



Hyperbaric Oxygen Therapy and the Surgical Patient: Who, When, and Why?

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Indications

- Air or Gas Embolism
- Carbon Monoxide
- Clostridial Myositis and Myonecrosis (Gas Gangrene)
- Crush Injury, Compartment Syndrome, and other Acute Traumatic Ischemias
- Decompression Sickness
- Arterial Insufficiencies
- Severe Anemia
- Intracranial Abscess
- Necrotizing Soft Tissue Infections
- Osteomyelitis (refractory)
- Delayed radiation Injury (Soft Tissue and Bony Necrosis)
- Compromised Flaps or Grafts
- Acute Thermal Burn Injury
- Idiopathic Sudden Sensorineural Hearing Loss

Not Ready For Prime Time

- Inflammatory Bowel Disease
 - healing fistulas

Not Ready For Prime Time... and may never be

- Autism
- Traumatic Brain Injury
- Stroke
- Post-Stroke Care
- Autoimmune diseases
- Covid

HBO Does NOT

- Improve your IQ
- Improve your vision
- Improve memory
- Improve hair growth
- Improve your sexual potency



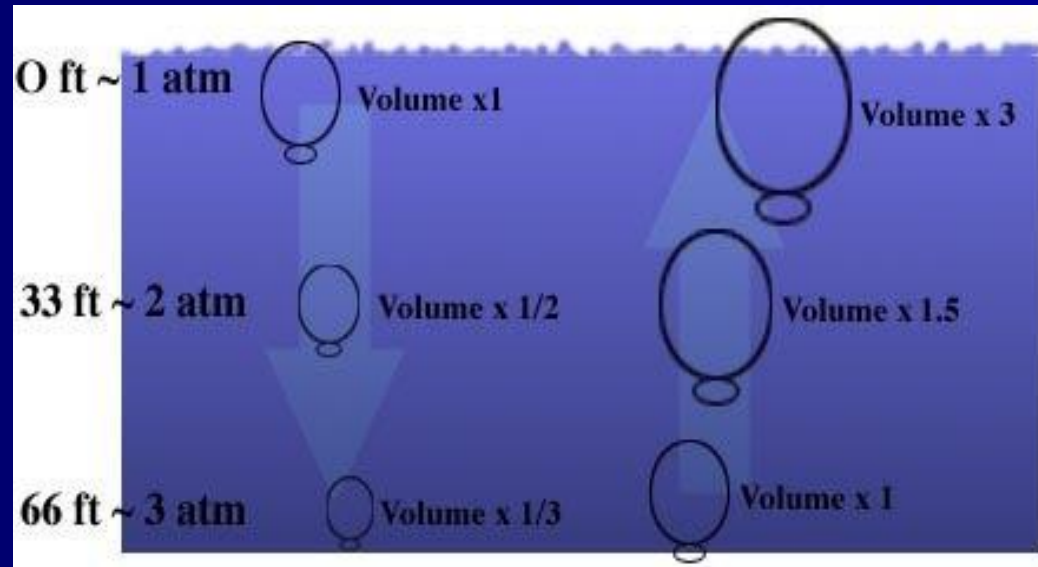
Hyperbarics -Chambers

- Multiplace vs. monoplace chambers



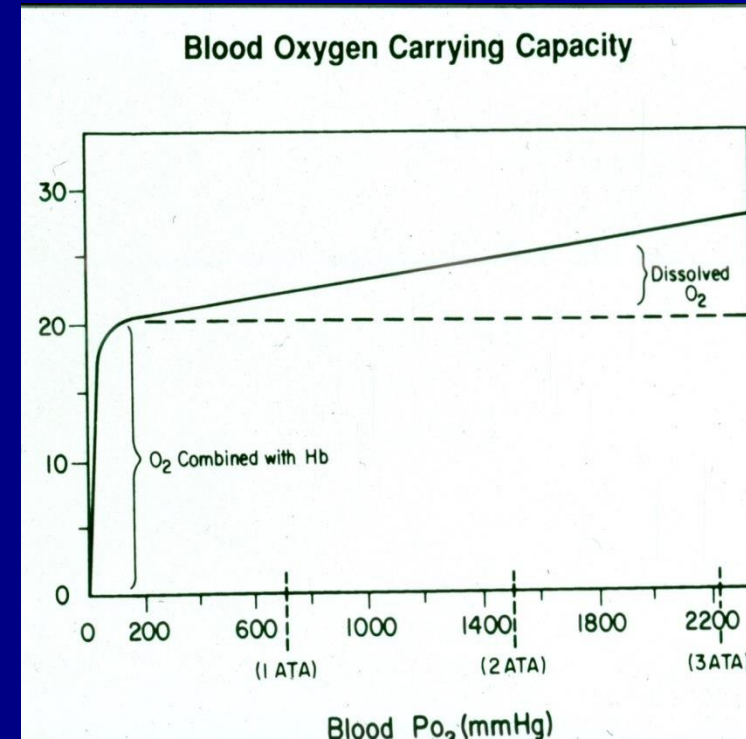
Hyperbarics -How it Works

- Mechanical Effects of Pressure
 - Decreases bubble volume



Hyperbarics -How it Works

- Effects of Elevated Partial Pressure of O₂
 - Vasoconstriction
 - Antibacterial Effect-enhanced leukocyte killing activity
 - Wound Healing-fibroblast growth and collagen production
 - Ischemia – Reperfusion Injury

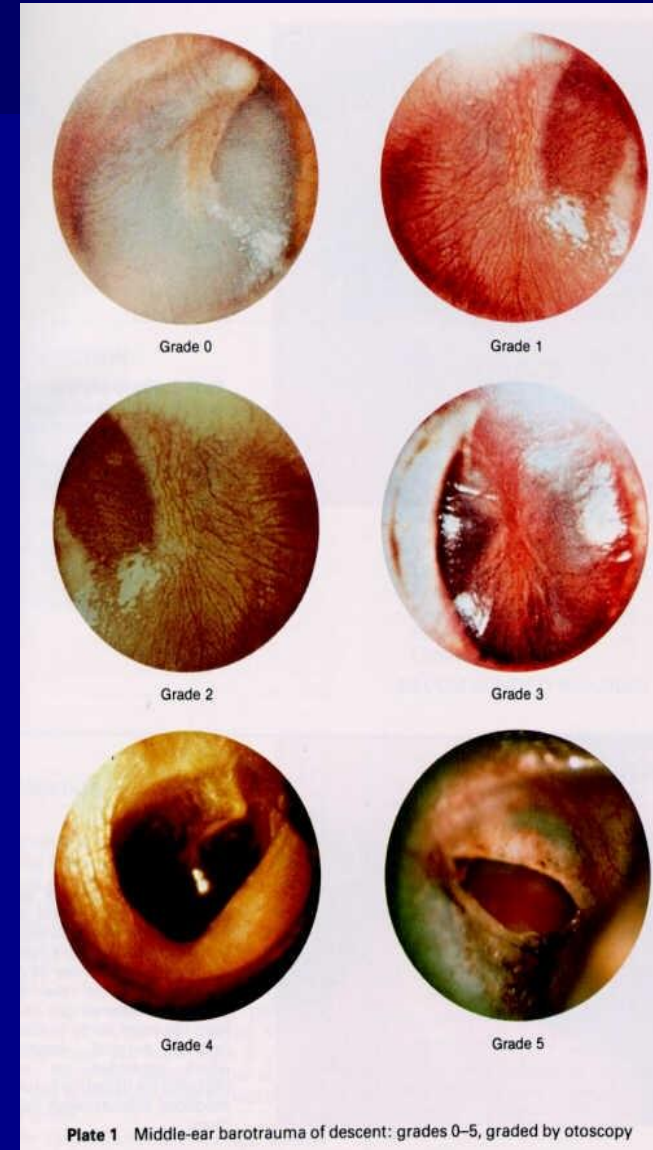


Hyperbarics –Side Effects

- Oxygen Toxicity
 - Pulmonary and CNS
- Highly reactive oxygen-derived free radicals
 - Lipid peroxidation, cell membrane disruption

