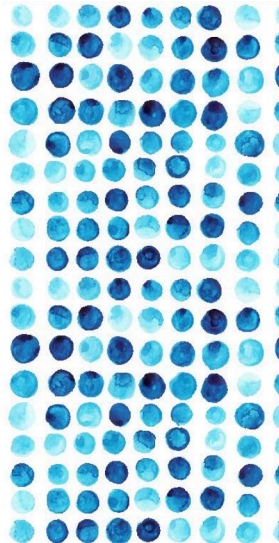


## Hyperbaric Oxygen Therapy: Understanding the Science and Exploring the Benefits

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Laura Smith CHT, LPN



## Introductions

- 4 **Chelsea Johnson** – Director of CentraCare Wound Centers
- 4 **Laura Smith** – Certified Hyperbaric Technologist, LPN - St. Cloud Wound Center
- A little about us..
  - 4 Wound centers in St. Cloud, Monticello and Willmar
    - Outreach programs in Sauk Centre and Paynesville
  - 4 Two monoplace chambers in both the St. Cloud and Monticello wound centers



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## Objectives

- 4 Identify and explain the core principles of hyperbaric oxygen therapy
- 4 Provide attendees with a clear understanding of hyperbaric oxygen therapy indications
- 4 Understand benefits of hyperbaric oxygen therapy
- 4 Understand how hyperbaric oxygen therapy can support patient healing both pre and post surgically
- 4 Demonstrate understanding of safety protocols and potential risks associated with hyperbaric oxygen therapy

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## What is Hyperbaric Oxygen Therapy (HBOT)?

- 4 Breathing in 100% oxygen in a pressurized space
  - Monoplace chambers – small chamber for one person
  - Multiplace chambers – large room with several people

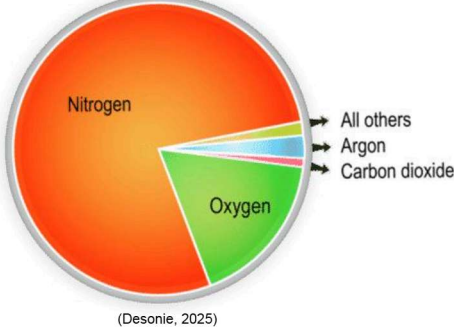


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Air versus oxygen

4 Air composition

- 78.1% Nitrogen
- 20.9% Oxygen
- 1% Other gasses such as carbon dioxide, argon, neon, helium, hydrogen, methane, nitrox oxide



Hyperbaric oxygen history

- Early 1600's – Dr. Nathaniel Henshaw build the first air pressurized room to treat respiratory problems, called a 'domicilium'
- Mid 1800's – First device developed to provide pressurized air to coal and cassion workers
- 1891 – First U.S. chamber was in Rochester, NY. Built to support cerebral spinal therapeutics
- Early 1900's – British Royal Navy developed decompression tables for safe diving practices
- 1955 – Used acrylic chambers with oxygen to treat cancer patients for soft tissue damage from radiation therapy
- 1937 – U.S. Navy officially used hyperbaric oxygen with air to treat decompression sickness (aka the bends)
- 1959 – U.S. Navy used hyperbaric chambers with oxygen to study treatment of decompression sickness for divers
- 1974 –School of Aerospace Medicine used hyperbaric chambers to study decompression sickness and then converted it to a clinical chamber.
- Mid 1970's to present – U.S. have been increasing hyperbaric chambers from 30 chamber to nearly 1,200 medicine program with multiple chambers.

HENSHAW & 'THE DOMICILIUM'



(Athens Hyperbaric Diving Medicine, n.d.)



(Athens Hyperbaric Diving Medicine, n.d.)

U.S. Navy Dive Tables

Table 9-7. No-Decompression Limits and Repetitive Group Designators for No-Decompression Air Dives.

Depth (feet)	No-Stop Limit	Repetitive Group Designation														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
10	Unlimited	57	101	158	245	406	*									
15	Unlimited	36	60	88	121	163	217	297	449	*						
20	Unlimited	26	43	61	82	106	133	165	205	256	330	401	*			
25	1102	20	33	47	62	76	97	117	140	166	198	236	285	354	469	992
30	371	17	27	38	50	62	76	91	107	125	145	167	193	233	280	307
35	232	14	22	32	42	50	63	74	87	100	115	131	148	168	190	215
40	163	12	20	27	36	44	53	63	73	84	95	108	121	135	151	163
45	125	11	17	24	31	39	46	55	63	72	82	92	102	114	125	
50	92	9	15	21	26	34	41	48	56	63	71	80	89	92		
55	74	8	14	19	25	31	37	43	50	56	63	71	74			
60	63	7	12	17	22	28	33	39	45	51	57	63				
70	48	6	10	14	19	23	28	32	37	42	47	48				
80	39	5	9	12	16	20	24	28	32	36	39					
90	33	4	7	11	14	17	21	24	28	31	33					
100	25	4	6	9	12	15	18	21	25							
110	20	3	6	8	11	14	16	19	20							
120	15	3	5	7	10	12	15									
130	12	2	4	6	9	11	12									
140	10	2	4	6	8	10										
150	8	3	5	7	8											
160	7	3	5	6	7											
170	6	4	6													
180	6	4	5	6												
190	5	3	5													

