

Hyperbaric Oxygen Therapy

Hyperbaric oxygen therapy (HBOT) has well-established benefits across multiple clinical domains, with the strongest evidence supporting its use in **wound healing, decompression sickness, carbon monoxide poisoning, and radiation injury**. The Undersea and Hyperbaric Medical Society (UHMS) currently recognizes 14 approved indications.

Established Indications with Strong Evidence

- **Diabetic foot ulcers:** HBOT significantly improves wound healing and reduces amputation risk. A systematic review found an increased healing rate (Peto OR 14.25; 95% CI 7.08–28.68) and reduced amputation rate (Peto OR 0.30; 95% CI 0.10–0.89) compared with conventional therapy. Patients receiving HBOT are approximately one-third as likely to require major amputation, with an NNT of 4 to prevent one amputation.
- **Carbon monoxide poisoning:** One of the most well-established indications, HBOT accelerates carboxyhemoglobin elimination and reduces neurological sequelae.
- **Decompression sickness:** A primary indication with strong clinical consensus.
- **Gas gangrene (clostridial myositis/myonecrosis) and necrotizing soft tissue infections:** HBOT serves as an important adjunct to surgical debridement and antibiotics.
- **Delayed radiation injury:** Supported by systematic reviews for treatment of radiation-induced tissue damage, including osteoradionecrosis.
- **Crush injuries:** An RCT demonstrated complete healing in significantly more patients receiving HBOT versus placebo ($p < 0.01$), with fewer requiring skin grafts, vascular procedures, or amputations.
- **Compromised skin grafts and flaps:** HBOT enhances graft survival through improved oxygenation and neovascularization.

Spinal Cord Injury

This is the area with the most encouraging clinical data. A retrospective study of 78 patients with incomplete cervical SCI found that adjunctive HBOT after surgical decompression resulted in a **90% total effectiveness rate vs. 78.9%** in the non-HBOT group ($p < 0.05$), with significantly better ASIA motor/sensory scores and Barthel Index scores at 1 month, 3 months, 6 months, and 1 year

postoperatively. The greatest benefit was observed when HBOT was initiated within 3 months of surgery, with peak recovery in the first 3 postoperative months. An RCT of 79 acute SCI patients similarly demonstrated that HBOT significantly improved ASIA and Frankel Grade motor/pain scores at day 30 ($p < 0.01$), with downregulation of inflammatory markers HMGB1 and NF- κ B. A case report described dramatic recovery (ASIA B $\rightarrow$ ASIA E) in a patient with perioperative spinal cord injury after T9-L5 decompression and fusion, with near-immediate motor improvement after the first HBOT session.

Postoperative Spinal Infections

A review of HBOT in spinal management found that adjunctive HBOT may **lessen the duration of antimicrobial therapy and mitigate the need for instrument removal and revision surgery** in postoperative spinal infections, supported by level III–IV evidence. A retrospective study of 19 patients with iatrogenic spinal infections refractory to antibiotics alone showed that all cases resolved with adjunctive HBOT (mean ~20 sessions), and **no revision or instrumentation removal was necessary** in any instrumented case. Similar results were reported in high-risk pediatric patients with neuromuscular spine deformity, where all deep postoperative infections resolved with HBOT, with intact implants and radiological fusion at a mean follow-up of 54 months.

Fracture Healing and Non-Union

Animal studies consistently demonstrate that HBOT enhances bone mineral apposition, bone formation rates, callus size, and biomechanical strength at fracture sites. HBOT combined with autologous bone grafting significantly increased new bone formation and angiogenesis in critical-sized diaphyseal defects in rabbits, with synergistic effects when combined with PRP.

Spinal Fusion

A rabbit model of posterolateral lumbar fusion showed that HBOT **did not significantly improve fusion rates** when combined with mesenchymal stem cells and alginate carrier (fusion: 6/12 with HBO vs. 10/22 without, $p = 0.80$). No human clinical trials have evaluated HBOT for enhancing spinal fusion rates.

Muscle and Soft Tissue Injury

A 2026 systematic review and meta-analysis of 10 RCTs (299 subjects) found that HBOT **significantly accelerated recovery from exercise-induced muscle injury** ($p < 0.0001$), effective at both higher (>2.0 ATA) and lower (≤ 2.0 ATA) pressures. However, HBOT did not significantly reduce exercise-induced muscle soreness overall. Mechanistically, HBOT reduces inflammation, promotes macrophage invasion, activates satellite cells, and stimulates angiogenesis via the NO/VEGF/bFGF pathway in contused muscle. An earlier Cochrane review of 9 small trials found insufficient evidence for HBOT in ankle sprains, knee sprains, or DOMS, and concluded further research was not a high priority.

Safety Profile

HBOT is generally well tolerated. The most common adverse effect is **middle ear barotrauma** (~4% of treatments). Rare complications include oxygen toxicity seizures (~0.03% of treatments), which resolve upon oxygen removal, temporary myopia (usually resolving by 10 weeks), and claustrophobia. Relative contraindications include uncontrolled hypertension, untreated pneumothorax, and certain concurrent medications.

Mechanisms of Action

HBOT increases dissolved plasma oxygen, enhancing tissue oxygenation in hypoxic wound beds. This promotes collagen synthesis, angiogenesis (via upregulation of VEGF, EGF, PDGF), macrophage bactericidal activity, and anti-inflammatory responses while reducing edema.

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