ Bacteria
- ✓ Endotoxins
- ✓ Perfumes, dyes
- ✓ Pollutants



Lymph can be caustic to the skin; lymphorrhea (lymphatic drainage through the skin) can lead to denudement/chemical-like burn of the skin. It can occur with fluid stagnation or lymphostasis when the system is impaired.

Imagine what happens when this does not get properly filtered and cleansed

Lymphatic System



A healthy, functional lymphatic system is like a clean, flowing river

(no stagnation)

Lymphatic System

Disease Progression...the Lymphedema Continuum







Insufficiency, transient edema

Impairment, permanent edema

All the substances that make up lymph
become stagnant and congested when the system is disrupted

Lymphatic system = body's plumbing and recycling system

Edema vs Lymphedema
All Edema Is Lymphatic Fluid = Lymphedema Continuum

- **Edema** is the abnormal, excess accumulation of serous fluid in connective tissue that temporarily overwhelms the lymphatic system but does not cause permanent damage (lymphatic insufficiency)

- **Lymphedema** is an accumulation of protein-rich fluid in an extremity or body part as a result of damage or loss to part of the lymphatic vessel system (lymphatic impairment)





Low-protein edema = transient
Watery consistency





Protein-rich edema = progressive/permanent
Viscous (like honey in a plastic bag)

Another Way to Look at It

Lymphatics temporarily overwhelmed



Lymphatic transport capacity



Injuries
Postop edema
CHF

Overwhelmed … most edemas
(30+ medical causes of edema)
temporary lymphedema

Lymphatics permanently impaired or damaged



Permanently damaged …
the **disease** of lymphedema

If It's Just Swelling, Why Does This Happen to the Skin? Let's Discuss the VAIL...







