Textile Technology:
A New Era in Positive Pressure Wound Therapy (PPWT**): A Case Series

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Fuzzy Wale Compression Stockinet as a Contact Layer Delivers Dramatic Early Wound Bed Progress

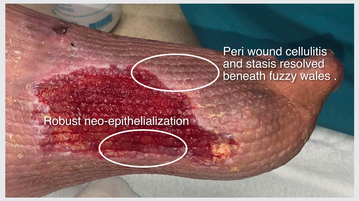
Rx day #0:
Intensely painful weeping bilateral venous stasis dermatitis with nonhealing refractory mixed etiology wound. Patient followed in a wound clinic ~ 48 months. Compression therapy was not tolerated due to pain. Observe wound edges epiboly and cobblestone edema changes. Compression with fuzzy wale stockinet started on this day.
(Photo © Marta Ostler, Sheridan Wyoming)

Rx Day ~ #8, 3rd Clinic Visit:
Wound bed progress is dramatic. (Photo © Marta Ostler)

Day #106:
Observe large area of recently regenerated peri-wound epithelium appears robust beneath cornrow furrows.
(Photo © Marta Ostler)

Tissue Micro Deformation via Fuzzy Wale Compression

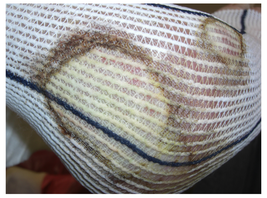
Rx Day #0:
Photo-refractory mixed etiology. (Photo © Suzie Ehmann)



Rx Day #14:
Observe: Upper oval shows complete resolution of peri wound cellulitis/dermatitis peri wound dermatitis /cellulitis. Lower oval shows robust neo-epithelialization between furrows created in granulation tissue that is similar to what is seen with Negative Pressure Wound Therapy (NPWT). Ehmann coined the term Positive Pressure Wound Therapy (PPWT) to explain the results of fuzzy wale elastic compression stockinet therapy seen above. (Ehmann 2023) We posit that granulation tissue in furrows beneath fuzzy wales experiences micro deformation, which upregulates gene expression and cell protein synthesis, via a process termed mechano transduction as also seen in NPWT.
(Photo © Suzie Ehmann)

Profoundly Ischemic Foot

Rx Day #0:
55 yo F vasculopath with aortic occlusion below renal arteries, S/P L BKA, no doppler signals below R knee.



Rx Day ~ #3:
Fuzzy wale elastic compression stockinet* was the wound contact and the compression layer for the full thickness ischemic wound.

Rx Day ~ #45:
Dramatic wound bed progress, neo epithelization, healthy new normal appearing skin at wound margins and bleeding, which all suggest improved perfusion.

Discharged on Day #193:
Profoundly ischemic full thickness mixed wound 'miraculously' (crucifix) healing without scar—a bedside clinical sign of regenerative healing which occurs when stem cells flourish.

Regenerative healing is commonly seen with NPWT, Ehmann (2022) observed that robust regenerative healing seen with EdemaWear®* is the result of Positive Pressure Wound Therapy (PPWT).** Elastic textile compression via fuzzy wales* creates furrows in 20% of the wound surface what is seen with NPWT. We posit PPWT from fuzzy wale compression delivers three unique physiologic therapies:

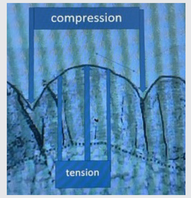
1) enhanced skin perfusion - (probable upregulation of Nitric Oxide?),

2) rapid edema control,

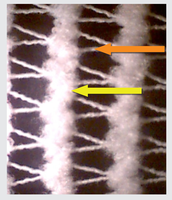
3) tissues experiencing micro deformation in furrows beneath fuzzy wales send mechano transduction signals to their DNA to upregulate gene expression and synthesize the myriad proteins required to heal the wound.