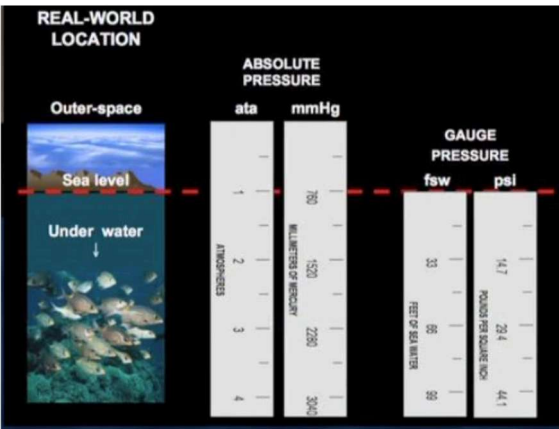
(U.S. Navy Diving Manual, 2016)

Table 9-8. Residual Nitrogen Time Table for Repetitive Air Dives.

Table 9-8. Residual Nitrogen Time Table for Repetitive Air Dives. (Detailed table content follows the same structure as Table 9-7 but with different values for residual nitrogen times.)

It's all about the pressure

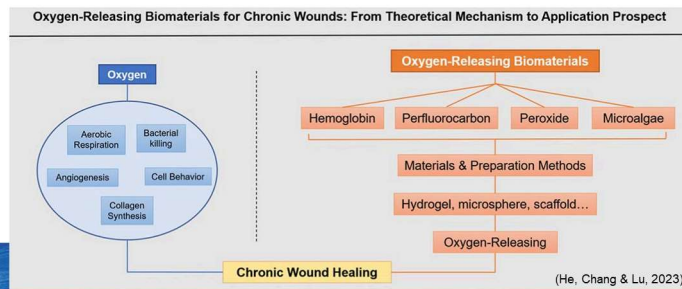
- Pressure changes
- Atmospheric pressure
- Gauge pressure
- Absolute pressure



(International ATMO, 2016)

## Mechanisms of action at the cellular and systemic level

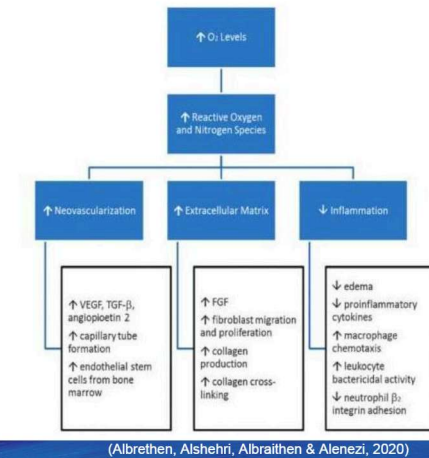
- 4 More pressure = more oxygen
- 4 Oxygen supercharges healing
- 4 Bubble trouble fixer



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## Benefits of HBOT in Wound Healing

- 4 Hyperoxygenation
- 4 Neovascularization
- 4 Vasoconstriction
- 4 Control infection



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## Approved Indications for HBOT

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>4 Preparation and preservation of compromised skin grafts</li> <li>4 Chronic osteomyelitis</li> <li>4 Delayed radiation injury and soft tissue radio necrosis</li> <li>4 Osteoradionecrosis</li> <li>4 Diabetic wounds of the lower extremities (must be classified as Wagner grade III or higher)</li> <li>4 Idiopathic sudden sensorineural hearing loss</li> </ul> | <p>Acute indications – typically treated at Hennepin County or Mayo</p> <ul style="list-style-type: none"> <li>4 Air or gas embolism</li> <li>4 Carbon monoxide poisoning</li> <li>4 Crush injury</li> <li>4 Acute thermal burn injury</li> <li>4 Intracranial abscess</li> <li>4 Severe anemia</li> <li>4 Decompression sickness</li> <li>4 Arterial insufficiency wounds</li> <li>4 Central retinal artery occlusion</li> </ul> |
|--|---|



(Undersea and Hyperbaric Medical Society, 2020; U.S. Food and Drug Administration, 2021)

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## Off-label Uses of HBOT

- 4 2 fatal fires in the United States in 2025
  - Michigan – Oxford Center
  - Arizona – Navasu Health and Hyperbarics
- 4 Prior to that, the last fatal fire was in 2009
  - Florida - Lauderdale By The Sea Hyperbaric Oxygen Treatment Center – treating cerebral palsy

Sport injuries and surgery recovery

Memory deficits

Autism

ADD/ ADHD

TBI/stroke

Long COVID symptoms

Cosmetic (beauty/wellness)

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## Contraindications

- 4 The following must be assessed further prior to diving:
- Heart and lung diagnosis (ex: severe aortic stenosis and spontaneous pneumothorax)
  - Brain and spine stimulators
  - Implanted devices
  - Certain chemotherapy agents
  - Retinal detachment
- 4 Most people can dive; there are very few absolute contraindications