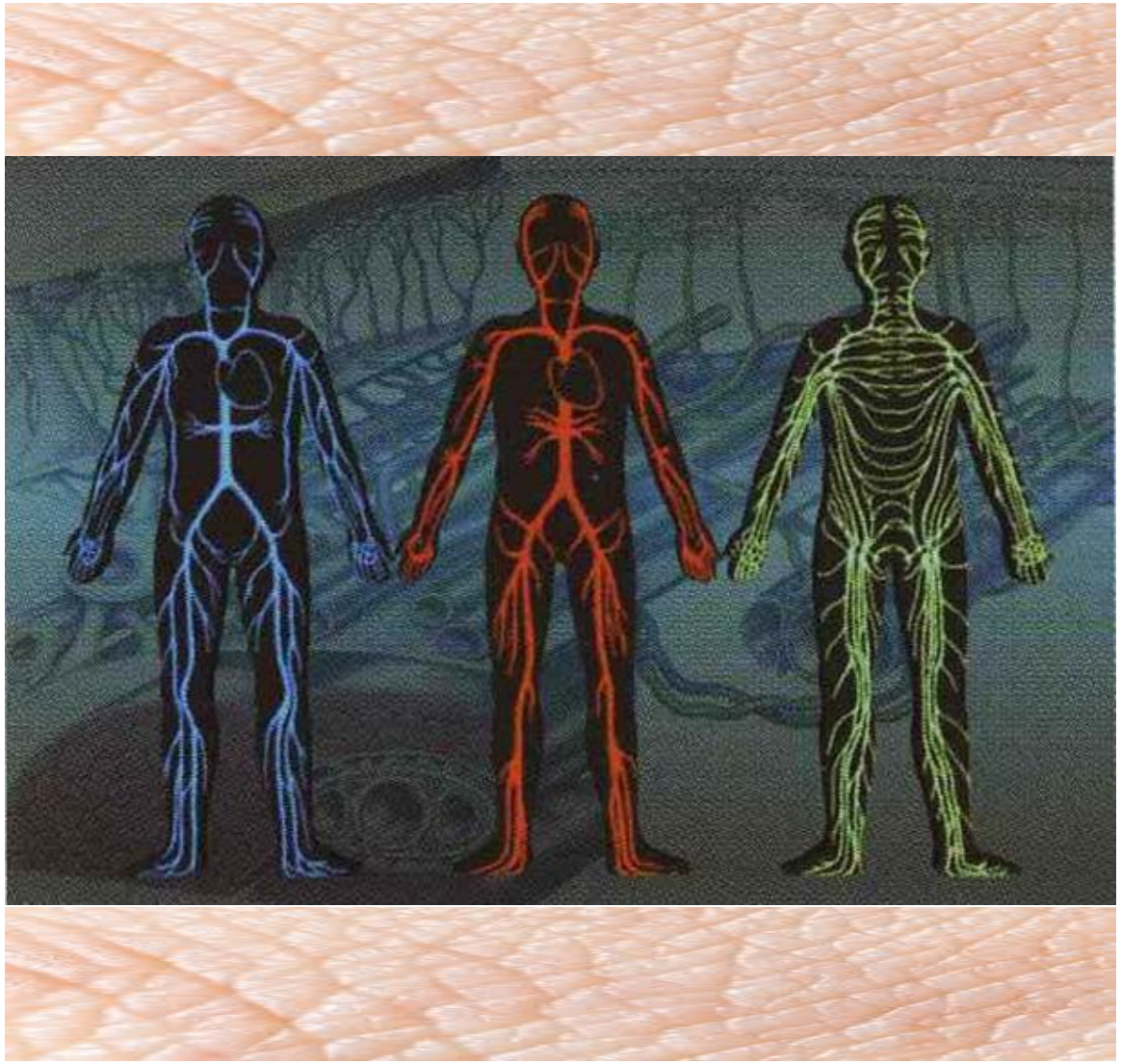
Origin of the VAIL Concept

The venous, arterial, integumentary, and lymphatic systems (think VAIL) are interrelated.

Anatomically, physiologically, and biochemically, these systems work in unison to maintain homeostasis.

Dysfunction in one system will lead to dysfunction in the other systems, and this may manifest sub-clinically or be overt.