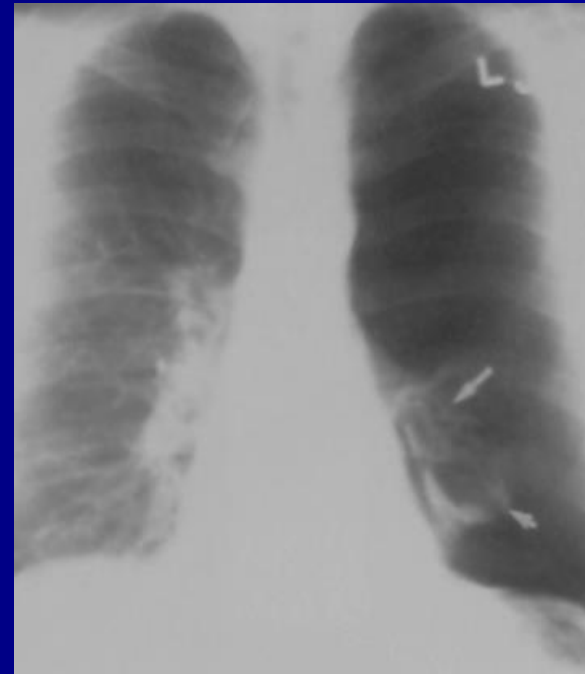
Hyperbarics –Side Effects

- Middle Ear Barotrauma
- Sinus Barotrauma
- Claustrophobia
- Visual Refractive Changes



Hyperbarics - Contraindications

- Absolute (????)
 - Untreated pneumothorax
 - Doxorubicin (Adriamycin)
 - Cis-Platinum
 - Bleomycin
 - Disulfiram (Antabuse)
 - Mafenide Acetate (Sulfamylon)



Hyperbarics - Contraindications

- Relative
 - Inability to equalize ears or sinuses
 - URI, OM, sinusitis, eustachian tube dysfunction
 - Emphysema with CO₂ retention
 - Seizure Disorder
 - Pregnancy
 - NOT contraindicated in an emergency

HBO and the General Surgeon

- Air or Gas Embolism
- Clostridial Myositis and Myonecrosis (Gas Gangrene)
- Necrotizing Soft Tissue Infections
- Osteomyelitis (refractory)
- Compromised Flaps or Grafts
- Delayed radiation Injury (Soft Tissue and Bony Necrosis)
- Acute Thermal Burn Injury
- Severe Anemia

HBO and the General Surgeon

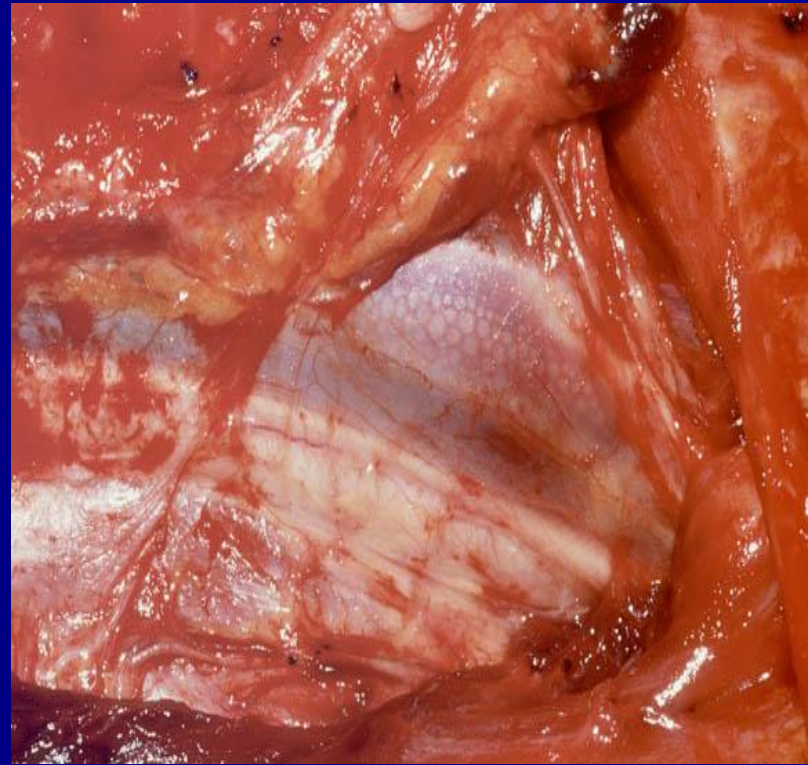
- Clostridial Myositis and Myonecrosis (Gas Gangrene)/Necrotizing Soft Tissue Infections
- Compromised Flaps or Grafts
- Delayed radiation Injury (Soft Tissue and Bony Necrosis)

