

An Overview of Available Oxygen Therapies for Woundcare

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INTRODUCTION

Chronic wound ischemia is a clearly pathological condition that inhibits normal wound healing. Oxygen plays an essential role in energy metabolism, and is important for polymorphonuclear cell function, neovascularization, fibroblast proliferation and collagen deposition – all of which are critical in wound repair. Several excellent reviews are available in the literature on the role of oxygen in wound healing¹⁻³.

Modalities of Oxygen Therapy:

Oxygen therapy can be administered by the following modalities:

- Hyperbaric Oxygen Therapy (HBOT) – 2.4 atmosphere, intermittent
- Topical Oxygen Therapy – 1.03 atmosphere, 6 LPM, intermittent
- Transdermal Continuous Oxygen Therapy (TCOT) – 1 atmosphere, 3 ml/hr, continuous

HBOT: Relies on the increased solubility of oxygen in plasma due to the higher pressure (Henry's law - the amount of a gas that dissolves in a liquid is proportional to its partial pressure.). This transport mechanism is significant provided adequate circulation exists in the needed regions. Under ischemic conditions, particularly in large vessels, increased oxygen concentration in blood plasma will not reach the wound site due to inadequate perfusion. There have been a total of five RCTs reported in the literature for HBOT. A critical analysis of these trials and their outcome was published by Kranke et al⁴. Of the various studies reviewed, Abidia et al's⁵ provides the strongest support in favor of HBOT for the treatment of diabetic foot ulcers. HBOT's risk includes damage to ears, sinuses and lungs (due to high pressure), claustrophobia and oxygen poisoning⁴.

Topical Oxygen Therapy: This mode of therapy is applied by enclosing the extremity in a plastic chamber and subjecting the limb to pure oxygen flow at 6 Liters/minute, for up to 90 minutes/day, 3-5 times/week. Both dry and humidified oxygen are used in practice. A major advantage of Topical Oxygen therapy is its independence of the wound's microcirculation¹. The oxygen therapy research group at Ohio State University has published beneficial outcomes through Topical Oxygen treatment both in animal and human trials⁶. In a recent parallel observational comparative study on venous wounds, Tawfick and Sultan⁷ treated 80 patients with refractory non-healing venous ulcers. At three months, 80% of topical oxygen-managed ulcers (n = 37) were completely healed, compared to 25% (n = 9) in the control group. A very recent prospective controlled study of diabetic foot ulcers using topical oxygen therapy showed 82.4% efficacy for the treatment group vs. 45.5% for the control group (p = 0.04)⁸

Transdermal Continuous Oxygen Therapy: Said et al⁹ notes, as a potential alternative to systemic hyperbaric therapy, transdermal (sustained) oxygen) delivery represents an easily applied and inexpensive option that can be incorporated into a wound dressing. They note that all other oxygen treatments to date have been intermittent whether applied systemically or regionally. There is (currently) only one commercially available system that can deliver Transdermal Continuous Oxygen therapy – EPIFLO® (Ogenix, Beachwood, OH). EPIFLO provides 3 mL/hour oxygen (98+%) to the wound site continuously, 24/7. Lowell et al¹⁰., present a series of 4 case presentations of wounds in 4 separate patients, that were recalcitrant to multiple treatment modalities and each had a significant component of pain. They conclude that all wounds healed completely, with a added benefit of complete reduction in pain. Banks & Ho¹¹ used TCOT on chronic and difficult to heal pressure ulcers on spinal cord injury patients: The chronic Stage IV pressure ulcers of 3 SCI (spinal cord injury patients) improved significantly when TCOT was applied as an adjunctive therapy after standard therapy failed for between 5 weeks and 6 months. TCOT therapy has been reported to have closed many diabetic wounds that were previously unresponsive to other multimodal therapies. In some cases, amputation was avoided through this adjunctive intervention¹².

Two of the many difficult cases treated successfully with this therapy are discussed below:

- References**
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Case 1

88 year old male Type 1 diabetes. Pack per day smoker quit in his 70's. Left leg amputated below the knee. The wound (inner Malleolus of right foot) has been stuck for over 6 years (2002) prior to EPIFLO ® treatment and fluctuated in size from the current (first photo) dimensions to about 1cm larger in both dimensions. The physician treated this as a maintenance wound with little chance of healing based on other treatments which included various modalities including NPWT, Providine, and Moist wound care. Infection was frequent and antibiotics were often applied orally, topically and sometimes through IV. Initially, the wound had moderate sero-sanguineous drainage. Note the size decrease and increased epithelialization

3 months w/
EPIFLO



11 months with EPIFLO

Case 2

47 year old male. Paraplegic . Accident at 16 years of age repairing automobile. Frame of car fell and crushed legs. Smoker. At age 43 developed Fournier's Gangrene requiring removal of entire genital area. Surgery resulted in long term chronic wound (~ 4 years). Other wound treatment used included MWT and NPWT.

day 1 w/
EPIFLO



10 months
w/ EPIFLO

Conclusions

It is clear that there is mounting evidence in the literature that all modes of oxygen therapy (and not just HBOT) are helpful in healing wounds of various etiologies. The 2 cases in this small study indicate that Transdermal Continuous Oxygen Therapy (administered as EPIFLO®) shows great potential for wound healing for a variety of wound etiologies including :diabetic, ischemic, recalcitrant wounds that previously failed to progress despite aggressive use of advanced treatment modalities. A large multi-centre, double blinded, Randomized Controlled Trial (RCT) is underway to investigate the effect of EPIFLO® on diabetic foot ulcers vs. a control group receiving standard wound care. Further studies that would identify indications where EPIFLO® could be utilized as an adjunct or even primary therapy may be desirable and may allow clinicians to work towards healing wounds that were once believed to be untreatable or maintenance wounds. The portable nature of EPIFLO® makes it a preferable treatment modality for both clinician and patient alike.

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*EPIFLO is manufactured by Ogenix Corporation of Beechwood ,Ohio, USA