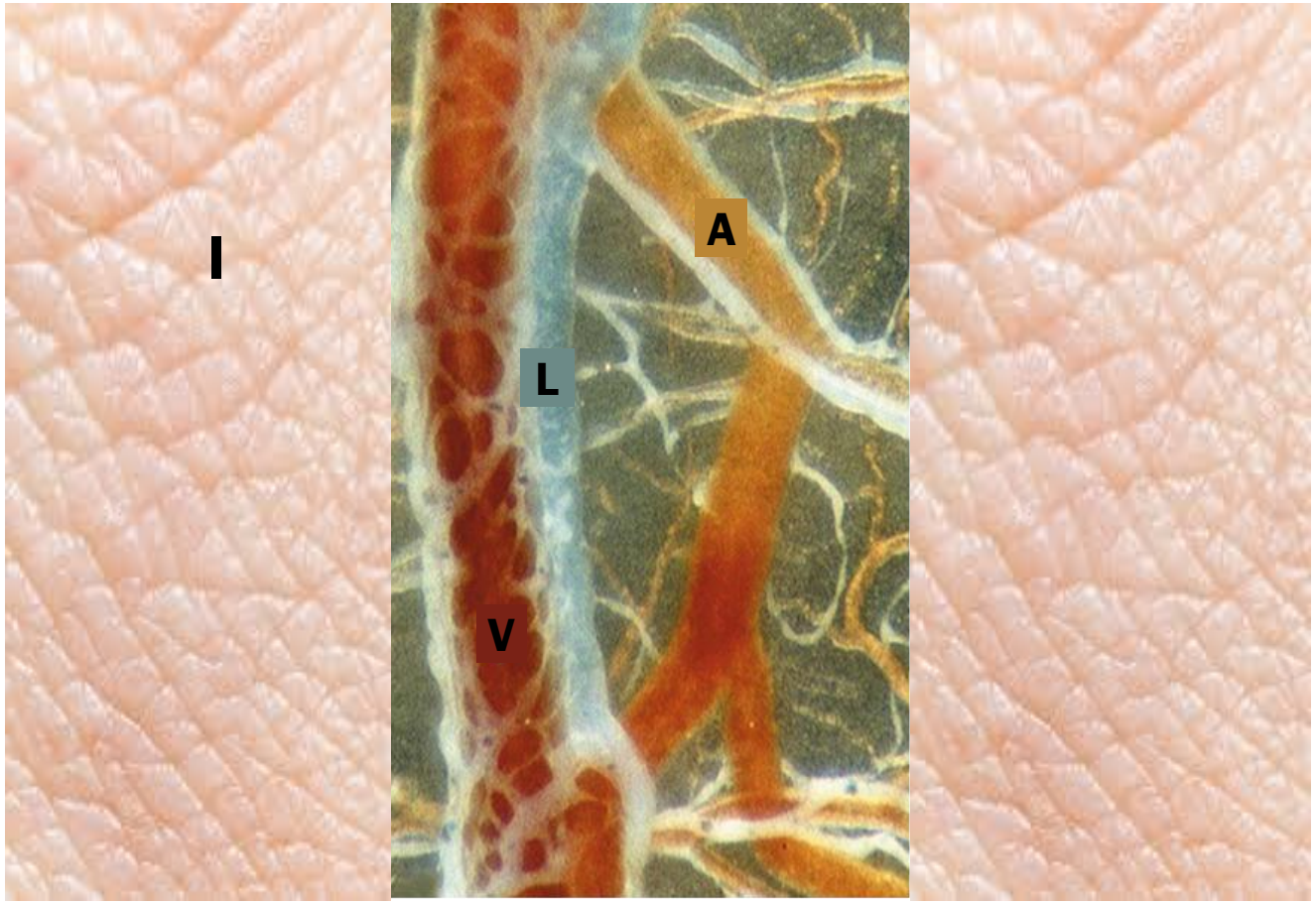
-Dr. Heather Barnhart



VAIL = venous, arterial, integumentary, and lymphatic.

VAIL Interrelationship

V = vein
A = artery
I = integument
L = lymph vessels



VAIL: Interconnected Systems

- ***Decongesting and maintaining interstitial fluid mitigates and prevents deleterious effects of stagnant fluid on tissue and skin***
- ***Chronic lymph stasis (lymphostasis) has numerous consequences***, including inflammation, lipogenesis, fibrosis, and immunosuppression
- Lymphostasis leads to the accumulation of antigens, foreign material, and immune complexes in the interstitial space, which leads to ***chronic localized inflammation***
- This can ***manifest on the skin*** as disruption of immune cell trafficking leading to localized immune suppression, predisposing the area affected to chronic inflammation, connective tissue proliferation, infection, and malignancy
- In essence, it ***disrupts the skin's barrier function***



Carlson JA. *Clin Dermatol*. 2014;32(5):599-615. Finegold DN, et al. *Lymphat Res Biol*. 2008;6(2):65-68.

VAIL: Interconnected Systems

- The venous and lymphatic systems are mutually interdependent; when dysfunctional, the result is a ***dual outflow system failure*** → tri-system failure with integumentary impairments (VLUs, dermatitis, etc.)
- ***Disorders of the lymph system*** – whether systemic (macro-lymphedema) or localized (micro-lymphedema) – ***produce cutaneous regions susceptible to infection, inflammation, and carcinogenesis*** (lymphostatic dermopathy = skin barrier failure; tri-system failure)
- The ***pathophysiology of lymphedema explains the propensity for infections*** (cellulitis) and ***hypersensitivity*** reactions in ***patients with CVI*** (lymphostatic dermopathy)
- A functional lymphatic system is essential to an organism's overall health given its role in fluid homeostasis, removal of cellular debris, and mediating immunity and inflammation
- ***Lymph stasis (lymphostasis/stagnation) is problematic → it induces a chronic inflammatory state which ultimately can manifest on the skin***

Carlson JA. *Clin Dermatol*. 2014;32(5):599-615. Finegold DN, et al. *Lymphat Res Biol*. 2008;6(2):65-68.

Lymph Stasis = Chronic Inflammatory State



…stagnating lymphatic load/lymph results in a pathohistological state of chronic inflammation resulting in fibrotic changes, thickening, and connective tissue proliferation…

"Oxidation and degradation of interstitial proteins attract monocytes that change into macrophages. Macrophages ingest the proteins and activate fibroblasts that, in turn, form collagen, resulting in connective tissue proliferation." Also triggers adipocytes, leading to fatty tissue proliferation.