Hyperbarics -AGE

- SCUBA Diving
- Non-diving etiologies
 - Central venous catheterization, angioplasty, lung biopsy, liver transplant, hemodialysis, penetrating chest trauma, laparoscopy, cesarean delivery

Hyperbarics -AGE

- Rationale
 - Reduces bubble size
 - Increases diffusion gradient of embolized gas
 - Oxygenates hypoxemic tissues
 - Reduces cerebral edema
- Treatment
 - USN TT 6A or TT 6 or COMEX 30



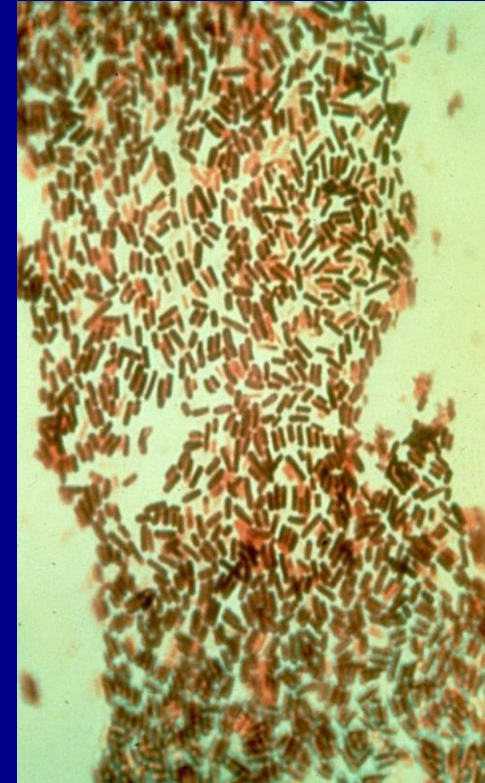


Gas Embolism

- Who? Anyone you suspect has it
- When? ASAP
- Why? Gold Standard
- Common? No

Hyperbarics –Soft Tissue Infections

- Clostridial Myonecrosis (Gas Gangrene)
 - Anaerobic, spore-forming G+ encapsulated bacillus
 - C. Perfringens (80-90%)
 - Facultative anaerobe, multiplies freely at 30 mmHg, restricted growth at 70 mm Hg
 - 20 toxins, most prevalent and lethal is alpha toxin



Hyperbarics –Soft Tissue Infections

- Rationale

- Bacteriostatic effect
- Inhibits alpha-toxin production
- Surgery, antibiotics, and HBO improves morbidity and mortality in animals
- Improved survival and decreased rate of amputations in humans

Hyperbarics –Soft Tissue Infections

- Indications:
 - Clinical picture
 - Gram positive rods
 - Radiographic evidence of soft tissue air



Hyperbarics –Soft Tissue Infections

- Treatment
 - Aggressive surgical debridement
 - Antibiotics
 - HBO as adjunct
 - 2.8 ATA q8 hours for the first 24-48 hours, then bid for 3-5 days



Hyperbarics –Soft Tissue Infections

- Rationale

- Local tissue hypoxia and infection-induced occlusive endarteritis
- HBO effects anaerobic bacterial growth and improves PMN function
- HBO, surgery, antibiotics reduces mortality



Necrotizing Infections

- Who? Anyone suspected
- When? ASAP
- Why? Can be life and limb saving
- Common? No

Hyperbarics -Osteomyelitis

- Rationale

- Osteomyelitis refractory to standard therapy
- HBO causes osteoclastic stimulation in animals
- Enhance host defenses, PMN stimulation

- Indications

- Adjunct with aggressive debridement and antibiotics for refractory cases



Chronic Osteomyelitis

- Who? If bone cannot be removed
- When? Post optimal treatment (debridement and IVAB) 3 months
- Why? Adjuvant therapy to treat infection
- Common? Yes

Hyperbarics –Skin Grafts

- Rationale

- Improves tissue oxygenation and increase flap capillary density
- Animal data show benefit of HBO
- No randomized studies but successful clinical trials