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## Potential risks to treatment



Barotrauma – Middle ear, sinus, lung, GI, and tooth



Oxygen toxicity – increases risk for seizures



Hypoglycemia – increases risk for seizures

(Undersea and Hyperbaric Medical Society, 2020; U.S. Food and Drug Administration, 2021)

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## Fire risk

### WHAT MAKES FIRE IN HYPERBARIC CHAMBER SO DANGEROUS?



(Anona, 2025)

- 4 Things we do to mitigate the risk of a fire:
- Follow all chamber manufacturer guidelines for cleaning protocols and operational use
  - Strict protocols for what can and cannot go into the chamber
  - Grounding
  - No alcohol-based products allowed in the HBO suite
  - Yearly fire drills to ensure staff competency

(National Fire Protection Agency, 2021)

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## Patient Experience and Education



What to expect before, during and after treatments



Patients are in clinic for approximately 2 hours, daily (M-F) for 30-60 treatments



'Go and no-go list'



Vitals obtained and physician assessment prior to each treatment



Teach how to clear ears to reduce risk of barotrauma



Discuss concerns regarding claustrophobia

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## HBO in the perioperative and OR Setting

### • Diagnosis:

- Soft Tissue Radiation Necrosis
- Osteoradionecrosis
- Refractory osteomyelitis
- Diabetic foot wounds/amputation
- Compromised grafts and flaps
- Crush injury
- Compartment syndrome
- Acute thermal burn injury
- Necrotizing soft tissue infections
- Gas gangrene

### • Referral sources:

- Urology
- GI
- Oral surgery
- ENT
- Plastic surgery
- Orthopedics
- Podiatry
- Vascular



(Getty Images, n.d.)

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## Multidisciplinary Collaboration

- 4 Collaboration between surgeons, nurses and wound care specialists
- 4 Team approach to advocate for HBO therapy which includes an awareness of FDA approved indications
- 4 A referral for HBO should be placed, and the HBO team can review if patient is a candidate or not. You don't need to be the expert!
  - How to refer a patient in Epic: AMB CONSULT HYPERBARIC MEDICINE to SCH WOUND CARE or MONT WOUND CARE



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## Emerging Research and Innovations



- 4 Currently being studied for potential FDA approval in the future:
  - TBI/stroke
  - PTSD
  - Post-concussion Syndrome
  - Neurological disorders (Fibromyalgia)
  - Psychological disorders (Depression)

(Shutterstock, 2020)

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## Key Takeaways



- 4 FDA approved indications
- 4 How hyperbaric oxygen works within the body
- 4 Collaboration between the specialties both pre and post op to support optimal wound healing
- 4 What patients can expect from hyperbaric oxygen therapy
- 4 How to refer a patient for hyperbaric oxygen therapy

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## References

- 4 Albrethen, I., Alshehri, T., Albraithen, K., Alenezi, A. (2020). Update of Hyperbaric Oxygen Therapy in the Management of Chronic Wound. *Journal of Current Medical Research and Opinion* (3): 422–425. DOI: 10.15520/jcmro.v3i02.255
- 4 Anona, A. (2025). *Hyperbaric Chamber Fire: What you need to know about safety*. Retrieved from Hyperbaric Chamber Fire: What You Need to Know About Safety
- 4 Athens Hyperbaric Diving Medicine. (n.d.) *History of Hyperbaric Medicine*. Retrieved from <https://ykia.gr/en/history-of-hyperbaric-medicine/>
- 4 Desonie, D. (2025). *10.2 Composition of the Atmosphere*. Retrieved from <https://flexbooks.ck12.org/cbook/ck-12-middle-school-earth-science-flexbook-2.0/section/10.2/primary/lesson/composition-of-the-atmosphere-ms-es/>
- 4 He, Y., Chang, Q., Lu, F. (2023). *Oxygen-releasing biomaterials for chronic wounds breathing: From theoretical mechanism to application prospect*. Retrieved from <https://doi.org/10.1016/j.mtbio.2023.100687>
- 4 International ATMO. (2016). *Hyperbaric Medicine Team Training*. Retrieved from <https://learn.hyperbaricmedicine.com/>

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- 4 National Fire Protection Agency. (2021). *Fire Protection for Hyperbaric Oxygen Facilities in Hospitals*. Retrieved from NFPA 99, NFPA Journal, Fall 2021 | NFPA
- 4 Undersea and Hyperbaric Medical Society. (2020). *Hyperbaric oxygen therapy indications*. Retrieved from <https://www.uhms.org/resources/featured-resources/hbo-indications.html>
- 4 U.S. Food and Drug Administration. (2021). *Hyperbaric Oxygen Therapy: Get The Facts*. Retrieved from Hyperbaric Oxygen Therapy: Get the Facts | FDA
- 4 U.S. Navy Diving Manual. (2016). Retrieved from [https://www.divetable.info/workshop/USN\\_Rev7\\_Tables.pdf](https://www.divetable.info/workshop/USN_Rev7_Tables.pdf)

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