

# Grand Rounds

## Hyperbaric Oxygen in Wound Healing: *Understanding the Essential Science*

### What's the problem?

Acute wounds (such as surgical incisions) normally proceed through an orderly and timely sequence of physiologic events that ultimately result in the restoration of anatomic and functional integrity. Conversely, chronic wounds fail to proceed through this normal restorative cascade, with the clinical result of poor or delayed healing. Diabetic foot ulcerations, venous leg ulcers, and tissue pressure injuries are common examples of this phenomenon. Additionally, acute wounds may unfortunately transition into a chronic state as a result of well-identified stimuli:

- ▶ infection
- ▶ ischemia
- ▶ cellular senescence
- ▶ unrelieved pressure or repetitive mechanical injury

Underlying these deterrents to normal healing is the pathophysiologic foundation of tissue hypoxia. Identified in a variety of disease states (i.e., peripheral vascular disease and diabetes mellitus), hypoxia increases the risk of local infection while simultaneously retarding tissue growth. Thus, correction of this local oxygen deficit is vital to successful wound care. A tool commonly used to address this in the advanced wound care center is hyperbaric oxygen therapy (HBOT).

### How does HBOT work?

HBOT increases the dissolved oxygen content in blood plasma. Functionally speaking, this translates into a systemic increase in reactive oxygen (oxygen free radicals) and reactive nitrogen species. The direct result includes a number of physiological benefits to the wounded host including:

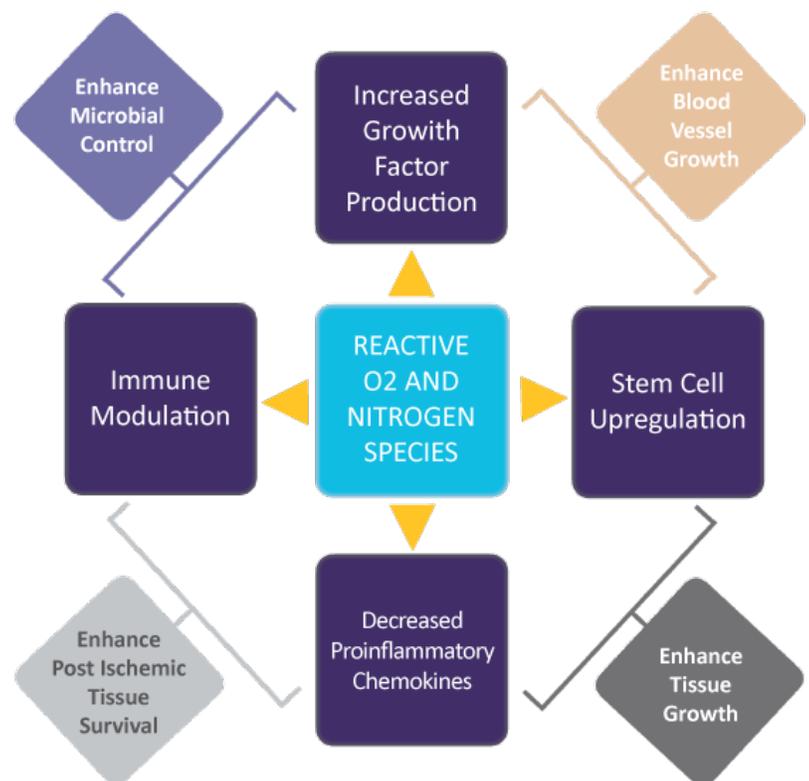
- ▶ Immediate correction of tissue hypoxia in ischemic, infected, or irradiated tissue
- ▶ Stimulation and support of collagen synthesis and new blood vessel growth (angiogenesis)
- ▶ Reduction of local tissue edema by local alteration in blood flow
- ▶ Enhancement of immune function by supporting WBC-mediated microbial control and improving antibiotic effectiveness

### How is HBOT provided?

Appropriately selected patients are placed in a large, clear acrylic chamber that is pressurized with 100% oxygen, typically at twice the ambient atmospheric pressure. They comfortably breathe this medical gas while enjoying a nap or watching television. Ninety minute sessions are most commonly provided 5 days per week, for a total of 30-40 treatments.

### Is HBOT safer for my patient?

Generally speaking, HBOT is both safe and well-tolerated. Occasionally, patients will sense a pressure change or discomfort in the ears (as during a plane flight). More serious complications can occur, though very rarely so. A trained hyperbaric physician performs a comprehensive patient assessment to insure that potential treatment candidates are screened for the prevention of such issues. This provider helps patients to understand their role in successful therapy and, in addition, observes the patient during the actual treatment phase.



## What specific diseases or conditions benefit from HBOT?

When combined with appropriate conventional wound care such as debridement, antibiotics, edema control, and pressure relief, many previously non-healing wounds can be successfully managed. More specifically, the FDA approves 14 recognized treatment indications (most are reimbursed by CMS and private payers when the patient meets other medical necessity criteria):

- ▶ Air or gas embolism
- ▶ Carbon monoxide poisoning
- ▶ Carbon monoxide poisoning complicated by cyanide poisoning
- ▶ Clostridial myositis and myonecrosis (gas gangrene)
- ▶ Crush injury, compartment syndrome and other acute traumatic ischemias
- ▶ Decompression sickness
- ▶ Arterial insufficiencies
- ▶ Central retinal artery occlusion
- ▶ Enhancement of healing in selected problem wounds
- ▶ Severe anemia
- ▶ Intracranial abscess
- ▶ Necrotizing soft tissue infections
- ▶ Osteomyelitis (refractory)
- ▶ Delayed radiation injury (soft tissue and bony necrosis)
- ▶ Compromised grafts and flaps
- ▶ Acute thermal burn injury
- ▶ Idiopathic sudden sensorineural hearing loss

Adjunctive HBOT cannot improve healing in all problem wounds. However, those demonstrating reversible local tissue hypoxia and poor response to local infection will frequently benefit from this therapy, when applied in a system of advanced local wound care, appropriate antibiotics, and control of systemic host factors.

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