Hyperbarics –Skin Flap





Compromised Grafts/Flaps

- Who? Patient who has had graft/flap which looks tenuous due to venous congestion
- When? Intra-op to 72 hours out
- Why? Demarcate tissue, salvage graft/flap
- Common? yes

Hyperbarics –Problem Wounds

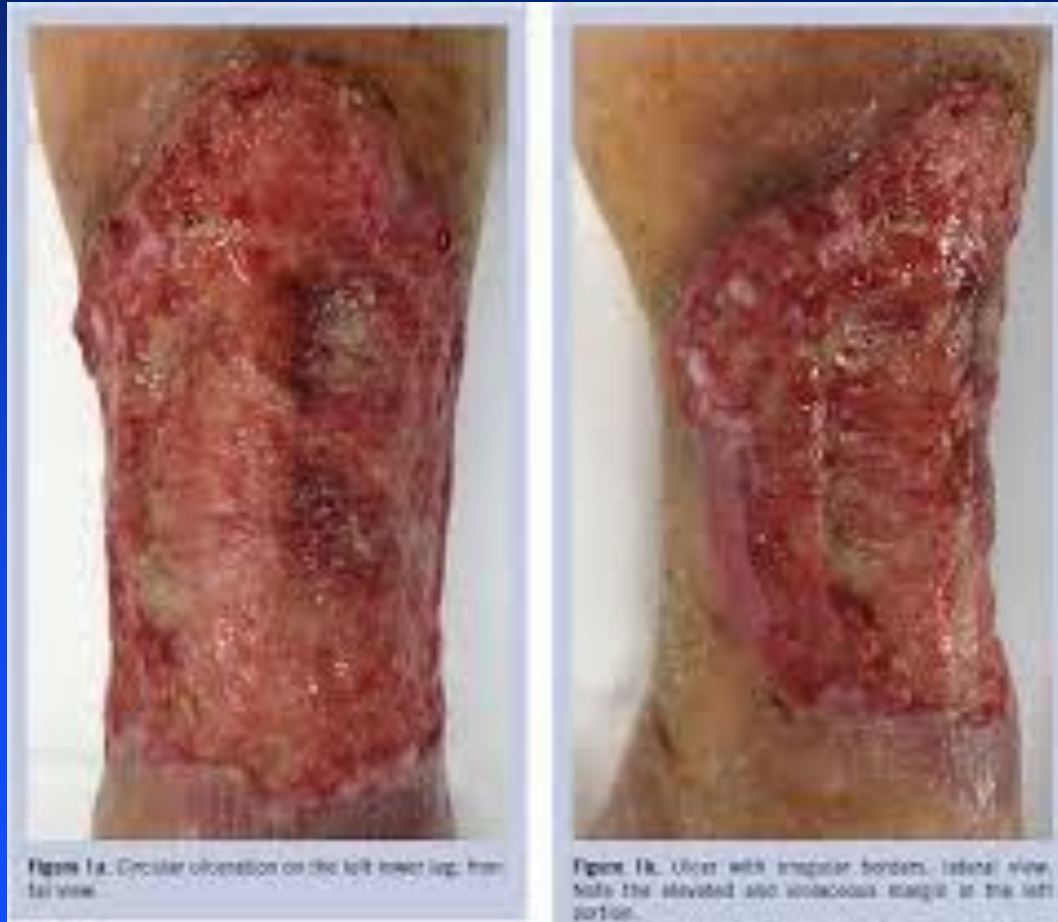
- Rationale

- HBO can stimulate fibroblasts, collagen synthesis, angiogenesis, and PMN oxidative killing of microorganisms
- HBO is **not** a substitute for surgical revascularization