Skin changes = visual biomarker of lymphostasis

The body's plumbing and recycling are backed up; this affects the skin's barrier function negatively

VAIL: Interconnected Systems

- Clinically, fibrosis, papillomatosis, stasis dermatitis, and classic venous and lymphatic skin changes are seen
- ***Chronic inflammation*** also attenuates (reduces) lymphatic contraction, ***hindering lymphatic flow*** to the lymph node
- Hemosiderin, classic with CVI, also suppresses lymphatic contractility





- To trigger an effective immune response, antigen and antigen-presenting cells must travel to the lymph node; thus, lymphostasis disrupts cell-mediated (adaptive) immunity by decreasing or obstructing immune trafficking by antigen, lymphocytes, macrophages, and dendritic/antigen-presenting cells to the lymph node, creating a ***cutaneous region of immunosuppression***
- All of these abnormalities lead to a condition termed *lymphostatic dermopathy*, which is *failure of the skin as an immune organ*

Carlson JA. *Clin Dermatol*. 2014;32(5):599-615. Finegold DN, et al. *Lymphat Res Biol*. 2008;6(2):65-68. Wandolo G, et al. *J Vasc Res*. 1992;29(3):248-255.

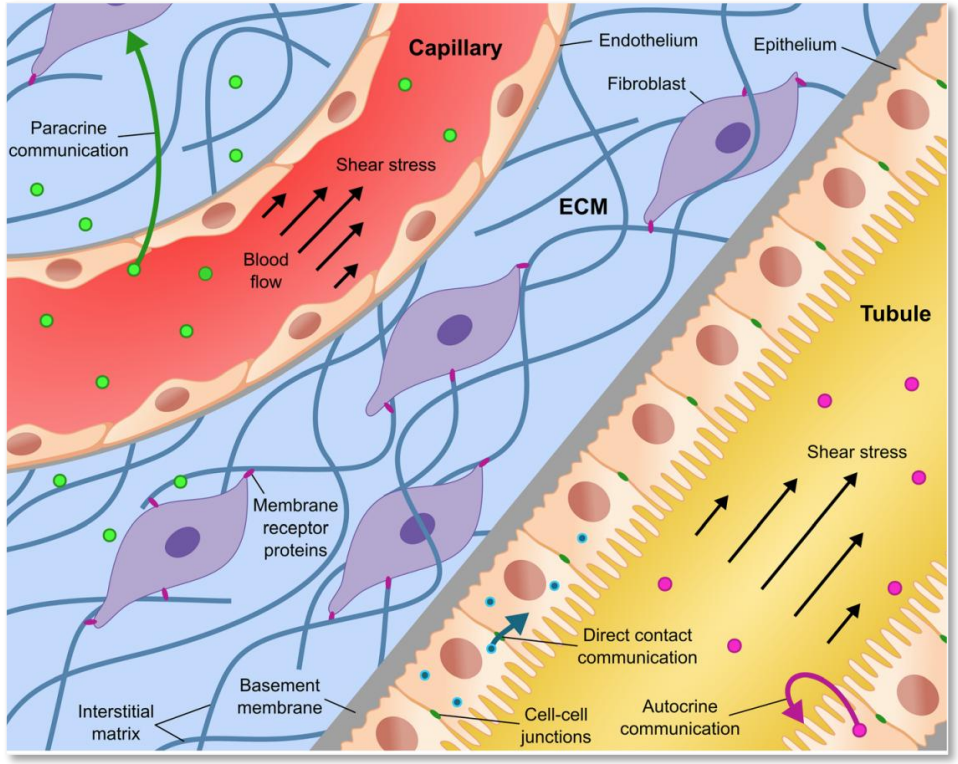
VAIL: Interconnected Systems

- Lymphostatic dermopathy, in part, explains the propensity of skin infections and VLUs in people with CVI
- Therefore, it is imperative to reduce and manage the fluid burden to optimize venous and lymphatic function while simultaneously facilitating wound resolution and tissue remodeling
  - Reducing the fluid burden and diffusion distance also supports better perfusion by optimizing arterial inflow
  - Compression over time restores the skin barrier function and reverses the effects of lymphostatic dermopathy
  - ***Compression is the cornerstone intervention for all forms of edema and is essential for managing venous/lymphatic impairment***
  - ***It also helps with remodeling the skin***

Think: Drain, Contain, and Maintain!

Compression Effects

- Vascular
  - Enhances venous, lymphatic, and arterial flow
- Cellular
  - Compression forces mechanically deform tissue
    - Internal – within the vessels – shear forces
    - External – within extracellular matrix (ECM) – shear forces
  - "Outside-in signaling" triggers a change in biochemistry and gene expression impacting cellular processes, such as cellular migration, growth, and differentiation



ECM = extracellular matrix.

