Effect of Transdermal Continuous Oxygen Therapy on four wounds after treatment with Negative Pressure Wound Therapy

Steven Berlin DPM, Donald Kemp MD, David Hoffman BS and S Sarangapani PhD

A) Ogenix Corporation, Norwood, Massachusetts (02062) B) Renfrew Victoria Hospital, Wound Care Clinic, Renfrew, Ottawa ON C) Converg Medical Corporation, Ottawa ON

PURPOSE
The purpose of this case series of 4 patients was to determine the effect of Transdermal Continuous Oxygen Therapy (TCOT) on wounds that became “stuck” and did not close following treatment with Negative Pressure Wound Therapy (NPWT). The concept of NPWT is to accelerate wound healing by various mechanisms including: removal of edema, reduction of edema, contraction of wound edges, stimulation of angiogenesis, changes in the wound edges, and the production of granulation tissue. Initially, Negative Pressure Wound Therapy (NPWT) was intended as a means of bringing a recalcitrant wound to a manageable state by increasing granulation.

Nonetheless, wounds treated with NPWT can still fail or get stuck during treatment, i.e., they fail to close after an initial improvement and sometimes another relation may be needed to close the wound. A recent consensus group has listed a number of reasons to discontinues NPWT and they include a failure to improve, complications – such as excessive bleeding, significant periwound maceration and when patient cannot tolerate treatment. One solution that has been shown to be effective is to add oxygen to the wound after wound healing has occurred and is the presence of NPWT. The role of oxygen is multifaceted in wound healing and is well documented in the literature[1-4]. The mechanisms of oxygen in wound healing include: acting as a infection control agent, stimulation of growth factors, assisting collagen synthesis and fibrin degradation, stimulation of angiogenesis. Oxygen also plays an essential role in energy metabolism, and is important for polymorphonuclear cell function.

Oxygen can be applied to a wound in 3 different ways, via Hyperbaric Oxygen Therapy (HBOT); Topical Oxygen and TCOT.

HBOT
HBOT conditions allow blood plasma to transport oxygen to various parts of the body provided that adequate circulation exists. 5-10% exist for HBOT and the strongest evidence is in favour of HBOT points to its efficacy in healing diabetic foot ulcers. However, HBOT has some significant drawbacks and risks, including, claustrophobia, damage to the ears, serious and long oxygen poisoning and of course the requirement to be treated in a dedicated facility each day to be placed in the chamber.

Topical Oxygen
Topical Oxygen is applied by enclosing the extremity with the wound in a plastic chamber and subjected the limb to pure oxygen flow at approximately 6 liters/min, for up to 90 minutes per session. In one paper both HBOT and TOP were published in the same paper in humans and animals[5]. In another study 80 patients with recalcitrant non-healing wounds were treated with Topical Oxygen. After 1 months, 80% of the topical oxygen treated ulcers were completely healed compared to 25% in the control group[6]. However, Topical Oxygen includes some drawbacks and issues including: limb immobility, necessity of oxygen for only short periods of time, patient must be stationary during treatment. Also, the wound may be in a position that does not allow it to be placed in the chamber.

TCOT
TCOT is delivered via a small 3.8 oz. fuel cell based oxygen concentrator. Whereas HBOT can produce vasoconstriction, toxicity and tissue destruction, TCOT may be a viable solution by providing oxygen transdermally and continuously[7]. Said it all have, as a potential alternative to HBOT, transdermal oxygen delivery represents an easily applied and inexpensive option that can be incorporated into a wound dressing[8]. Further, every other option for oxygen treatment to date has been intermittent whether applied systemically or topically and although HBOT may have greater impact due to its systemic delivery, the continuous nature of TCOT may offer this benefit.

METHOD
In each case a clinical judgment determined that NPWT was no longer assisting the wound towards closure, or was there a contraindication that required a change in therapy modality. In the following 4 cases, at that clinical junction, TCOT replaced NPWT.

REFERENCES

CONCLUSIONS
We have reported four stuck and/or contraindicated NPWT-treated cases in this post which we have been successfully treated to closure with the help of TCOT. We also note other advantages based on publications and clinical experience including patient and clinician friendly nature of the device, reduced risk of elimination of pain, delivery of free oxygen at ambient humidity, flexible dressing choices and easy dressing removal. The highly portable unit weighing only 3 lb is available commercially and minimal training is required allowing patients and caregivers the convenience of assisting, in the treatment of the wound.

CASE 1
Cuzzuolos Necrosis / Multiple Wounds — NPWT Stopped Due To Contraindication (Pain)
64 year old female. Cuzzuolis treatment for 27 years; renal failure (diabetes), multiple necrotic wounds appearing and healing associated with extreme pain. NPWT attempted but stopped due to increased pain with vacuum start.

1. Week 1 NPWT treatment
2. Week 1 EPIFLO® treatment
3. Week 2 NPWT treatment
4. Week 2 EPIFLO® treatment
5. Week 3 NPWT treatment
6. Week 3 EPIFLO® treatment

Neuropathic Ulcer on Finger — NPWT Stopped Due To ‘Stalled’ Healing
Removal with wound jet debridement; Inpatient 1 week NPWT. Discontinued 12 weeks NPWT. (R-4) & (R-6) 89, 10 year old male. Type 1 Diabetes, neuropathic, pressure related ulcer on left leg with neuropathic ulcer base presentation. 1.0 cm to 1.5 x 1.2 mm depth — wound bed filled with necrotic spongy slough, wound circular impression; NPWT after 11 weeks with initial reduction in size has worsened became ‘stuck’ and would not improve (no change since Week 50).

1. NPWT applied
2. Week 1 NPWT treatment
3. Week 2 NPWT treatment
4. Week 4 NPWT treatment
5. Week 3 EPIFLO® treatment
6. Week 4 EPIFLO® treatment

Neuropathic (IADM) For Ulcer — NPWT Stopped Due To ‘Stalled’ Wound + Maceration
70 year old male. Neuropathic ulcer developed over 2 weeks before examination. NOTE: Note remnant present in original wound (previously excised, potential for osteomyelitis, subcutaneous scar = negative.

1. NPWT applied
2. Week 3 NPWT treatment
3. Week 5 NPWT treatment
4. Week 6 NPWT treatment
5. Week 7 NPWT treatment

Trauma Injury / Deep Tissue Infection — NPWT Stopped Due To Contraindication (Blood in Tissue)
50 year old female. (Leg amputation) long history being treated by a surgical oncologist. On NPWT as an diabetic foot ulcerated for 2 weeks to reduce size of wound. Patient was anticoagulated with NPWT suction due to presence of tissue-blood. Switched to EPIFLO®. Continuous antibiotics (Cipro/Teicoplanin) to control deep tissue infection.

1. NPWT treatment applied
2. Week 1 NPWT treatment
3. Week 4 NPWT treatment
4. Week 4 EPIFLO® treatment
5. Week 5 NPWT treatment
6. Week 5 EPIFLO® treatment