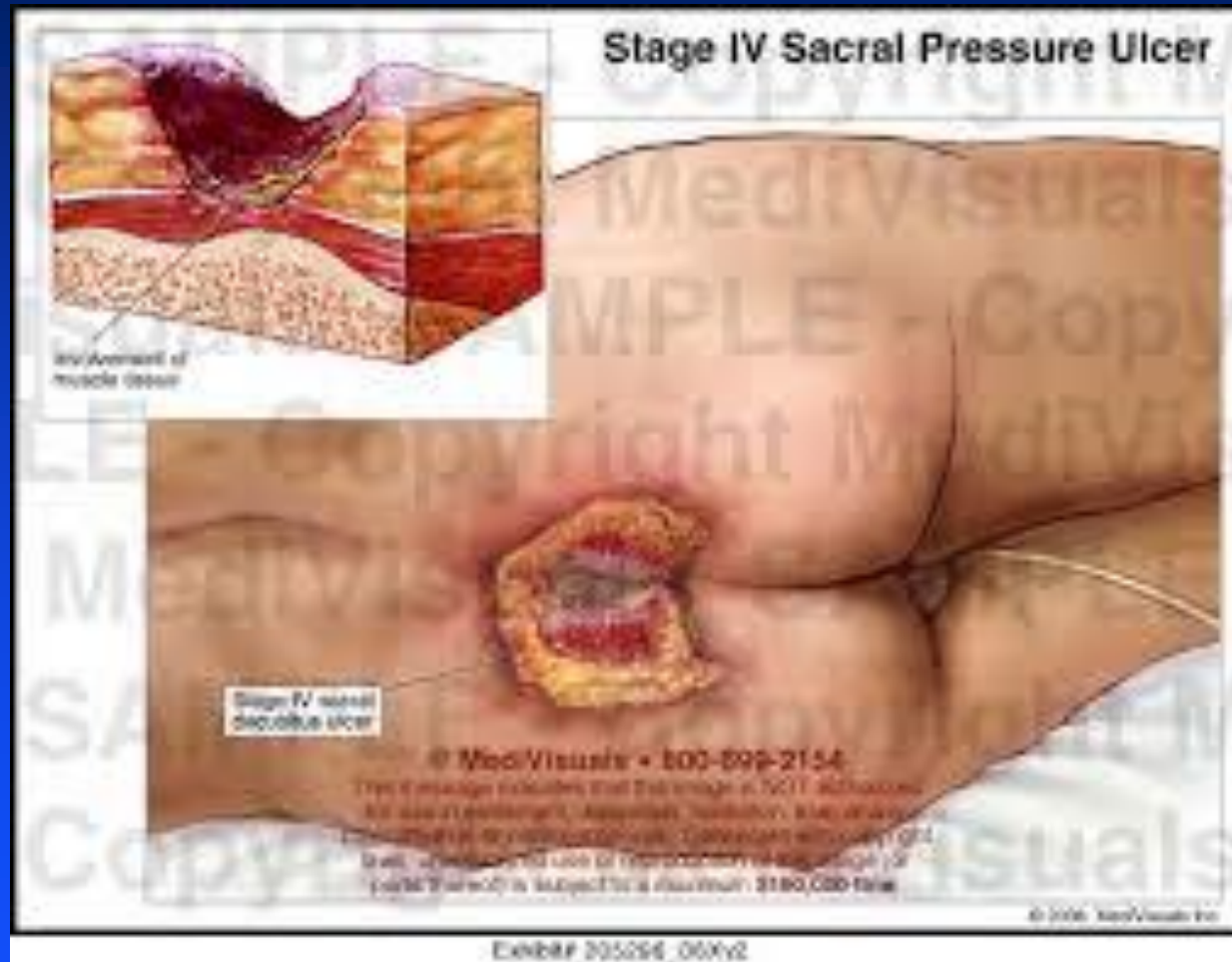
- Indications

- Non-healing diabetic foot wounds
- Arterial insufficiency ulcers

Other Problem Wounds



Other Problem Wounds



Venous Stasis

- What is the treatment?
 - Compression and Elevation
 - Consistency and Adherence
- No indication for HBOT

Pressure Ulcers

- What's the treatment?
 - Offloading
- Could there be a role for HBOT?
 - Radiated tissue
 - Concurrent Osteomyelitis
 - Otherwise, no indication

Hyperbarics –Problem Wounds





Problem Wounds

- Who? Patients with wound which has not healed despite optimal wound care (incl. blood sugar control), who have had any required vascular interventions
- When? After all the above x 6 months
- Why? Some wounds are hypoxic
- Common? Controversial

Hyperbarics –Radiation Injury

- Rationale

- Post-radiation progressive obliterative endarteritis with resultant tissue ischemia and fibrosis and eventual necrosis
- HBO stimulates angiogenesis
- Randomized, prospective trials for head and neck surgery post radiation
 - standard protocol for HBO when surgery is needed