Godoy MFG, et al. *Med Sci.* 2021;25(113):1578-1582. Geng X, et al. *Cell Mol Life Sci.* 2021;78(16):5903-5923. Berszakiewicz A, et al. *Postepy Dermatol Alergol.* 2020;37(6):842-847. Raffetto JD, et al. *J Clin Med.* 2020;10(1):1-34. Yeste J, et al. *J Biol Eng.* 2018;12(1)1-18. Nicolaides A, et al. *Int Angiol.* 2018;37(3):181-254. Mosti G, Partsch H. *Eur J Vasc Endovasc Surg.* 2014;47(5):545-549. Liu R, et al. *Adv Ther.* 2008;25(5):465-478. Mayrovitz HN, Larsen PB. *Clin Physiol.* 1997;17(1):105-117.

Compression Effects: Hot off the Press, Mosti 2026

Methods

- "…critically reviewed and integrated evidence from experimental studies, imaging, clinical investigations, randomized controlled trials, systematic reviews, consensus documents, and international guidelines into a mechanism-based framework.
- Rather than adopting a disease-oriented approach, the review organized the evidence around the biological targets through which compression exerts its therapeutic effects.

Results

- ***Compression therapy works by delivering a controlled mechanical stimulus to the entire compressed segment, thereby improving venous hemodynamics, lymphatic drainage, microvascular function, and arterial perfusion, while regulating inflammation.***
- These interconnected mechanisms explain **the *efficacy of compression across different vascular disorders*. *Therapeutic benefit depends on compression characteristics, including not only interface pressure but, most importantly, material stiffness, dynamic pressure changes during movement, treatment duration, and patient adherence.***
- The review also shows that much of the heterogeneity in the literature reflects methodological limitations rather than conflicting biological effects.

Conclusions

- Compression therapy should be viewed as a ***biomechanical intervention that restores tissue homeostasis***, with vascular changes reflecting coordinated downstream responses."

Mosti, G. Rethinking compression therapy: From resting pressure to global dynamic factors. *Phlebology*. 2026;0(0):1-22.

Compression Is Cornerstone

- It has been well established that externally applied compression aids in providing support to the venous system by approximating the valves to reduce venous backflow and promote blood flow toward the heart
- Additionally, compression provides necessary containment of interstitial fluid to prevent and reduce edema formation resulting from an overburdened superficial lymphatic system
- A reduction in edema, allows for improved arterial inflow (perfusion)
- **When compression is properly applied, it has been shown to reduce edema, normalize venous function, optimize healing of VLUs, improve lymphatic function, enhance arterial pulse width, diminish episodes of recurrent cellulitis, promote resolution of trophic changes, decrease the presence of inflammatory mediators and symptoms, and reduce pain**

Stout N, et al. *Int Angiol*. 2012;31(4):316-329. Gianesini S, et al. *Phlebology*. 2019;34(1 Suppl):4-66. Shi C, et al. *Cochrane Database Syst Rev*. 2021;7(7):Cd013397. Dissemond J, et al. *J Dtsch Dermatol Ges*. 2016;14(11):1072-1087. Kitayama S, et al. *Lymphat Res Biol*. 2017;15(1):77-86. Mukherjee A, et al. *J Physiol*. 2021;599(10):2699-2721. Negrini D, Moriondo A. *J Physiol*. 2011;589(Pt 12):2927-2934. Schmid-Schönbein GW. *Lymphat Res Biol*. 2003;1(1):25-29. McGeown JG, et al. *J Physiol*. 1987;387:83-93. Mosti G, Cavezzi A. *Phlebology*. 2019;34(8):515-522. Mosti G. *Phlebology*. 2014;29(1 suppl):13-17. Mayrovitz HN, Macdonald JM. *Int Angiol*. 2010;29(5):436-441. Mayrovitz HN, Larsen PB. *Clin Physiol*. 1997;17(1):105-117. O'Meara S, et al. *Cochrane Database Syst Rev*. 2012;11(11):CD000265. Partsch H. *J Wound Care*. 2019;28(7):427. White-Chu EF, Conner-Kerr TA. *J Multidiscip Healthc*. 2014;7:111-117. Beidler SK, et al. *J Vasc Surg*. 2009;49(4):1013-1020. Beidler SK, et al. *Wound Repair Regen*. 2008;16(5):642-648. Bojesen S, et al. *Eur J Dermatol*. 2019;29(4):396-400. Travis TE, et al. *Eplasty*. 2018;18:e1. Webb E, et al. *N Engl J Med*. 2020;383(7):630-639. Ebell MH. *Am Fam Physician*. 2021;103(4):247. Lerman M, et al. *J Vasc Surg*. 2019;69(2):571-580. Rabe E, et al. *Phlebology*. 2020;35(7):447-460. Kerr A, et al. *Wounds International*. 2020;10:4-32.

