



# **The Use of Hyperbaric Oxygen as an Adjunct for Post-Traumatic Amputation Wound Healing**

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# Introduction

- **Lower extremity amputations are common.<sup>1</sup>**
  - **30,000-40,000 performed annually**
- **Majority are performed for chronic diseases: diabetes and peripheral vascular disease.<sup>2</sup>**
- **Far fewer are performed for trauma.<sup>3</sup>**

1. Ziegler-Graham K, MacKenzie EJ, Ephraim PL, Travison TG, Brookmeyer R. Estimating the prevalence of limb loss in the United States: 2005 to 2050. Arch Phys Med Rehabil 2008 Mar; 89(3):422-9.
2. Mayfield JA, Reiber GE, Maynard C, Czerniecki JM, Caps MT, Sangeorzan BJ. Trends in lower limb amputation in the Veterans Health Administration, 1989-1998. J Rehabil Res Dev 2000 Jan-Feb; 37(1):23-30.
3. Ebskov LB. Trauma-related major lower limb amputations: an epidemiologic study. J Trauma 1994 Jun; 36(6):778-83.



# Introduction

- **Improvised explosive device (IED) use has resulted in a condition orthopaedists term “mangled extremities.”**
- **Affected extremities have soft-tissue, bone, and vascular injuries.**
- **Civilian criteria used to decide whether or not to amputate these severely injured limbs have been unreliable.<sup>4</sup>**

4. Gawande, A. Casualties of war--military care for the wounded from Iraq and Afghanistan. N Engl J Med 2004 Dec 9; 351(24):2471-5.



# Introduction

- **The benefits of early weight bearing have been recognized for many years.<sup>5</sup>**
- **Fitting amputees for prostheses soon after amputation offers physical and psychological benefits.<sup>6</sup>**
- **Fitness and motivation are highest immediately following surgery but wane over time.**

5. Wilson PD. Early weight-bearing in the treatment of amputations of the lower limbs. J Bone Joint Surg Am 1922; 4(2):224-47.

6. Smith DG, McFarland LV, Sangeorzan BJ, Reiber GE, Czerniecki JM. Postoperative dressing and management strategies for transtibial amputations: a critical review. J Rehabil Res Dev 2003 May/Jun; 40(3):213-24.



# Materials and Methods



- **Between 1 July 2010 and 30 January 2011, seven patients were referred to the U.S. Air Force School of Aerospace Medicine Hyperbaric Medicine Center from the Center for the Intrepid (CFI) for poorly healing stump wounds that were delaying the fitting of their prostheses.**
- **Patients had been receiving appropriate wound care at the CFI prior to referral for hyperbaric oxygen therapy (HBOT).**
- **The patients' wound healing courses were retrospectively reviewed.**



# Results



- **Amputation level**
  - 5 transtibial
  - 1 transfemoral
  - 1 transmetatarsal
- **Mechanism of Injury**
  - 5 IEDs
  - 1 parachuting accident
  - 1 motorcycle accident



# Results



- **Three patients had  $P_{TC}O_2$  assessment, two showing hypoxia. No patients had  $P_{TC}O_2$  assessment following hyperbaric oxygen course.**
- **Patients were treated at either 33 fsw or 45 fsw for 90 min.**
- **End point for hyperbaric oxygen was determined clinically.**



# Results



- **Patients were considered healed when the wound was epithelized, not when the patients were ready for prosthetic fitting.**
- **One patient developed osteomyelitis, requiring further surgical intervention.**





# Results



	Age (years)	HBOT Sessions (days)	Amputation to HBOT (days)	HBOT to Healing (days)
Mean	25.4	9.3	60.9	22.3
Median	22	10	65	21
Range	20-39	3-14	27-111	9-40



# Results





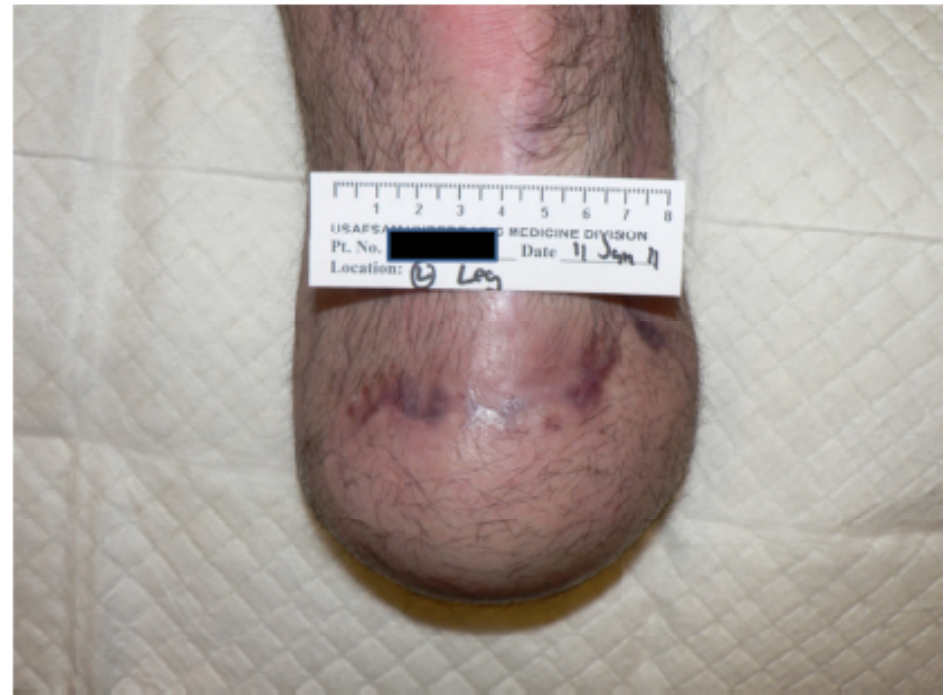
# Results







# Results





# Results





# Discussion



- **Although there are reports of improved wound healing in normal tissue,<sup>7</sup> most literature supports the use of HBOT for wounds in hypoxic tissue.**
- **Radiation injury, diabetes, peripheral vascular disease, and venous stasis cause tissue hypoxia.<sup>8</sup>**
- **This case series suggests that trauma causes tissue hypoxia in otherwise normal appearing tissue.**

7. Uhl E, Sirsjö A, Haapaniemi T, Nilsson G, Nylander G. Hyperbaric oxygen improves wound healing in normal and ischemic skin tissue. *Plast Reconstr Surg* 1994 Apr; 93(4):835-41.

8. Davidson JD, Mustoe, TA. Oxygen in wound healing: more than a nutrient. *Wound Repair and Regeneration* 2001 May; 9(3):175-7.



# Conclusions


- **HBOT, in conjunction with appropriate wound care, is a useful adjunct to achieve stump healing for chronic wounds.**
- **Reducing the healing time allows patients to be fitted with prosthetic limbs sooner when patients are more physically fit and motivated for rehabilitation.**





# QUESTIONS?





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