Hyperbarics –Radiation Injury

- Indications

- Soft tissue radionecrosis

- radiation enteritis, radiation cystitis

- laryngeal and tracheal radionecrosis

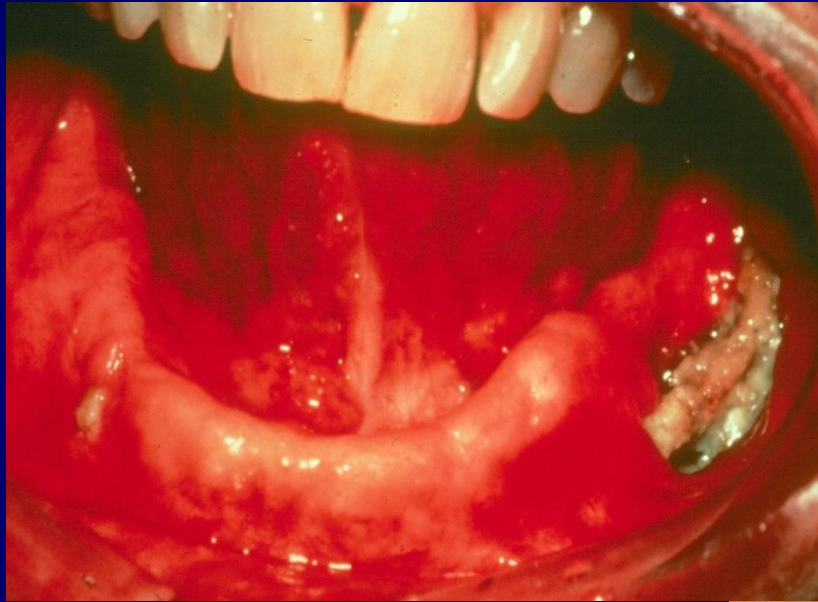
- radiation mucositis

- Osteoradionecrosis

- Head and neck post-radiation surgery

- graft reconstruction, soft tissue vascular flaps, tooth extraction

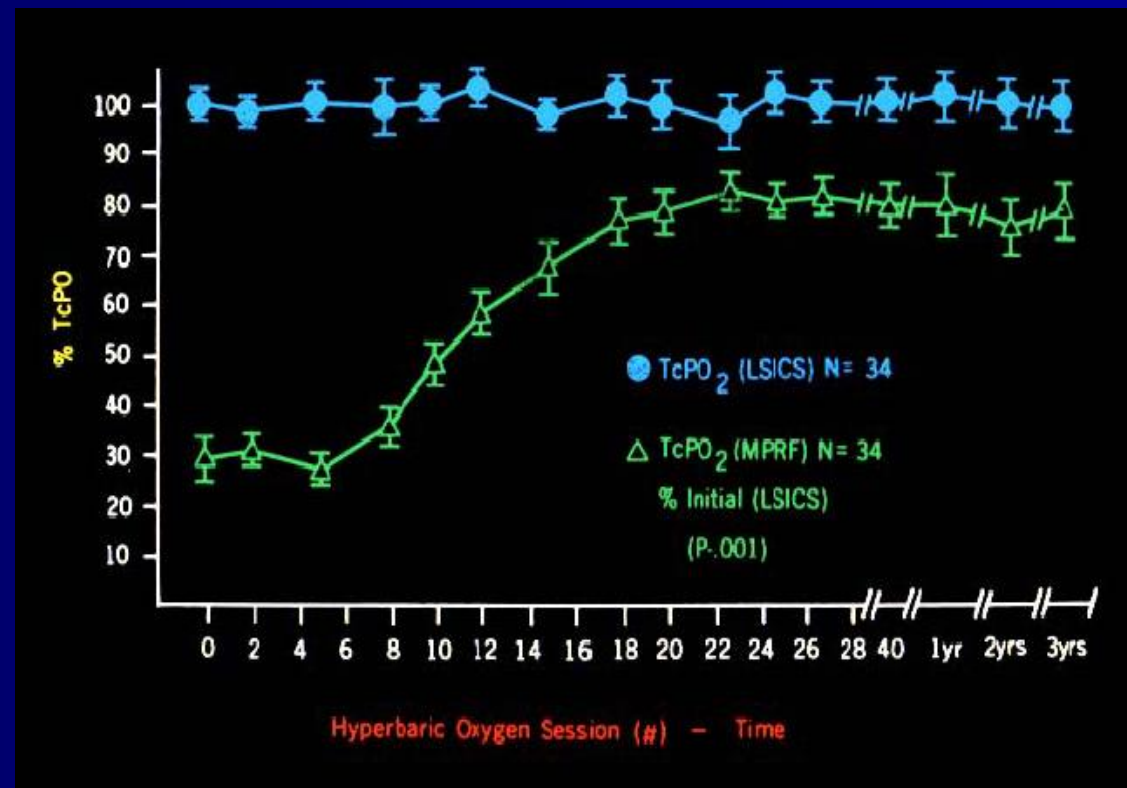
Hyperbarics –Radiation Injury



Hyperbarics –Radiation Injury

- Treatment
 - Standard Protocol
 - 2.4 ATA 90 minutes O2
 - Prophylactic Protocol (to prevent osteoradionecrosis)
 - 20 treatments pre-op
 - 10 treatments post-op
 - Marx Protocol (if ORN already present)
 - 30 treatments pre-op and 10 post

Hyperbarics – Radiation Injury





Late Effects of Radiation

- Who? Plan to operate in irradiated field, non healing wound in irradiated field
- When? At least 6 months post radiation therapy (and at least 2 years before planned operation)
- Why? Optimize tissue for healing
- Common? Yes

Hyperbarics -Burns

- Rationale

- HBO decreases edema, enhance host defenses