Compression Is Cornerstone

- **Compression increases ulcer healing** rates compared with no compression
- **Multi-component systems are more effective** than single-component systems
- Multi-component **systems containing an elastic bandage appear to be more effective** than those composed mainly of inelastic constituents
- 2-component bandage systems appear to perform as well as 4-layer bandage (4LB)
- Patients receiving the 4LB heal faster than those allocated the short stretch bandage (SSB)

SVS Society for Vascular Surgery

THE GOLD STANDARD

Cochrane

SSB = short stretch bandage.

O'Meara S, et al. *Cochrane Database Syst Rev*. 2012;11(11):CD000265.

Compression is Cornerstone; However…

Patients don’t like it…

“It’s too tight…

It’s uncomfortable…

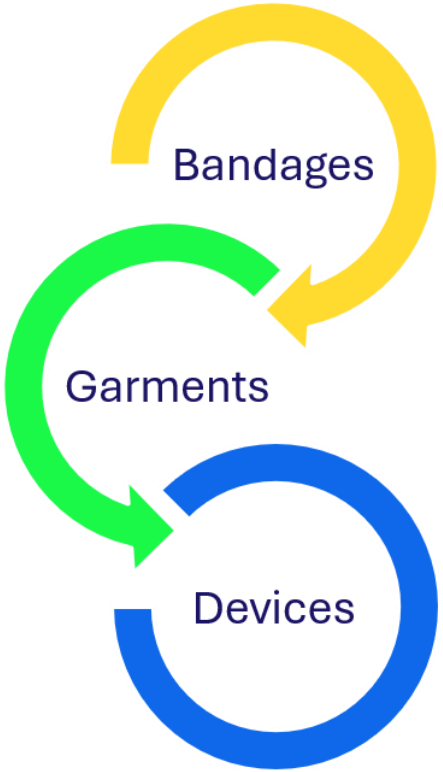
I can’t get it on…

It hurts…

It rolls down…

Compression is too hard to use…

It takes too much time…”



Foundational Data: The 3 Cs (following the 4th C, Cutis)

Comfortable



journal of wound care JWC

VOLUME 16. NUMBER 9. OCTOBER 2007

Efficacy, safety and acceptability of a new two-layer bandage system for venous leg ulcers

J.P. Benigni, MD, Angiologist, Sainte Geneviève des Bois, France;
I. Lazareth, MD, Vascular Unit, Saint Joseph Hospital, Paris, France;
P. Parpex, MD, Angiologist, Paris, France;
J.L. Gerard, MD, Angiologist, Paris, France;
M. Alves, MD, Angiologist, Autun, France
F. Vin, MD, Angiologist, Neuilly-sur-Seine, France;
S. Meaume, MD, Dermatologist and Head of Department of Gerontology, Charles Foix Hospital, Ivry-sur-Seine, France;
P. Senet, MD, Dermatologist, Rothschild Hospital, Paris, France;
F.A. Allaert, MD, Biostatistician, Cambiotech, Dijon, France;
A. Sauvadet, PhD, Research and Development, Laboratoires Urgo, Chenôve, France;
S. Bohbot, MD, Research and Development, Laboratoires Urgo, Chenôve, France.
Email: snipe@easynet.fr