* EdemaWear® Elastic Compression Stockinet, Compression Dynamics LLC, Omaha, Nebraska 68102

Fuzzy Wales are a Physiologic Mandrel to Create Tissue Micro Deformation

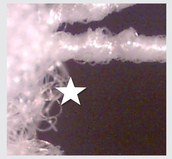


Histology at tissue/foam interface of mammal granulation tissue: Simultaneous compression and tension (blue arrows) create cell micro deformation, a term coined by Orgill (2007). The open cell foam wall (strut in diagram) is sucked down to compress the wound surface that it touches, simultaneously tissue in the center of the foam cell is sucked up, creating tenson, illustrated by artist with blue arrows. (Saxena 2004) Ehmann coined the term Positive Pressure Wound Therapy (PPWT) to describe wound surface and stasis dermatitis results of fuzzy wale elastic compression stockinet that she observed. (Ehmann 2022) We posit that PPWT is in part, a mechanism of traditional limb swaddling introduced by Greek healers of antiquity.



Vertical fuzzy wales (~7X power – marked with **yellow arrow**) have a fractal pile like texture that acts as a physiologic mandril to deliver static force to tissue via with dimensions similar in magnitude to the open cells in the black polymer foam mandril used in Negative Pressure Wound Therapy. Static force, when delivered via an appropriate contact **mandrel** creates adjacent areas of tissue tension and tissue compression resulting in tissue micro deformation (TMD). Mechanical transduction signals from TMD upregulates local gene expression to synthesize myriad protein required to reverse stasis dermatitis and heal wounds.

Horizontal spandex yarns (marked with the **orange arrow**) under tension span ~80% of the limb surface that is not under compression between the wales that deliver static elastic force to create furrows in subcutaneous fat as edema and extra cellular fluid enter patent lymphatic collection vessels and flow down a pressure gradient toward the heart. (Photo EdemaWear® Stockinet © David Coberly Council Bluffs, Iowa)



Fuzzy wale elastic compression stockinet* (photo 20X power) is warp knitted with yarn composed of 5 spiderweb thin strands of nylon that are not spun, not attached to each other, and individual fibers can be seen (marked with **white star**) in photograph above. Vertical wales deliver a fractal, 'faux shearling pile' interface with skin and wound granulation tissue. We posit that fuzzy wales act as a physiologic mandril with a microscopic fractal surface similar to the tiny individual open cells in polymer foam effective for NPWT, (both deliver static force to tissue create local tissue micro deformation). Micro deformation creates tissue conditions required for mechano transduction signaling of local cell DNA, turning on gene expression to synthesize proteins required to reverse stasis dermatitis and heal wounds. (Photo EdemaWear® Stockinet © David Coberly)

Introduction
This case series suggests that elastic textile compression delivers mechano transduction effective to heal wounds. Caroline Fife published polaroids of her first Negative Pressure Wound Therapy (NPWT) case, a large abdominal dehiscence treated in 1997 with dramatic results. Fife reminisces *"... the entire field of wound care had changed … had been running wound center for 7 years ... could do little more than Ambroise Paré, 'I dress the wounds and God heals them.'"* (Fife 2019). Louis Argenta published dramatic NPWT results, like Pare, he could only speculate on the physiology at work. (Argenta. L, 1997).

In our reading of Orgill's seminal work on the cell physiology of NPWT, open cell polymer foam acts as a physiologic mandril to deliver sub atmospheric pressure, aka static mechanical force, to wound tissue creating tissue mechano transduction signals that upregulate gene expression, dramatically increasing protein synthesis and healing. (Orgill, D 2013).

Fuzzy Wale Elastic Compression Stockinet (FWEC)*, (Sibbald 2022) delivers Wound Bed Preparation that rivals NPWT - what's going on?

Methods
Wound photos document details of wound bed preparation in 3 patients with refractory lower extremity wounds, using fuzzy wale elastic compression stockinet (FWEC)* as the wound contact layer.***

Results
Clear photos document:

(1) Early resolution of peri wound edema, lymphorrhea, and stasis dermatitis.

(2) Early clearing of wound edge epiboly.

(3) Robust wound bed progression to complete healing.

Discussion
Fuzzy longitudinal wales of FWEC* stockinet as a wound compression / contact layer delivers robust 'wound bed preparation' (Schultz G 2003) similar to that seen with NPWT. Wales may act as an effective mandril to deliver static physiologic force, mechano transduction signals sent to cell nuclei upregulate protein synthesis. (Winkler 2023) Ehmann has coined the term Positive Pressure Wound Therapy (PPWT)** to describe the findings we are reporting--future research has exciting implications.*** (Ehmann S., Ostler M. 2022)

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*** Nota Bene (This report includes off label use of compression textiles.)