- Improves wound healing, reduce fluid requirements
- Human clinical series suggest improved wound healing, reduced mortality, decrease in surgical procedures, reduced hospital stay
- Although approved by UHMS, many burn centers do not use HBO



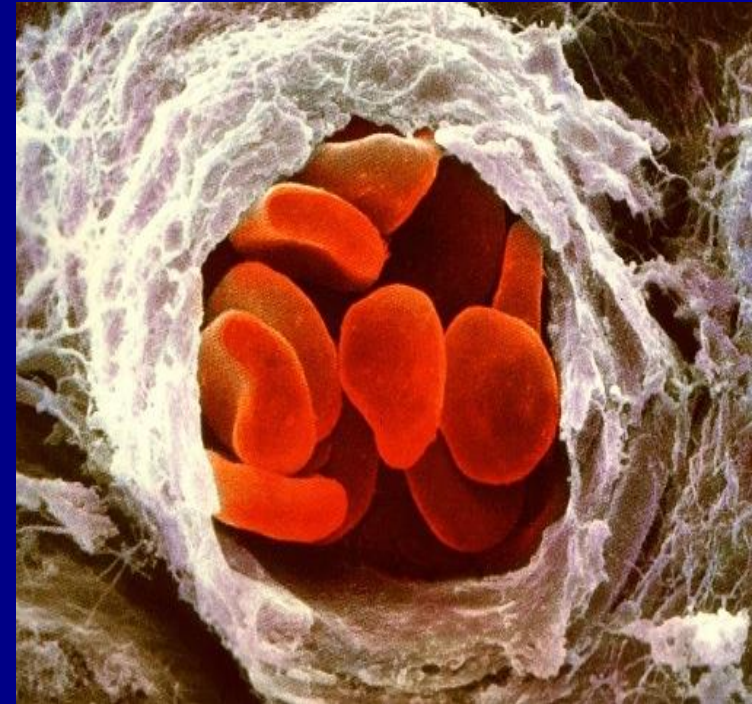
Acute Thermal Burns

- Who? Significant burns
- When? Up to 4 hours post-burn
- Why? Decreased fluid requirement, decreased number of visits to theatre
- Common? No

Hyperbarics –Exceptional Anemia

- Rationale

- Compromised O₂ carrying capacity with problematic transfusion
 - medical, personal, religious
- HBO can dissolve enough O₂ to meet oxygen requirements of tissues
- Animal studies demonstrate beneficial effect in hemorrhagic shock models
- No randomized, prospective human studies
- HBO + erythropoietin may increase benefit





Exceptional anemia

- Who? Patient who is hemodynamically unstable from anemia and can't/won't accept transfusion
- When? Immediately
- Why? Stabilize until blood available
- Common? No



Do you want a consult?



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Hyperbarics -Questions