THIS ARTICLE IS REPRINTED FROM JOURNAL OF WOUND CARE VOL 16, NO 9, OCTOBER 2007

Consistent



A comparison of interface pressures of three compression bandage systems

Richard Hanna, Serge Bohbot, Nicki Connolly

Abstract

Objective: To measure and compare the interface pressures achieved with two compression bandage systems – a four-layer system (4LB) and a two-layer short-stretch system (SSB) – with a new two-layer system (2LB), which uses an etalonnage (performance indicator) to help achieve the correct therapeutic pressure for healing venous leg ulcers – recommended as 40 mmHg. *Method:* 32 nurses with experience of using compression bandages applied each of the three systems to a healthy female volunteer in a sitting position. The interface pressures and time taken to apply the systems were measured. A questionnaire regarding the concept of the new system and its application in comparison to the existing two systems was then completed by the nurses. *Results:* The interface pressures achieved show that many nurses applied very high pressures with the 4LB (25% achieving pressures >50 mmHg) whereas the majority of the nurses (75%) achieved a pressure of <30 mmHg when using the SSB. A pressure of 30–50 mmHg was achieved with the new 2LB. The SSB took the least time to be applied (mean: 1 minute 50 seconds) with the 4LB the slowest (mean: 3 minutes 46 seconds). A mean time of 2 minutes 35 seconds was taken to apply the 2LB. Over 63% of the nurses felt the 2LB was very easy to apply. *Conclusion:* These results suggest that the 2LB achieves the required therapeutic pressure necessary for the management of venous leg ulcers, is easy to apply and may provide a suitable alternative to other multi-layer bandage systems.

Key words: Bandage • Compression • Interface pressure • Tissue viability • Venous leg ulcer

Continuous



research

Comparison of interface pressures of three compression bandaging systems used on healthy volunteers

• **Objective:** To compare changes in interface pressures of three compression systems (four layer, two layer and short stretch) recorded over seven days in healthy volunteers in different positions: supine, sitting, active standing and working pressure during exercise.
• **Method:** Twenty-four volunteers were bandaged with one of the three compression systems on both legs. Interface pressures were measured at inclusion (day 0) and on days 1, 3 and 7 using an air sensor system, with the sensor placed in the medial B1 position above the inner ankle. In addition, the volume of the lower legs were also measured on days 0 and 7 using a three-dimensional imaging system. Comfort and tolerability were also assessed.
• **Results:** The performance, based on the loss of interface pressure compared with baseline, of the two-layer system was partially better than that of the short-stretch system for maximal working pressure and loss of volume. The two-layer system and short-stretch system had similar results for the supine, sitting and active standing positions. No difference was observed between the two-layer system and the four-layer system for the maximal working pressure. However, the two-layer system compared better than the two other systems for comfort and tolerability: 25% of the patients treated with the four-layer system discontinued the treatment after three days because of pain.
• **Conclusion:** The two-layer bandage system maintained, over one week, a similar level of sub-bandage pressure similar to a four-layer system and was partially better than short-stretch bandaging. However, the volunteers found the two-layer system more comfortable and tolerable than the other two systems.
• **Declaration of interest:** The investigators received an education grant from Urgo for the study. However, Urgo had no influence on the data analysis or interpretation.

compression therapy; two-layer bandaging system; comfort; tolerance

Efficacy



journal of wound care JWC

VOLUME 21. NUMBER 11. NOVEMBER 2012

Efficacy of two compression systems in the management of VLUs: results of a European RCT

I. Lazareth,[1] MD; C. Moffatt,[2] PhD; J. Dissemond,[3] MD; A.S. Lesne Padieu,[4] MD; F. Truchetet,[5] MD; S. Beissert,[6] MD; G. Wicks,[7] RN; H. Tilbe,[8] RN; A. Sauvadet,[9] PhD; S. Bohbot,[9] MD; S. Meaume,[10] MD;
[1] Vascular Medicine Unit, Saint-Joseph Hospital, Paris, France; [2] Thames Valley University, London, UK; [3] Head, Dermatology Department, University Hospital, Essen, Germany; [4] Dermatology Department, University Hospital, Dijon, France; [5] Head, Dermatology Department, Beauregard Hospital, Thionville, France; [6] Dermatology Department, University Hospital, Münster, Germany; [7] Leg Ulcer Clinic, Wrafton House Surgery, Hatfield, UK; [8] Trowbridge Community Hospital, Trowbridge, UK; [9] R&D Department, Laboratoires URGO, Chenôve, France; [10] Head, Geriatric Department, Rothschild Hospital, Paris, France.
E mail: ilazareth@hpsj.fr

THIS ARTICLE IS REPRINTED FROM THE JOURNAL OF WOUND CARE VOL 21, NO 11, NOVEMBER 2012

Begnini

- 95% of patients prefer 2LB in the day
- 92% of patients prefer 2LB at night

Hanna

- 85% of nurses applied 2LB in therapeutic range in their first application

Junger

- 2LB maintained therapeutic compression for 7 days in supine, sitting, and working positions

Odyssey

- 186 patient RCT proving 2LB is non-inferior to 4LB

Compression Evidence

- Some compression is better than none
- Inelastic compression has a significant effect on deep venous hemodynamics compared with elastic compression applications
- Multi-layer compression bandage is more effective than low-compression, single-layer
  - Interface pressure (IP)/dosage (mm Hg) and stiffness are changeable according to combination of materials in a bandage set
  - Inclusion of a cohesive component has been shown to maintain IP longer
  - Inclusion of an elastic component has been shown to have higher IP maintained over a longer period of time
- Compression garment (self-gripping wrap/stockings) stiffness varies *independent* of dosage

IP = interface pressure.

Benigni JP, et al. *Int Angiol.* 2023;42(3):247-253. Ehmann S, et al. *Wound Manag Prev*. 2023:69(2):14-25. Shi C, et al. *Cochrane Database Sys Rev*. 2021;7(7). Vowden KA, Mosti G. *Wounds Int*. 2020. Rabe E, et al. *Phlebology*. 2020;35(7):447-446. Lantis JC, et al. *J Wound Care*. 2020;29(S9):S29-S37. Liu R, et al. *Text Res J*. 2017; 87(9):1121-1141. Franks PJ, et al. *J Wound Care*. 2016;25(Suppl6):S1-S67. Junger M, et al. *J Wound Care*. 2009;18(11):474-480. van der Wegen-Franken CP, et al. *Phlebology*. 2008;23(2):77-84.

Compression Evidence

- Compression results in an increase in leg pulsatile blood flow likely due to arteriolar vasodilation due to a myogenic arteriolar response and a shear dependent venous effect
  - The myogenic mechanism is the intrinsic ability of vascular smooth muscle to contract in response to an increase in intraluminal pressure and dilate due to a decrease in pressure
    - Compression can directly impact this process by its effects on IP
  - The venous effect elicits a release of vasodilatory substances which directly impact arteriolar vasculature
    - This synergistic effect improves VLU resolution likely related to a decrease in leukocyte effects in the distal microvasculature
    - Also helps to explain how compression can impact the VAIL

Mayrovitz H, Macdonald J. *Int Angio*. 2010;29(5):436-441.

Clinical Pearls

- Tear down the silos, practice VAIL clinically
- Integument health is VAIL dependent; healing the wound/skin requires improving the function of all vascular players
- Lymphatic dysfunction ←→ chronic edema; lymph stasis triggers an inflammatory response due to accumulation of antigens, foreign material, and immune complexes… Stagnant lymph attenuates lymphatic contraction… Cytokines induce fibroblasts to proliferate, increasing connective tissue formation
- Pathologic tissue changes include epidermal thickening, fibrosclerosis, and adipocyte proliferation
- Compression and compression textiles matter and can augment wound resolution and tissue restoration→

Think of the 4Cs: Comfortable- Consistent- Continuous- Cutis = Efficacy

Clinical Pearls

- Wound healing requires adequate macro and micro circulation; impaired wound healing occurs when growth factors, key peptides, and matrix proteins become trapped (not being mobilized by the lymphatic system = lymph stasis)
  - Improved by reducing the congestion… drain and maintain → maintain with compression!
- Tissue perfusion may be impaired by arterial occlusion or vasoconstriction, hypotension, hypothermia, peripheral venous congestion, increased diffusion distance (edema and adipose)
  - Improved by reducing the congestion… drain, contain, and maintain → with compression!
- Compression assists with integument restoration by acting on the VAIL; mechanical deformation, mechanotransduction
- "We hypothesize that the application of mechanical force to wounds induces tissue deformation at the level of individual cells, leading to cell stretch, thereby providing a powerful mechanism for inducing cell proliferation and angiogenesis and hence promoting wound healing"

Saxena V, et al. *Plast Reconstr Surg*. 2004;114(5):1086-1096.

Thank You

